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SOUTHERN CROSS CARE
CARMELITE STAGE – 2

30% DESIGN DEVELOPMENT REPORT

ACOUSTIC SERVICES

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11 September 2025

Place Project Management
Faraway House
21 Franklin Street
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Attention: Mr L Coulls

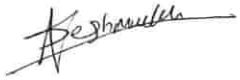
Dear Sir,

SOUTHERN CROSS CARE – CARMELITE STAGE 2
30% DESIGN DEVELOPMENT REPORT
ACOUSTIC SERVICES

As requested, we enclose a copy of the 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



AJAY DESHMUKH
SENIOR ACOUSTIC SERVICES ENGINEER

REPORT ISSUE REGISTER

REVISION	DATE	REVISION DESCRIPTION
00	10.11.2023	*Initial Issue*
01	11.09.2025	*30% Issue*

CONTENTS

Introduction

BESTEC Pty Ltd has been engaged to provide acoustic engineering services during the design and construction stages of the proposed Southern Cross Care Carmelite Stage 2 at the Carmelite Precinct, corner of Cross Road and Myrtle Bank, SA 5064. This document presents the proposed acoustic design criteria, the results of attended noise survey and acoustic design recommendations to achieve the selected design criteria where required.

Executive Summary

In summary:

- Attended acoustic survey was conducted at the proposed site to determine the existing ambient noise levels and dominant sources of noise on 15 September 2023.
- Appropriate acoustic design criteria for environmental noise and building acoustics have been nominated;
- The architectural concept design plans have been reviewed;
- Acoustic concept design recommendations to achieve the selected criteria have been provided where necessary, including:
    - Appropriate constructions of the building façade, external glazing, and roof in order to control traffic noise intrusion;
    - Appropriate constructions of the walls and floors separating the apartments were nominated to ensure compliance with the requirements of National Construction Code Series 2022, Building Code of Australia for sound insulation (Section F7);
    - An assessment of the operational noise emissions from the development, including carpark activities has been conducted, however the noise emissions deliveries and waste collection will be conducted in later design stages demonstrating that the environmental noise emissions comply with the selected relevant noise criterion
    - The mechanical services and specifications for airborne and structure borne noise will be reviewed in later design stages and recommendations for engineering noise and vibration controls will be provided to ensure the selected acoustic design criteria are achieved.

For explanation of acoustic terms within this document, please refer to the glossary of acoustic terminology attached to this document (Appendix B).

References

The following documents have been referenced during the preparation of this acoustic report:

[1] SA Planning and Design Code.

[2] SA Environment Protection (Commercial and Industrial Noise) Policy 2023.

[3] World Health Organisation (1999) “Guidelines for Community Noise”.

[4] Australian/New Zealand Standard 2107:2016 “Acoustics – Recommended design sound levels and reverberation times for building interiors”.

[5] National Construction Code Series 2022, Building Code of Australia, Class 2 to Class 9 Buildings.

[6] Walter Brooke concept plans dated October 2023.

[7] AS ISO 140.4–2006 “Acoustics – Measurement of sound insulation in buildings and of building elements. Part 4: Field measurements of airborne sound insulation between rooms”.

[8] Environmental criteria for road traffic noise, NSW Environment Protection Agency, May 1999.

[9] Ministerial Building Standard MBS 010 “Construction requirements for the control of external sound”, May 2023.

Proposed Development

The proposed development is apartment building located on land zoned “Urban Renewal Neighbourhood” (URN) in SA Planning and Design Code [1] with following boundaries.

- West – Spence Ave separating proposed development from residential development in same “Urban Renewal Neighbourhood” (URN) zone.
- North, South – existing Carmelite Convent.
- East – Glen Osmond Road separating proposed site from developments in “Suburban Activity Centre” (SAC) zone.

Figure 1 illustrates the location of the development, with respect to the SA Planning and Design Code [1].

Figure 1 Location of proposed development with respect to SA Planning and Design Code [1]

Proposed Development

It is proposed for the new residential apartment buildings on the site with the following components:

- Building 1 (2 floors):
  - Basement/Undercroft – carparks, mechanical plant, fire pump, comms, waste rooms, lobby 1,2, store, hydraulic plant;
  - Ground floor: Residential apartments
  - Level 1 – 2: Residential apartments.
  - Roof;
- Building 2 (5 floors):
  - Basement/Undercroft – carparks, mechanical plant, fire pump, comms, waste rooms, lobby 1,2, store, hydraulic plant;
  - Ground floor: Carpark, lobby, lift;
  - Level 1 – 4: Residential apartments;
  - Level 5 : Residential apartment/Penthouse
  - Roof;

The proposed development will comprise basement/undercroft carpark (94 parking spaces).

Conditions

SA Planning and Design Code [1] sets the desired outcome for proposed developments, which affect adjacent sensitive receivers 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 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.*
>
> *P0 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 2.1 Non-residential development does not unreasonably impact on the amenity of sensitive receivers (or lawfully approved sensitive receivers), or an adjacent zone primarily for sensitive receivers through its hours of operation having regard to:*
>
> *a) The nature of the development*
>
> *b) Measures to mitigate off-site impacts*
>
> *c) The extent to which the development is desired in the zone*
>
> *d) Measures that might be taken in an adjacent zone primarily for sensitive receivers that mitigate adverse impacts without unreasonably compromising the intended use of that land.*

A non-residential development is deemed to satisfy the above requirement if the noise emissions that affect the noise sensitive receivers achieves the relevant Environment Protection (Commercial and Industrial Noise) Policy criteria (DTS/DPF 4.1).

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

A non-residential development is deemed to satisfy the above requirement if its operating hours are within 7am to 9pm (Mon to Fri) and 8am to 5pm (Sat and Sun) (DTS/DPF 2.1)

> *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.

The SA Planning and Design Code 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:

(a) placing buildings containing non-sensitive receivers (such as retail and commercial) between the emission source and sensitive receivers

(b) 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

(c) providing appropriate separation or erecting noise attenuation barriers, provided the requirements for safety, urban design and access can be met

(d) the use of building design elements such as podiums and jutting, deep or enclosed balconies (including with solid balustrades).

Attended Noise Survey

Attended noise survey was conducted on the proposed development site (Glen Osmond Road and Cross road) at location L1, L2 and L3 (refer to Figure 1) between 16:30 – 17:00 (typical busy/rush hours), on 15 September 2023, in order to determine the maximum traffic noise levels over 15-minute intervals. The measurements were conducted using a Brüel & Kjær Hand-held Analyser Type 2270 Sound Level Meter (Serial Number: 3006966, last calibrated on the 16 November 2022, due for calibration 16 November 2023), with an approved windshield fitted at all times. The calibration of the analyser was spot checked before and after the measurements and no drift was detected

Figure 2: Attended noise survey measurement locations

Location	Time	L_{Aeq}, dB(A)	L_{Amax}, dB(A)	L_{A10}, dB(A)	L_{A90}, dB(A)
L1	16:15	72	94	75	57
L2	16:30	73	94	76	62
L3	16:45	71	94	74	61

Table 1: Summary of the measured noise levels 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, operational noise from the commercial component, car park etc.

The Environment Protection (Commercial and Industrial Noise) Policy 2023 (EPP 2023) 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. Based on the site location and the land zoning stipulated in the SA Planning and Design Code [1], the proposed development is located within the zone designated “Urban Renewal Neighbourhood” (URN) and with the nearest noise sensitive receivers located within the same zone. In regards to noise generating activities, the SA Planning and Design Code refers to the criteria set by the Environment Protection (Commercial and Industrial Noise) Policy 2023 [2]. The indicative noise factors applicable to a residential zone based on the time of day as stipulated in Table 2 of the EPP 2023 are summarised below.

- Day-time (7:00 a.m. to 10:00 p.m.): 52dBA
- Night-time (10:00 p.m. to 7:00 a.m.): 45dBA

We note that for planning purposes, the predicted noise level (continuous) for a new development should not exceed the relevant indicative noise level, minus 5 dB(A). Therefore, the indicative noise levels for assessment of the noise impact from the proposed development to the adjacent areas are as follows:

- Day-time (7:00 a.m. to 10:00 p.m.): 47dBA
- Night-time (10:00 p.m. to 7:00 a.m.): 40dBA

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.

Intermittent Noise

This criterion will be relevant to noise emitted from the proposed development resulting from short term noise events – car door slams, etc.

The criteria provided in the above sections relate to continuous noise sources, and do not cater for intermittent noise events, such as slamming of car doors, car horns sounding, etc. We recommend the use of the World Health Organisation (WHO) Guidelines [3], which recommends a maximum A-weighted noise level L_{Amax} of 45 dB(A) in a bedroom, which is equivalent to approximately 55 dB(A) to 60 dB(A) at the façade of the residential building with windows partially open.

In addition, the EPP 2023 provides assessment criterion of L_{Amax} of 60 dB(A) for night-time for the proposed development (for application for development authorisation), which agrees with the criterion stipulated by the WHO [3].

Building Acoustics

The level of background and transient/ intermittent noise, the speech privacy rating and the intelligibility of speech define the quality of the acoustics within a building. The recommended criteria for each space[1] are shown in Table *2*. Refer to each individual section below for an interpretation of these criteria.

Type of occupancy/activity	Background Noise dBA	Reverberation Time Secs	Weighted Sound Reduction Index R_W	Weighted Sound Reduction Index R_{W+Ctr}	Speech Privacy D_W
Retirement Living Apartments			50[2]	50[3]	
Sleeping areas	30 – 40				
Living and Work Areas	35 – 45				
Carpark	<65	-			N/A
Corridor/Lobby	< 50	Minimise as practical			N/A
Plantrooms	-				45 – 50[4]
Comms	45 – 50	-			35 – 40

Table 2: Recommended Acoustic Design Criteria

Sound Insulation

For enclosed spaces, the noise from activities in the adjacent rooms transmitted through walls, floors, ceilings etc. increases the background noise level similarly to the noise intrusion from any outside sources. The level of noise transmitted from the adjacent rooms and the level of sound insulation/speech privacy is controlled by the design of building elements and providing adequate level

[1] The internal elevations are not available at the moment therefore the concept acoustic recommendations will be revised/updated later in the design stages. .
[2] Between apartments and a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification.
[3] Between Apartments.
4 Detailed recommendations will be provided once the specifications/selections of plant equipment are available.

of sound attenuation through specifying appropriate construction types for walls, floors, doors, ceilings etc.

Retirement living apartments

The minimum requirements for sound insulation for the residential component (Buildings Class 3) are set by the National Construction Code Series 2022, Building Code of Australia [5] stipulates the required weighted sound reduction index (R_w), weighted sound reduction index with spectrum adaptation term ($R_w + C_{tr}$) and weighted normalised impact sound pressure level ($L_{n,w}$) for building elements separating sole-occupancy units. We note that the proposed residential apartments would be classified as Class 2 or 3 buildings, and therefore note the following criteria are applicable to the proposed development:

> *"A floor in a Class 2 or 3 building must have R_W+C_{tr} (airborne) not less than 50 and an $L_{n,w}$ not more than 62 (impact) if it separates –*
>
> *(i) Sole occupancy units; or*
>
> *(ii) A sole occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of different classification"*
>
> *"A wall in Class 2 or 3 building must –*
>
> *(i) Have an $R_W + C_{tr}$ (airborne) not less than 50, if it separates sole-occupancy units; and*
>
> *(ii) Have an R_W (airborne) not less than 50, if it separates a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification; and*
>
> *(iii) Is of discontinuous construction if it separates –*
>
> *(A) A bathroom, sanitary compartment, laundry or kitchen in one sole-occupancy unit from a habitable room (other than kitchen) in an adjoining unit; or*
>
> *(B) A sole-occupancy unit from a plant room or lift shaft."*
>
> *"A door may be incorporated in a wall of Class 2 or 3 building that separates a sole-occupancy unit from a stairway, public corridor, public lobby or the like, provided the door assembly has an R_W not less than 30."*
>
> *"Where a wall required to have sound insulation rating has a floor above, the wall must continue to-*
>
> *(i) The underside of the floor above; or*
>
> *(ii) A ceiling that provides the sound insulation required for the wall."*
>
> *"If a duct, soil, waste or water supply pipe, including a duct or pipe that is located in a wall or floor cavity, serves or passes through more than one sole-occupancy unit, the duct or pipe must be separated from the rooms of any sole-occupancy unit by construction with an $R_W + C_{tr}$ (airborne) not less than –*
>
> *(i) 40 if the adjacent room is a habitable room (other than a kitchen); or*
>
> *(ii) 25 if the adjacent room is a kitchen or non-habitable room."*

Administration/Communal Component

There are no Australian or International Standards giving recommendations for sound insulation ratings for adjoining spaces in commercial tenancies or administration offices. Instead, recommendations are based on experience from previous projects, with these recommendations reflecting budget constraints and user expectations. The privacy rating is dependent on the sound absorption and background noise level in the adjoining space as well as the area and acoustic performance of the dividing partition.

The proposed criteria for speech privacy between the spaces separated by partitions (extending either to the ceiling level or to the roof structure above) are presented in terms of Weighted Sound Level Difference (D_W) as defined by AS ISO 140.4–2006 [7], which is related to the sound level difference between two spaces and are detailed in [7]. The criteria are based on our experience in the acoustic design of similar facilities. Table 3 details the subjective response of individuals to the proposed privacy ratings for interpretation of the recommendations.

D_W Rating	Subjective Rating
50	Confidential privacy
45	Very good privacy. Speech inaudible unless raised
40	Good privacy. Speech audible but unintelligible
35	Normal privacy. Neighbouring conversations are audible and may be understood
< 35	Privacy not required

Table 3*:* Subjective perceptions for various privacy ratings

Room Acoustics

AS 2107-2016 [4] 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 4 outlining the subjective impression for spaces with varying volume. Criteria considered appropriate for the various spaces are listed in Table *2*.

Reverberation Time (sec)			Subjective Rating
Small ($100m^3$)	Medium ($1,000\ m^3$)	Large ($10,000m^3$)	
< 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 4 Subjective response to various reverberation times and room volumes

Background Noise

AS 2107-2016 [4] sets out the design criteria for steady state noise such as from air-conditioning systems and road traffic depending on the type/use of the different rooms. Recommendations for each space are provided in [4] in terms of averaged A-weighted sound pressure level (L_{Aeq}). Table 5 details 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 5: Subjective ratings for various average sound pressure levels.

In addition, Ministerial Building Standard MBS 010 [9] stipulates that the traffic noise attenuation provided by the building envelope must be sufficient to ensure that the internal sound levels do not exceed the internal sound criteria values stated in “Table 3.1” of the MBS 010 as given in Table 6 below.

Type of room	Sound Source	Internal sound criteria	
		Building design target averaged over the total number 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 6: Ministerial Building Standard MBS 010 criteria for noise intrusion (Table 3.1 of MBS 010 reproduced)

The MBS 010 also specifies the traffic and aircraft noise levels used in the assessment (Table A1.2: Sound source levels for Road and rail) in accordance with the road type, determined by relevant development plan (SA Planning and Design Code). This requires that the road source be a Type A, B or R road as indicated by SA planning and Design Code [1], Glen Osmond Road is classified as Type A road with speed limit of 60km/h and also proposed development falls under Noise and Air Emission Overlay therefore, the assessment against the Ministerial Building Standard requirements will be warranted.

Assessment and Recommendations

General Recommendations

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 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

Unless otherwise specified, where a cavity infill is required, equivalent alternatives are:

- Fibreglass – 100mm, 12kg/m^3.
- Rockwool – 100mm, 38kg/m^3.
- Polyester – 900gsm.

Ceiling Overlay

Unless otherwise specified, where a ceiling overlay is required, equivalent alternatives are:

- Glasswool – 100mm, 12kg/m3.
- Rockwool – 100mm, 38kg/m^3.
- Polyester – 100mm, 32kg/m^3.

Where higher durability and/or water resistance is required, 6mm compressed fibre cement sheeting could be used in lieu of the 13mm fire-rated plasterboard and 9mm compressed fibre cement in-lieu of 16mm fire-rated plasterboard.

Noise Intrusion

The recommendations on the building construction elements such as glazing, solid façade and roof structure is based on the traffic noise levels measured on the site of the proposed development and the specified traffic assessment sound levels as per the Ministerial Building Standard, MBS 010 [9]. Based on the results of our assessment, we make following preliminary recommendations for the construction of the building envelope[5]:

Façade

We recommend following construction:

- Minimum 110mm masonry brick with 1 layer of 13mm plasterboard to the internal side of 76mm steel studs (or as required structurally) with cavity infill of 50mm, 12kg/m^3 glasswool, or;
- 150mm precast concrete with 1 layer of 13mm plasterboard to the internal side of 76mm steel studs with cavity infill of 50mm, 12kg/m^3, glasswool insulation, or;

[5] Please note that these preliminary recommendations are based on traffic noise only and will be revised/changed once details about the engineering services plant and the detailed drawings/floor plans are available.

- Composite light weight façade constructed of 9mm compressed fibre cement panel with 1 layer of 13mm plasterboard on internal side of 92mm steel studs with cavity infill of 75mm, 14kg/m^3, glasswool insulation.

We consider above construction of façade adequate for traffic noise intrusion control, however, the above recommendations will be reviewed once the mechanical services plant is selected.

Glazing

Bedrooms:

- Building A1 – Double glazing (southern, eastern, western, and northern façade) constructed of minimum 6.38mm laminated glass – 12mm air space – 6mm toughened glass.
- Building A2 – Double glazing (southern, eastern, and northern façade) constructed of minimum 10.38mm laminated glass – 12mm air space – 6mm toughened glass, furthermore western side can be 6.38mm laminated glass – 12mm air space – 6mm toughened glass.

Living Rooms:

- Building A1 – Minimum 10.38mm laminated glass, if double glazing is required, we recommend 6.38mm laminated glass – 12mm air space – 4mm toughened glass;
- Building A2 – Minimum 6.38mm laminated glass – 12mm air space – 6mm toughened glass;

Where the glazing is operable, we recommend acoustic seals (Shlegel or Raven range) be used.

Note – the glazing recommendations are based on traffic noise intrusion only, the recommendations will be revised once the internal elevation and details of mechanical services plant are available.

Roof/ceiling

Conventional metal roof cladding (0.48mm BMT) over 100mm thick roof insulation blanket with minimum density of 15kg/m^3 (e.g., Anticon HP100 or equivalent) with ceiling of 1 layer of 13mm plasterboard in the suspension grid, and the ceiling overlay as specified in section General Recommendations, and we consider it sufficient from acoustic point of view.

The above preliminary recommendations will be revised subject to assessment of the mechanical services plant.

Sound Insulation

Retirement Living Apartment

To achieve NCC 2022 requirements, we recommend:

- *Partitions*
  - Walls between sole-occupancy units/apartments (CSR 1385) – 1 layer of 16mm fire rated plasterboard to the external sides of two rows 64mm separates steel studs offset from each other by 20mm air space extending to the structure with cavity infill of 2 batts of 75mm, 14kg/m^3 Acoustigard glasswool (NCC R_{w+Ctr} *50*)
  - Walls between sole-occupancy units/apartments and stairwells – 200mm thick precast concrete wall (assuming building core) with 1 layer of 13mm plasterboard on 28mm furring channel to the internal side with cavity infill of 25mm, 12kg/m^3 glasswool (*NCC Rw 50*).
  - Walls between sole occupancy units and lift core – 1 layer of 13mm plasterboard on internal side of 76mm steel studs offset by 20mm from the building core (200mm thick precast concrete) with cavity infill of 50mm, 12kg/m^3, glasswool insulation (*NCC Rw 50 + discontinuous*).
  - Walls separating sole-occupancy units/apartments from corridor/lobbies (CSR 1133) – 1 layer of 16mm fire rated plasterboard to each side of 92mm RONDO Quiet Steel studs with cavity infill of 90mm, 14kg/m^3 glasswool (*NCC Rw 50*).
- *Floors* – Assuming a 200mm thick concrete slab and ceiling of 1 layer of 13mm plasterboard offset from the concrete by 300mm cavity with ceiling overlay as per section General would be sufficient to achieve airborne sound insulation requirements as per NCC 2022 guidelines (NCC R_{w+Ctr} *50)*. Where hard floor finishes (tiles or timber) are used above habitable areas (living rooms and bedrooms), resilient underlay (Acoustifloor, Regupol, Damtec etc.) will be required to comply with the NCC 2022 requirements for impact noise (*Lnw not more than 62 Impact*).

- *Doors*
  - *Apartments' entry doors* – minimum 45mm thick solid core doors with compressible seals (e.g., Raven or Schlegel ranges) to achieve Weighted Sound Reduction Index of *Rw 30*.
  - *Stairwell doors* – minimum 45 mm thick solid core doors or as 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.

Room Acoustics

Recommendations for acoustic treatment of the critical spaces in order to achieve the nominated room acoustics criteria will be provided once architectural floor plans, finishes schedule and internal elevations are available.

Engineering Services Acoustics

The engineering services design is currently being developed and detailed recommendations will be provided when it is sufficiently developed, however, we note that the airborne noise emissions from all plant and equipment will be assessed against the nominated environmental and internal noise criteria and engineering noise controls will be designed to ensure compliance. In order to limit vibration emissions and structure borne noise, vibration isolators will be designed for all plant units.

Hydraulic Services

The following stipulates the recommended design, in order to reach NCC 2022 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/apartment, we recommend the following constructions:

<u>PVC pipes:</u>

- Where the adjacent room is a habitable room (i.e., bedroom, open plan living room, etc.), the pipes should be lagged with Soundlag 4525C or equivalent and enclosed with 1 layer of 13mm fire rated plasterboard with cavity infill of 75mm, 12kg/m^3 glasswool (See Appendix A Detail 1 attached).
- Where a waste water pipe is running within the ceiling space of a habitable room or the waste water 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 75mm, 12kg/m^3 glasswool extending minimum 1,200mm each side of the pipe. Please note that down lights should be avoided in these areas (See Appendix A Detail 2).

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.

- Where the room is a non-habitable room (See Appendix A Detail 3)
  - 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.

<u>Acoustically rated pipes (Geberit, Raupiano, Silere etc.)</u>

If the drainage system is constructed using acoustically rated pipes, the following wall constructions will be sufficient to achieve NCC 2022 requirements:

- Where the adjacent room is a habitable room, construction of 1 layer of 13mm plasterboard with cavity infill of 75mm, 12kg/m^3 glasswool. Where a waste water pipe is running within the ceiling space of a habitable room or the waste water pipe is running within the ceiling space next to a habitable room ceiling overlay of 75mm, 12kg/m^3 glasswool extending minimum 1,200mm each side of the pipe will be required.
- Where the adjacent room is non-habitable – 1 layer of 13mm plasterboard.

General

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 areas of the building including sole-occupancies, staff/admin area, corridor spaces, riser ducts and all other associated areas.

Flexible couplings 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.

Environmental Noise

Noise Associated with Car Park

We have investigated the potential environmental noise impact on the surrounding noise sensitive receivers due to the car park operation. We used a time-weighted average approach to estimate maximum noise level (L_{Amax}), considering the following:

- Vehicle movement through car parking spaces
- Vehicle Ignition
- Vehicle door slamming
- Vehicle idle and take off from car parking and drop off zones

Undercroft Carpark

A time weighted averaged approach was implemented, based on the above breakdown of noise generating activities. To calculate the noise levels from the carpark operation over a typical 15-minute period, we assumed 20 vehicles entering and/or exiting the carpark during this period. Therefore, the noise level (L_{Amax}) used in this assessment was 71dBA at 5m.

Our assessment reveals that the predicted noise levels at the boundary of the nearest noise sensitive receivers (on northern side) will achieve the sleep disturbance criterion (refer section Intermittent Noise).

Carpark on Northen side

A time weighted averaged approach was implemented, based on the above breakdown of noise generating activities. To calculate the noise levels from the carpark operation over a typical 15-minute period, we assumed 5 vehicles entering and/or exiting the carpark during this period. Therefore, the noise level (L_{Amax}) used in this assessment was 70dBA at 1m.

Our assessment reveals that the noise levels at the boundary of the nearest noise sensitive receivers will achieve the will achieve the sleep disturbance criterion (refer section Intermittent Noise), taking into account the attenuation provided from minimum 1,800mm Good Neighbours fence[6] on northern side separating proposed car park/driveway and residential receivers.

Noise Associated with Mechanical Plant

Details of the engineering plant that will be serving the development are not available yet; however, we note that the airborne noise associated with engineering services will be controlled by design of appropriate attenuators, duct lagging and acoustic enclosures. The vibration and structure borne noise will be controlled by design of appropriate vibration isolators (double deflection mounts, spring isolators etc.).

[6] Minimum 1,800mm high fence (measured from ground level) separating proposed carpark from the residential development on northern side will be required. The fence/acoustic barrier be constructed of a material with minimum surface mass of 5kg/m^2 (e.g., colorbond or similar). The fence should be continuous with no gaps and openings, and all the interfaces must be blocked off to prevent sound flanking.

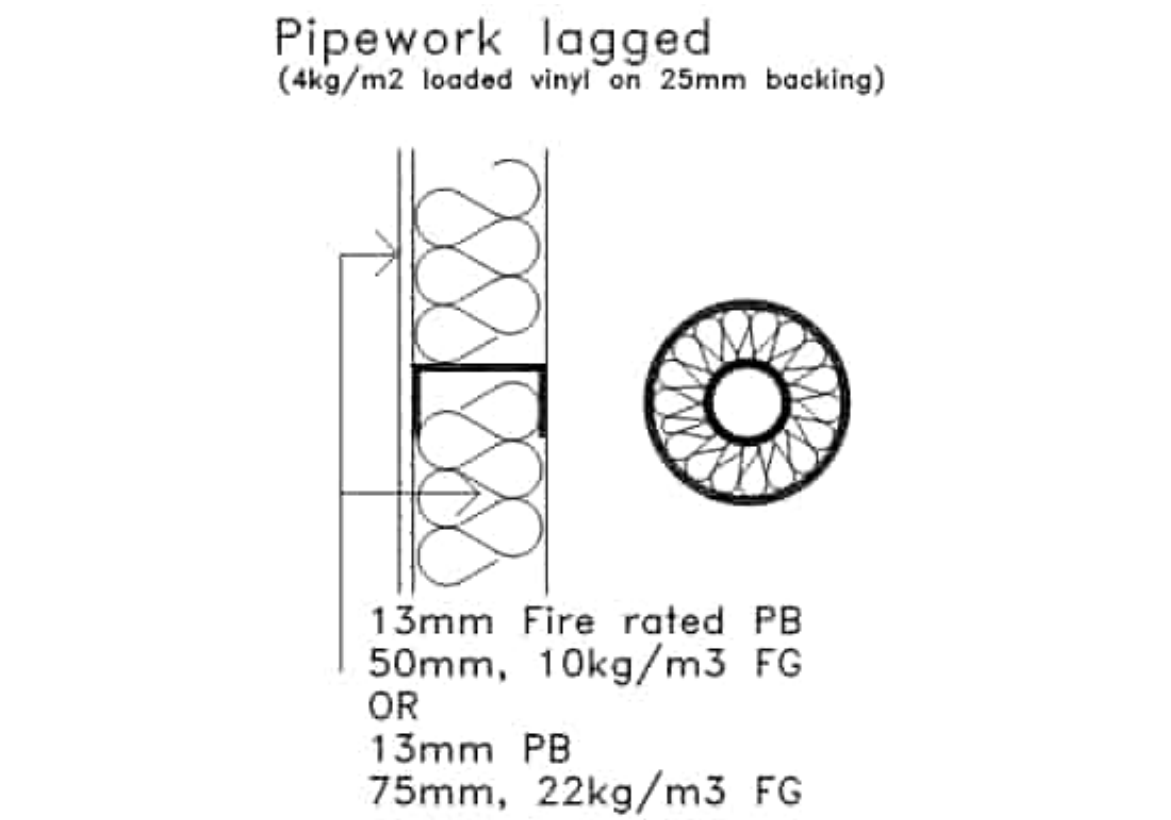
Noise Associated with Waste Collection

The Local Nuisance and Litter Control Act 2016 addresses the noise generated from waste collection activities by way of limiting the house 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:

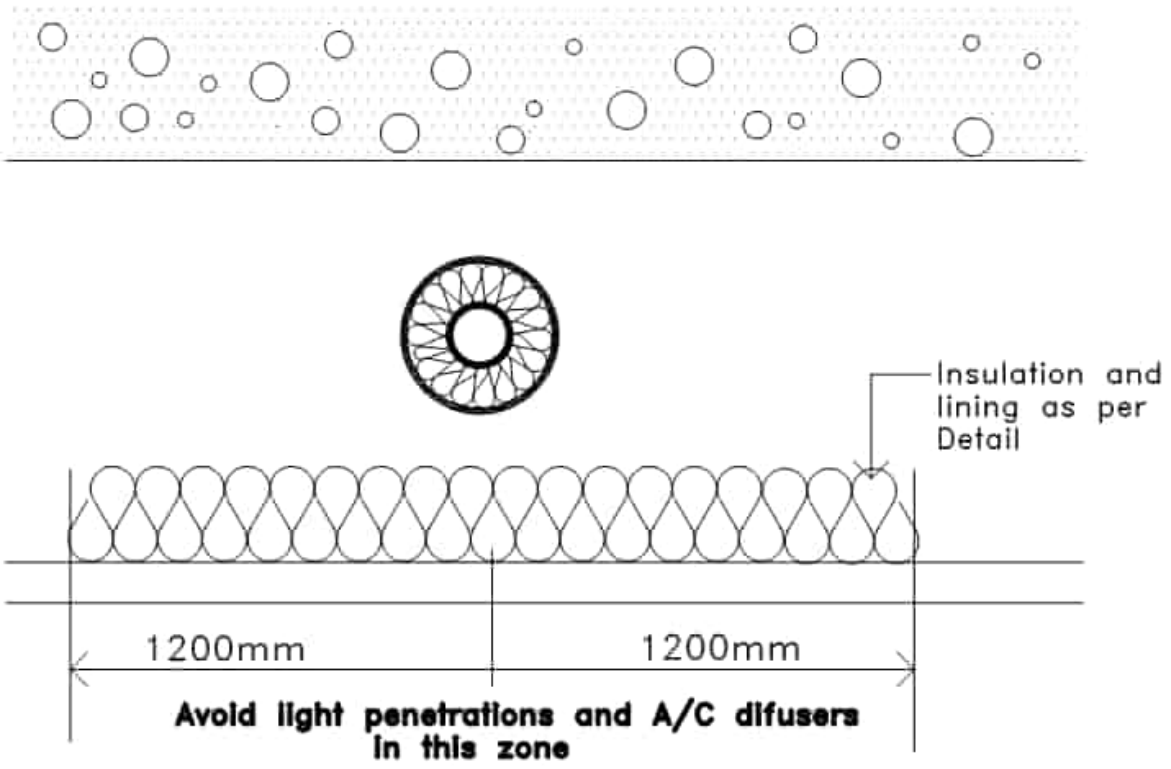
- Between 7am and 7pm on Monday to Saturday; and,
- Between 9am and 7pm on any Sunday or public holiday.

Appendix A

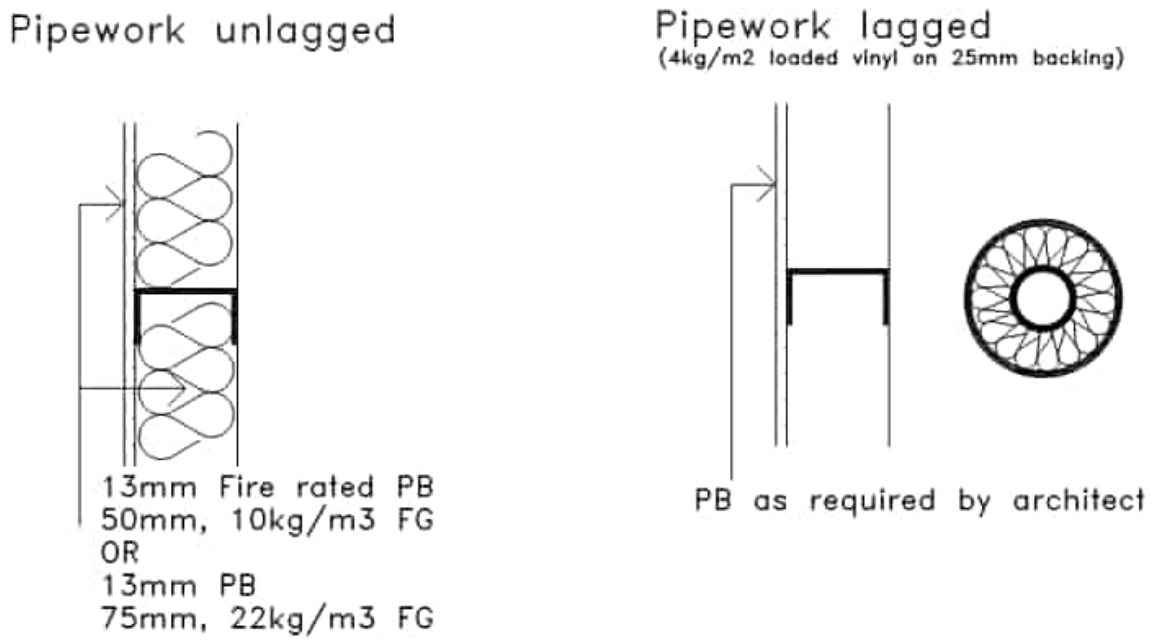
Hydraulic services details to achieve NCC compliance



Detail 1: Construction to achieve R_w+C_{tr} 40, for pipes running adjoining habitable spaces (Bedroom, Living)



Detail 2: Construction for pipes running through ceiling of habitable spaces



Detail 3: Construction to achieve R_w+C_{tr} 25 for pipes adjoining non-habitable spaces (e.g., Bathroom, Laundry)

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.

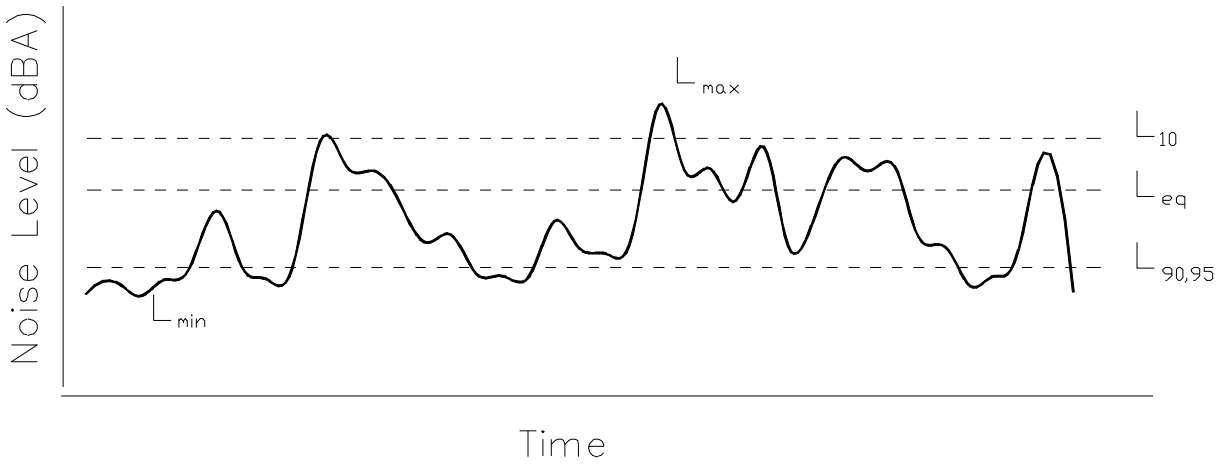
L_1 The noise level which is equaled or exceeded for 1% of the measurement period. L_1 is an indicator of the impulse noise level, and is used in Australia as the descriptor for intrusive noise (usually in dBA).

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

L_{90}, L_{95} The noise level which is equaled or exceeded for 90% of the measurement period. L_{90} 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 summarized 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/Rw 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	Lnw	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.