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Royal Hobart Hospital
Department of Health and Human Services - Tasmania
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Acoustic Design Report

Royal Hobart Hospital

Acoustic Design Report

Royal Hobart Hospital

Client: Department of Health and Human Services - Tasmania

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1.0 INTRODUCTION

AECOM have been engaged to provide acoustics consulting services for Stage 1 of the Royal Hobart Hospital (RHH) Redevelopment. Stage 1 of the project includes Building K, and the refurbishment and decanting of Buildings A, C, D and H. The following areas are included in Stage 1 of the project:

- General ward areas
- Office and administration areas
- Psychiatric intensive care unit
- Operating theatre facility and recovery areas
- Clean sterile supply department (CSSD)
- Orthopaedics ward
- Paediatrics' ward
- Birthing and delivery ward
- Neonatal paediatric intensive care unit
- Endoscopy
- Cardiology
- Ambulatory Care Centre
- Neurophysiology
- Day of Surgery Admission (DOSA)

This report outlines the acoustic treatments and design that have been incorporated into Stage 1 at the Design Development phase of the project.

The items outlined in this report include the following:

- Nominated acoustic criteria and specifications for the project for the following items:
  - Sound insulation between spaces
  - Acoustic reverberation
  - Internal noise levels in the spaces
  - Environmental noise emission
- Acoustic design advice for the following items:
  - Building facade
  - Partitions
  - Doors
  - Ceilings
  - Surface finishes
  - Services design, including mechanical, electrical, hydraulic and medical services
  - Medical services panels
- Acoustic nomenclature used throughout this report.

2.0 NOMENCLATURE

'A' Weighted	Frequency filter designed to adjust the absolute sound pressure levels to correspond to the subjective response of the human ear at low noise levels.
dB(A)	'A' Weighted overall Sound Pressure Level measured in decibels.
L_{eq}	Equivalent Continuous Sound Pressure Level. It is the value of the Sound Pressure Level of a continuous steady sound that has the same acoustic energy as a given time-varying Sound Pressure Level when determined over the same measurement time interval. Often referred to as average Sound Pressure Level.
L_{max}	The maximum Sound Pressure Level that occurs during a given measurement period.
RT	Reverberation Time (RT) of a closed space (i.e. room), for a sound of a given frequency or frequency band. The time that would be required for the decaying sound pressure level in the room to decrease by 60 decibels.
R_W	Weighted Sound Reduction Index. Laboratory test measurement procedure that provides a single number indication of the acoustic performance of a partition or single building element. Calculation procedures for R_W are defined in AS/NZS 1276.1:1999. The higher the R_W, the greater the noise isolation between enclosed spaces.
NRC	Noise Reduction Coefficient is a measure of sound absorbed by a material. The single number represents an average of the sound absorption coefficients at 250, 500, 1000 & 2000 Hz. Values approaching 1.0 have the highest levels of absorption.

3.0 DESIGN STANDARDS, GUIDELINES AND POLICIES

The design criteria and specifications for RHH Stage 1 have been based on the following standards, guidelines and policies:

- Australian Standard AS2107:2000, Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors
- Australasian Health Facility Guidelines
- Tasmanian Environment Protection Policy (Noise) 2009

Using the prescribed methods outlined in the standards and guidelines listed above, design criteria have been established for each of the following acoustic parameters:

- Sound insulation,
- Internal noise levels,
- Reverberation Time, and
- Environmental noise emission.

Table 1 below presents the documents that are relevant to each acoustic parameter that has been considered for the project.

Table 1 - Design Standards, Guidelines and Policies for Acoustic Criteria

Acoustic Parameter	Design Standard
Internal Noise Levels	• Australian Standard AS2107:2000
Sound Insulation	• Australasian Health Facility Guidelines
Reverberation Time	• Australian Standard AS2107:2000
Environmental Noise	• Tasmanian Environment Protection Policy (Noise) 2009

The policy relating to environmental noise emission is statutory; therefore achieving the environment noise criteria should be considered a mandatory design requirement for the project.

The requirements for internal noise levels and reverberation time are based on an Australian Standard. They are not a statutory requirement; they represent the recommended design criteria. To achieve compliance with these requirements typically results in a building that performs well acoustically, and generally it is unlikely to cause complaints from occupants in relation to internal noise and acoustic reverberation.

The sound insulation criteria are generally based on the client's requirements for each area in the building, and are not a mandatory requirement with respect to building codes or policies.

It should be noted that the Australasian Health Facility Guidelines that have been referenced have only be used to provide guidance for the types of rooms within a hospital that should maintain a level of sound insulation. The guidelines do not provide specific sound insulation values for each room type. For example, the guidelines state that sound insulation should be provided to a consulting room; however a specific sound insulation rating is not presented. The nominated sound insulation ratings have been based on our experience with healthcare facilities and the client's requirements for acoustic privacy.

4.0 GENERAL DESIGN PRINCIPLES

The acoustic design of Stage 1 of the redevelopment has been undertaken with consideration to key principles. The key design principles are outlined in the following sections, and relate to the functionality of hospital environments, and best practices to enable the progression of the Royal Hobart Hospital redevelopment masterplan.

4.1 Acoustic Material Selection

In designing the building to achieve the acoustic criteria, there are certain acoustic treatments and noise control measures that need to be considered with respect to their implementation in a health care environment.

The design of Royal Hobart Hospital has been developed by considering the acoustic performance of acceptable materials and the practicality of their use, rather than simply nominating materials with suitable acoustic performance that are unsuitable for use in a health care environment.

The main aspects of the acoustic design that need to be considered are the acoustic insulation used for mechanical plant and services, and the types of surface finishes used in rooms where acoustic absorption needs to be provided. In many cases, the functionality and practical requirements of a room will take precedence over the acoustic requirements of the room, and as a result, the amount of acoustically absorptive surfaces available is limited.

It is important to specify acoustically absorptive materials that comprise a surface finish that is suitable with respect to hygienic requirements, infection control, and has the ability to be cleaned if required.

For instance, the internal finishes in operating theatres may result in a reverberant environment, as it is not uncommon for operating theatres to comprise only acoustically reflective surfaces, as cleanability and contamination is of high concern in these spaces. Also, operating theatres are not likely to be subjected to high noise levels, thus the build-up of reverberant noise is not likely to be a concern.

4.2 Refurbishment Areas

In the decanting / refurbishment areas, consideration had been given to retaining existing partition constructions where possible. Refurbished facilities are temporary, and many of the refurbished areas will be used for similar purposes to their previous or current use. Therefore, some areas may be deemed acoustically suitable while falling slightly short of the acoustic criteria that have been nominated for those areas.

This approach has been taken to enable savings on project cost, materials, resources, and construction time where possible.

4.3 Mechanical Services Noise Control

The use of acoustic insulation in mechanical services systems and associated ductwork has been identified as an area that may adversely impact on the internal requirements of the hospital due to the potential shedding of the insulation fibres entering the ventilation system of the hospital.

As a result, the design of the mechanical services of Stage 1 has been undertaken with consideration to the following guidelines, which have been based on the Victorian DHS Design Guidelines for HVAC.

- All ductwork of air conditioning systems and ventilation systems which supply or recirculate air should have no internal lining.
- Attenuators with an impervious lining between the facing and the acoustic lining should be used for noise control in place of internal duct lining.

- Acoustic lining of equipment such as fan coil units, air conditioners and VAV boxes incorporating fibrous insulating materials should not have fibres exposed to the airstream, and be minimised where possible by the use of attenuators with an impervious lining.
- All perforated acoustic insulation facings should have impervious linings.

The mechanical services design of RHH Stage 1 has been undertaken with consideration to acoustics. The acoustic requirements for the mechanical services design have been incorporated into AECOM Mechanical Services Specifications.

5.0 ACOUSTIC DESIGN CRITERIA

The following sections present the design criteria for RHH Stage 1. The design criteria have been developed to enable a suitable acoustic environment within the spaces in the hospital, as well as nearby areas not associated with the hospital.

5.1 Internal Noise Level Criteria

To ensure that the acoustic amenity of the hospital will be satisfied, the noise levels in the internal areas of the building will be moderated to appropriate levels and achieve the internal noise level criteria that have been established for RHH Stage 1.

The internal noise levels are typically dominated by noise from external sources such as traffic noise, and mechanical services noise such as air conditioning. Sporadic noise sources such as helicopter noise and emergency vehicle sirens will also affect the internal areas of a hospital.

To control the internal noise levels for RHH Stage 1, the following noise sources have been considered:

- Traffic noise (See Section 6.0 for information on traffic noise measurements and Section 0 for details of the façade design to control traffic noise intrusion)
- Helicopter noise from the rooftop Helipad (See Section 6.0 for information on the helipad operation assumptions, and Section 7.0 for details of the façade design to control helicopter noise intrusion)
- Building services noise, such as from mechanical, hydraulic and electrical services (See Section 0)

The following sections outline the nominated internal noise criteria for RHH Stage 1.

5.1.1 Continuous Noise Sources

The internal noise criteria for RHH Stage 1 for continuous noise sources such as traffic noise and mechanical services noise are based on Australian Standard AS2107:2000.

AS2107:2000 provides recommended design sound levels for health care buildings, which apply to steady-state noise from building services and external noise. The sound levels do not apply to transient or short-term noise events, including helicopter noise or sirens.

Table 2 below presents the internal noise level criteria for the room types that will comprise RHH Stage 1. The noise levels presented in the Table below are expressed in terms of an A-weighted equivalent continuous Sound Pressure Level (L_{Aeq}).

Table 2 - Internal Noise Level Criteria

Room	Internal Noise Levels, dB(A)	
	Satisfactory	**Maximum**
Consulting / Interview Rooms	40	45
Wards	35	40
Operating Theatres / Endoscopy Rooms	40	45
Birthing / Delivery Suites	45	50
Rehabilitation / Recovery Areas	40	45
Sleep Studies Rooms (EEG / EMG)	30	35
Offices	40	45
Staff Areas	40	45
Corridors / Lobbies	40	50
Toilets	50	55

5.1.2 Helicopter Noise

Various standards and guidelines present noise criteria applicable to helicopter noise; however there are no clear definitive criteria for spaces within a hospital development that includes a helipad facility.

Furthermore, there are no mandatory requirements in Australia to control noise from emergency helicopters.

Helicopter movements within a hospital complex are generally accepted to be part of the overall hospital operation. Occupants of the hospital (staff and patients) are therefore expected to be less disturbed by the movement of emergency helicopters than occupants of unrelated buildings. The noise criteria should aim to achieve a balance between the desire to have acceptably low internal noise levels and the associated high potential capital costs, and high levels of noise that may interfere with communication and create a nuisance or annoyance.

The following sections describe the Australian Standards, guidelines and publications that relate to general noise criteria, as well as a publication that is directly related to helicopter noise It is important to note that the typical standards and guidelines that relate to noise do not apply to the less frequent, transient event such as emergency helicopter movements.

AS2107: 2000 ‘Recommended design sound levels and reverberation times for building interiors’

Australian Standards such as AS2107-2000 nominate design criteria for noise levels from mechanical services and external noise such as traffic noise and industry noise.

AS2107, however, does not apply to transient events such as emergency vehicles or aircraft noise.

AS2021, 2000 'Aircraft noise intrusion - building siting and construction'

Australian Standard AS2021:2000 nominates recommended indoor design sound levels for aircraft noise intrusion. It is intended to be used for buildings close to commercial airports that service a high volume of aircraft traffic, and where aircraft noise is expected to be a frequent occurrence, i.e. many events each day.

Therefore, the criteria in AS2021 are typically considered too stringent to apply to emergency helicopter noise.

World Health Organisation (WHO) 'Guidelines for community noise'

World Health Organisation stipulates a maximum level of 40 to 45 dB(A) L_{Amax}, to avoid sleep disturbance.

The criteria in this guideline value relates to frequent noise events such as road traffic or rail noise, and is typically considered too stringent for less frequent, transient occurrences such as emergency helicopter events.

Proceedings of Acoustics publication 'Helicopter noise impacts on hospital development design'

Publication *'Helicopter Noise Impacts on Hospital Development Design' (*Luke Zoontjens, Aaron James: presented at Proceedings of Acoustics, November 2012[1]) explores appropriate criteria for internal noise levels for hospital developments with associated helipads. The paper nominates a maximum limit of no less than 65 dB(A) L_{Amax} for general hospital wards and sensitive spaces, with a lower criterion of 55 dB(A) L_{Amax} for critical spaces such as NICU and PICU wards, and sleep study areas. Laboratories, offices and consulting areas could accept slightly higher levels of the order of 70 dB(A).

This or similar criteria is the contemporary standard for hospital design in Australia. A sample of recent hospitals that have been constructed using similar criteria to those outlined above include Royal Children's Hospital (Victoria) and Gold Coast University Hospital (Queensland), Cairns Hospital (Queensland) and Monash Children's Hospital (Victoria – in construction).

Recommended Design Criteria for Building K, Royal Hobart Hospital

Considering the standards, guidelines and research outlined in the preceding sections, Table 3 below outlines the internal noise level targets for emergency helicopter noise for the design of Building K at Royal Hobart Hospital.

Table 3 – Emergency helicopter noise intrusion criteria

Space	Criterion L_{Amax} dB(A)
Wards, operating theatres, birthing rooms, treatment and consulting rooms	65
NICU, PICU, paediatric wards	55
Laboratories, offices, workspaces and general areas	70

[1] http://www.acoustics.asn.au/conference_proceedings/AAS2012/papers/p21.pdf

5.2 Reverberation Time Criteria

The acoustic reverberation of an enclosed space, such as a ward or consulting room, is characterised by the size of the space, and the internal surface finishes within the space. Acoustic reverberation is best quantified by the use of a Reverberation Time (RT), which is a measure (in seconds) of how long it takes for sound to decrease in level by 60 dB after the noise event has ceased. Reverberation time is a fundamental indicator of the acoustic reverberation of a space, and is typically used as an indicator of the sound quality in the space.

For example, for spaces with mostly reflective surfaces such as concrete, plasterboard and glass, the reverberation time will be long, and noise can persist up to a second or more after the noise event is finished. Such a space may be considered 'lively', and would be susceptible to the build-up of reverberant noise.

Also, build-up of reverberant noise in a space can result in higher noise levels inside the space due to sound sources such as mechanical plant or occupant activity in adjacent spaces. This can increase the requirements for measures to control the noise from such sources.

Conversely, a space with mostly absorptive surfaces such as carpet, acoustic ceiling tiles, and acoustic wall panelling, will have a short reverberation time and noise events within the space will tend to dissipate quickly once the noise source has stopped. Such a space may be considered more 'dead', and is more appropriate for occupied and working environments.

To ensure that appropriate internal acoustic environments are achieved in the hospital, reverberation time criteria have been nominated for spaces where the acoustic environment is critical to the occupant's use of the space.

The recommendations in Australian Standard AS2107:2000, which includes recommendations for Reverberation Times for rooms in a healthcare building, has been used as a guide when assigning an appropriate Reverberation Time to internal areas of Stage 1 of the project. The Table below shows the recommended reverberation times.

To achieve the Reverberation Time criteria, the internal finishes to the spaces in Stage 1 will need to be selected with consideration to acoustic absorption. The internal finishes that may be selected with consideration to reverberant noise control includes floor finishes, ceiling types, and wall finishes. Section 9.0 details the acoustic design in relation to internal finishes.

Table 4 - Reverberation Time Criteria

Room	Reverberation Time (seconds)
Consulting / Interview Rooms	0.4 to 0.6
Wards	Note 1
Operating Theatres / Endoscopy	Note 1
Birthing /Delivery Suites	Minimised
Offices	0.4 to 0.7
Waiting Areas	0.4 to 0.7
Staff Areas	0.6 to 0.8

Note 1: Reverberation time criteria has not been applied to these spaces due to functional requirements

5.3 Sound Insulation Criteria

To ensure that an acceptable level of noise isolation is provided between internal areas of the hospital, sound insulation criteria have been established for the internal areas.

The sound insulation criteria have been expressed in terms of a Weighted Sound Reduction Index, also termed an R_W rating. An R_W rating is a single number quantity that represents the sound insulation performance of a single building element, such as a partition, ceiling, floor, or door. Building elements with a higher R_W rating will provide a greater level of sound insulation.

A subjective description of the sound insulation achieved by various R_W ratings is presented in Table 5 below.

Table 5 - Description of R_W Ratings

Acoustic Rating	Acoustic Performance
R_W 35	Normal speech audible, with some normal speech intelligible. Raised speech audible and intelligible.
R_W 40	Normal speech audible, but mostly unintelligible. Raised speech audible and mostly intelligible.
R_W 45	Normal speech just audible, but unintelligible. Raised speech audible but mostly unintelligible.
R_W 50	Raised speech just audible, but unintelligible. Shouting audible but mostly unintelligible.
R_W 55	Raised speech inaudible. Shouting just audible, but unintelligible.
R_W 60	Shouting inaudible.

The sound insulation criteria that have been applied to partitions of the typical room types in Stage 1 are presented in Table 6 below.

Table 6 - R_W Ratings of Partitions

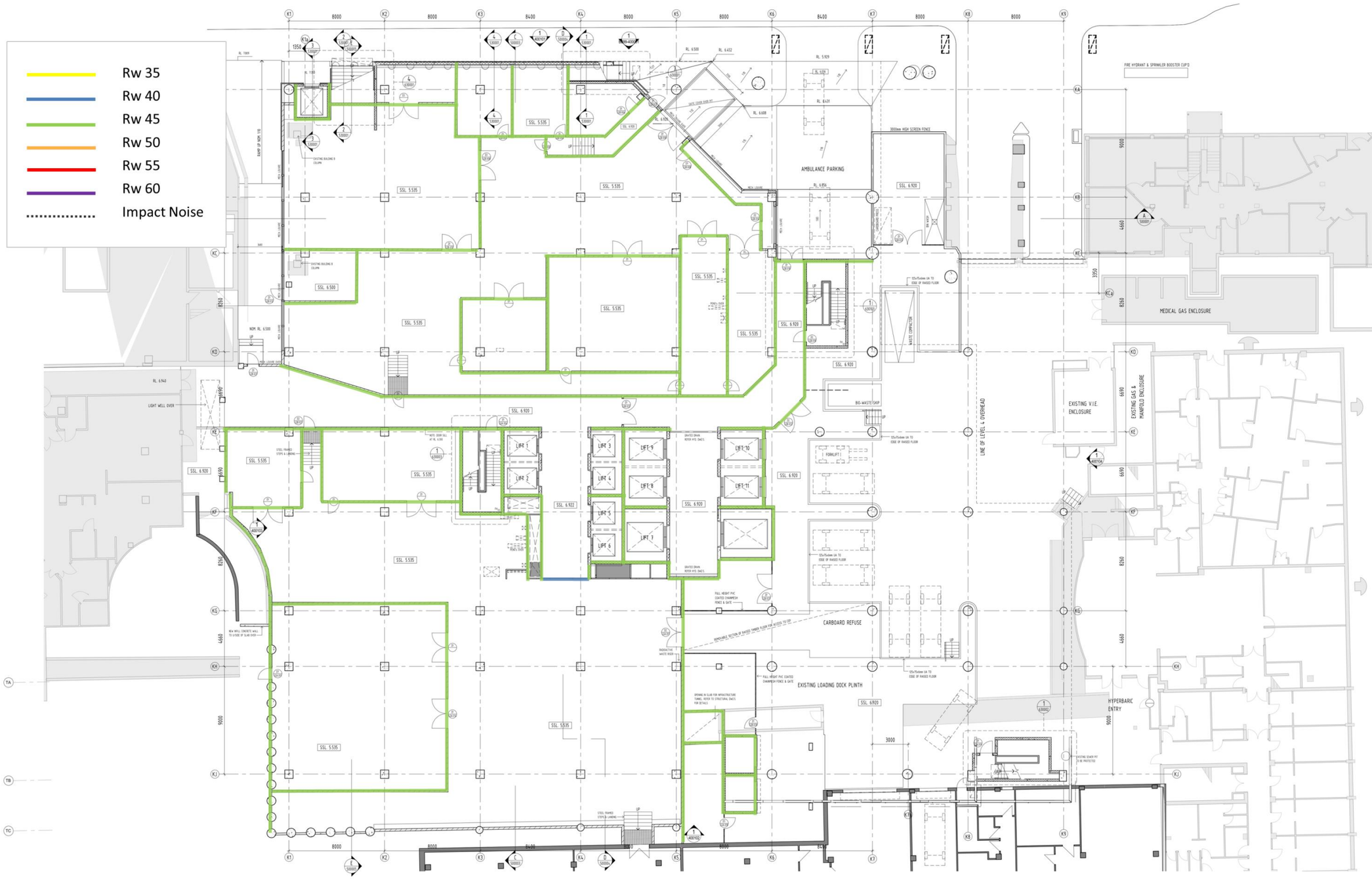
Room	Acoustic Rating
Consulting / Interview Rooms	R_W 40 – 45
Offices	R_W 40
Staff Areas	R_W 40
Wards	R_W 45
Wards (Mental Health)	R_W 50
Ensuites to 2-Bed Wards	R_W 40
Ensuites to 1-Bed Wards	R_W 35
Store rooms	R_W 35
Comms Rooms	R_W 45
Operating Theatres	R_W 50 – 55
Anaesthetic Bays	R_W 45
Birthing / Delivery Suites	R_W 55
Rehabilitation/Recovery Areas	R_W 40 – 45
Sleep Studies Rooms	R_W 50
Toilets / Change rooms	R_W 45

The floor plan mark-ups overleaf show these acoustic ratings as they have been applied to the areas of RHH Stage 1 on Floor Plan mark-ups.

In addition to achieving the R_W values above, some walls will require impact-noise isolation. This applies to locations where impact-noise can be a potential issue, such as:

- Between toilets and quiet-areas such as offices
- Between plant rooms and quiet areas
- To psychiatric treatment areas and wards

To achieve the sound insulation requirements outlined above, partitions and partition elements such as doors, windows and ceiling cavities with the appropriate constructions must be installed. Section 8.0 outlines the acoustic design of the partitions, doors, glazing and ceiling constructions that have been nominated to achieve the sound insulation criteria.



Royal Hobart Hospital - Lower Ground Floor Acoustic Markup

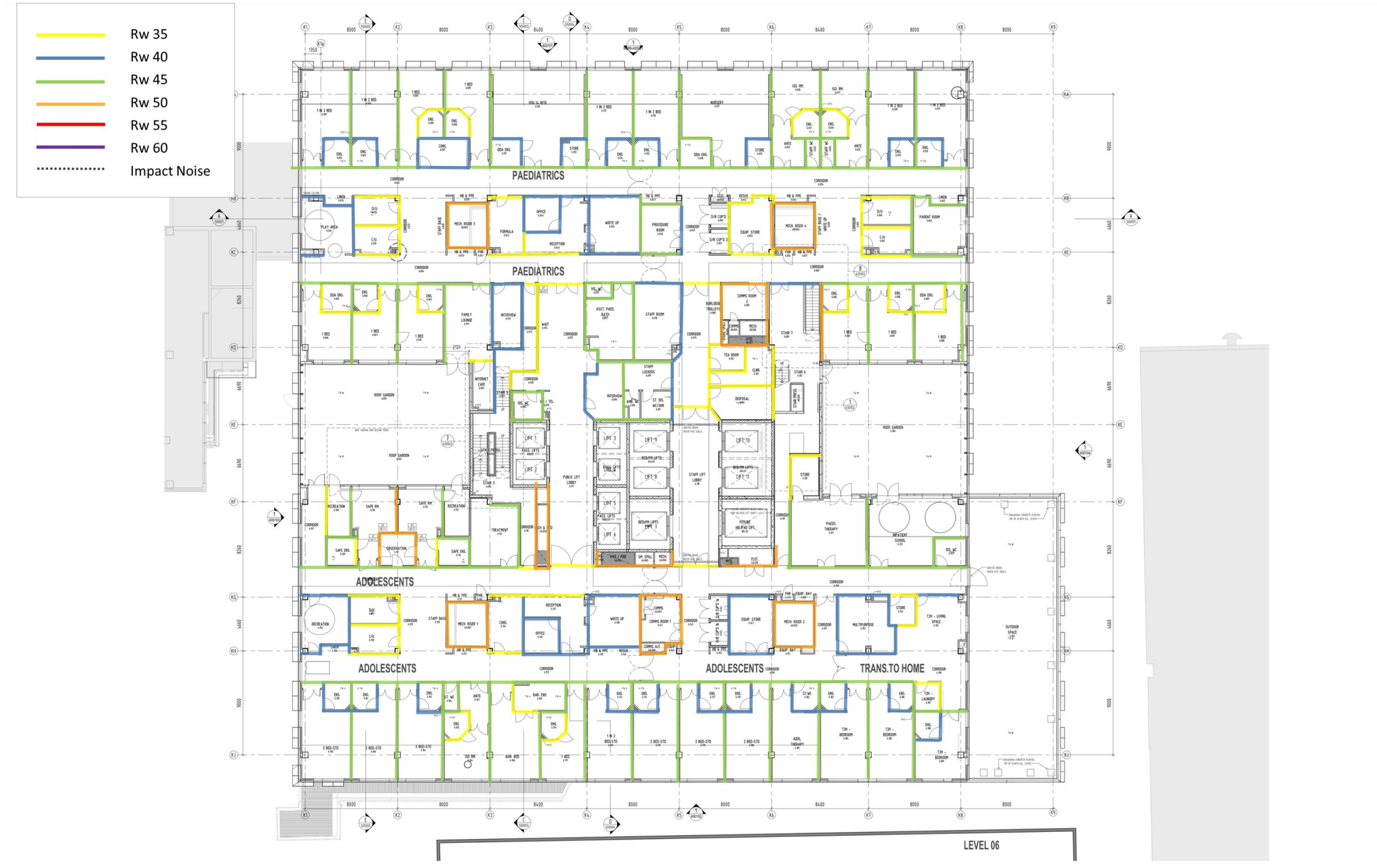
Royal Hobart Hospital - Ground Floor Acoustic Markup

Royal Hobart Hospital - Level 2 Acoustic Markup

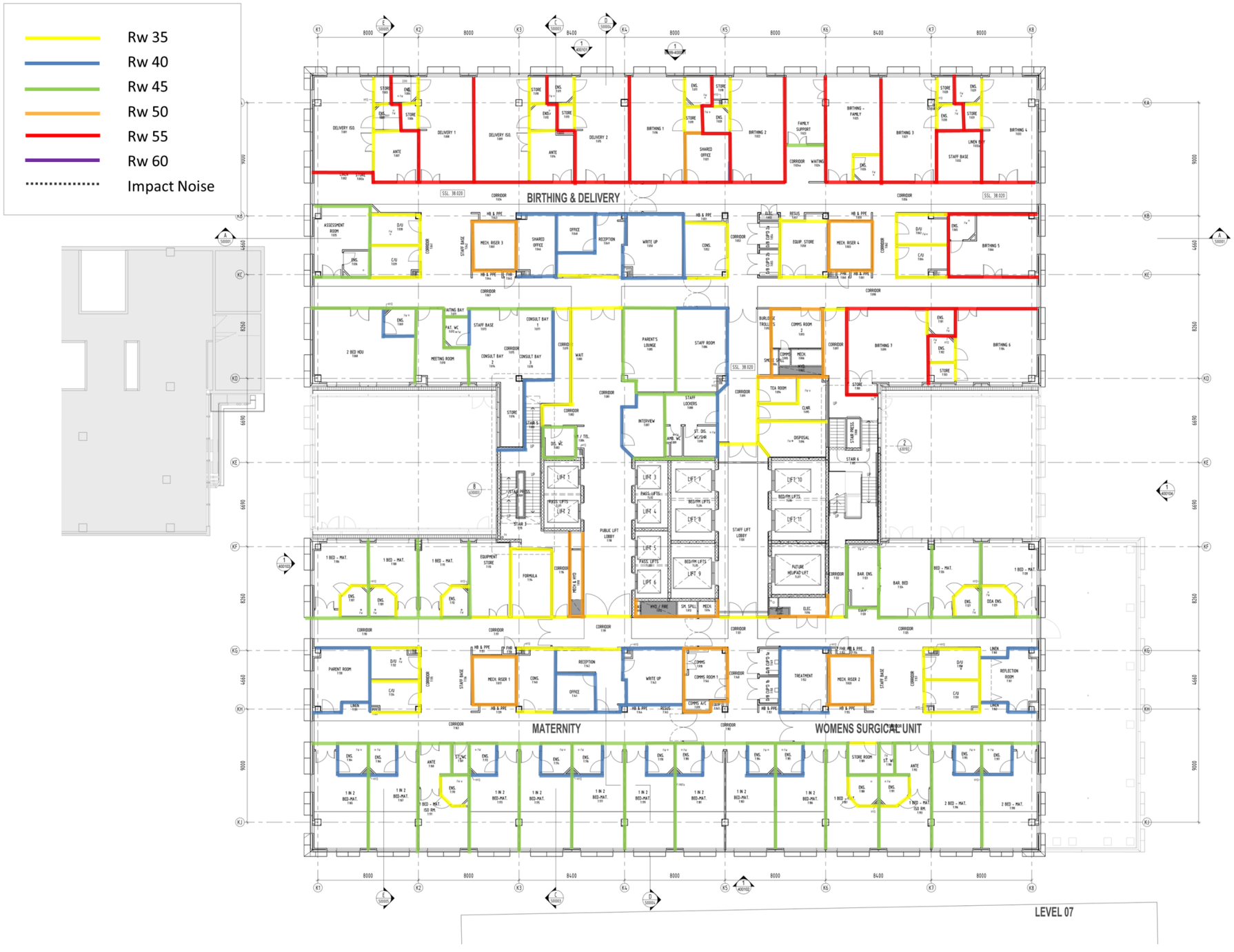
Royal Hobart Hospital - Level 3 Acoustic Markup

Royal Hobart Hospital - Level 4 Acoustic Markup

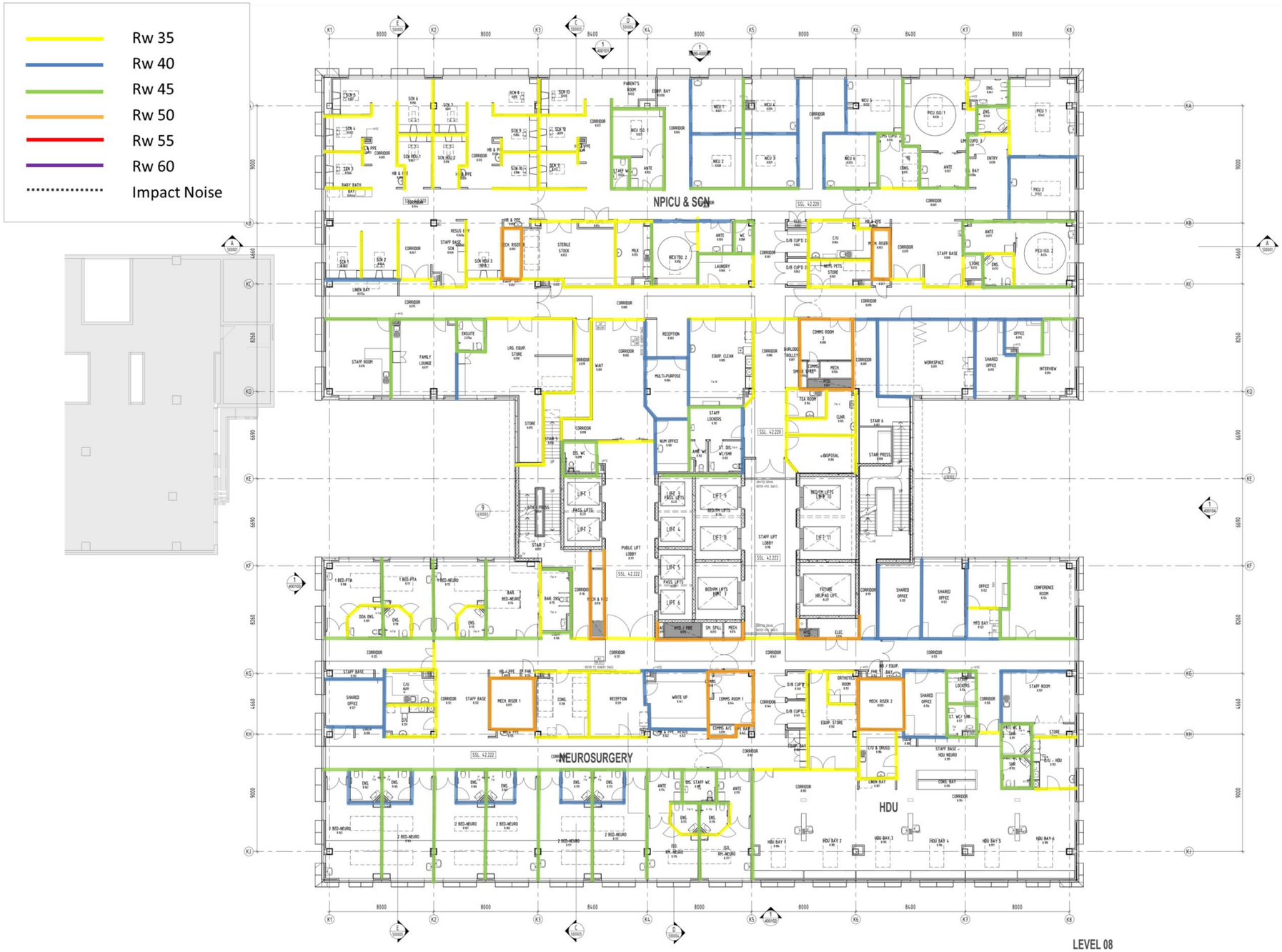
Royal Hobart Hospital - Level 5 Acoustic Markup



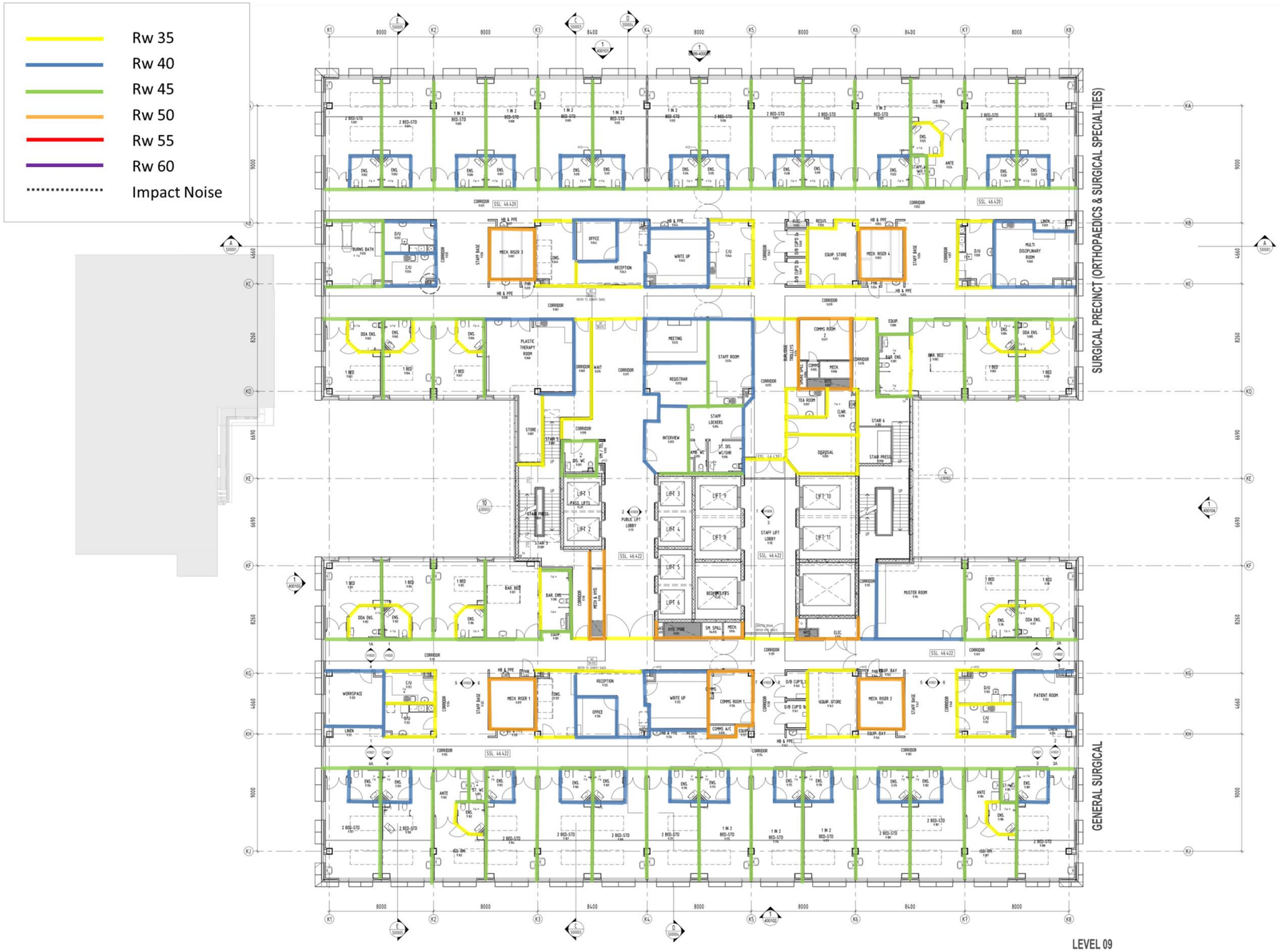
Royal Hobart Hospital - Level 6 Acoustic Markup



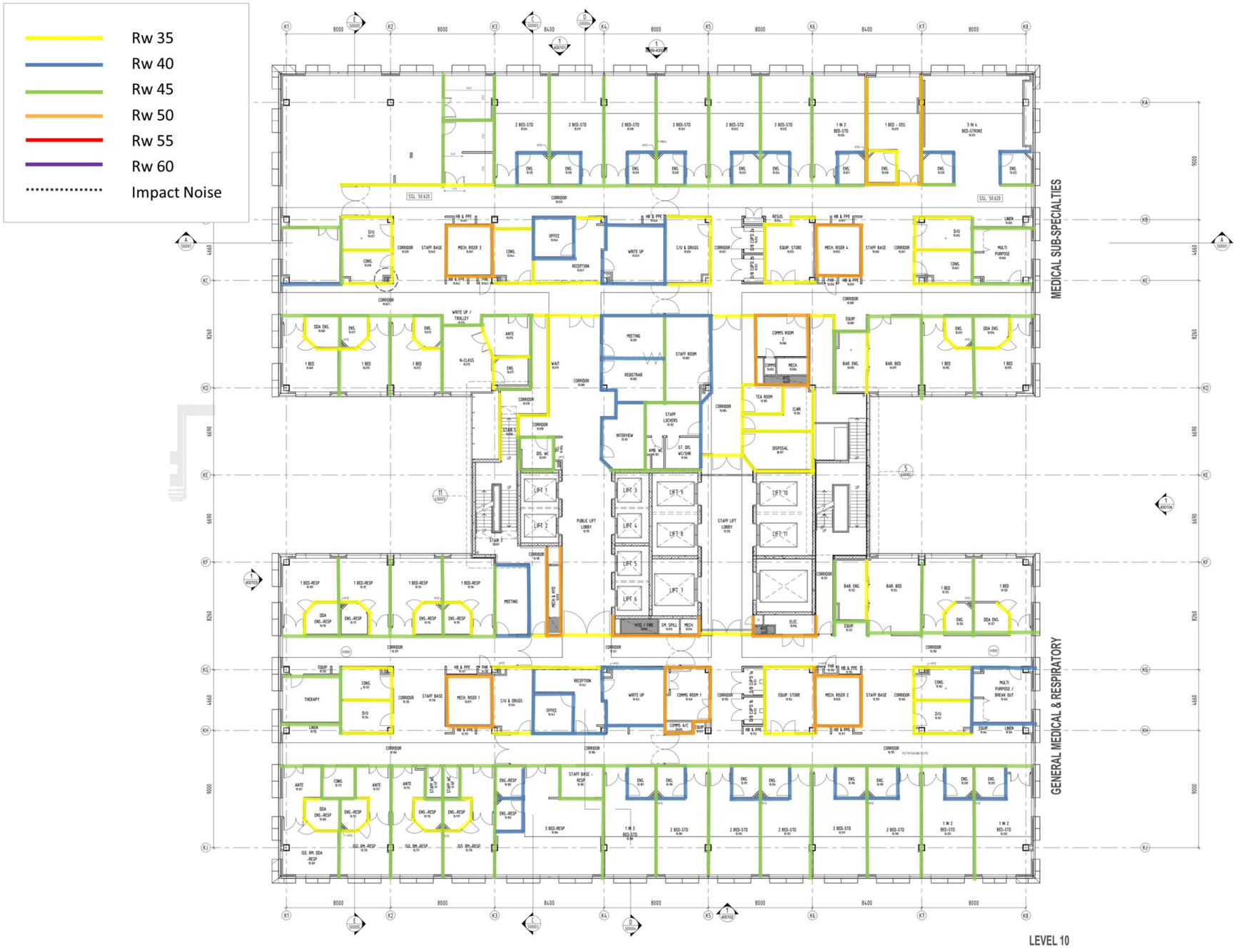
Royal Hobart Hospital - Level 7 Acoustic Markup



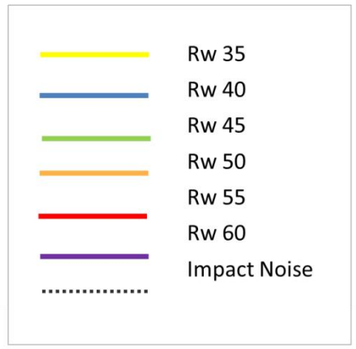
Royal Hobart Hospital - Level 8 Acoustic Markup



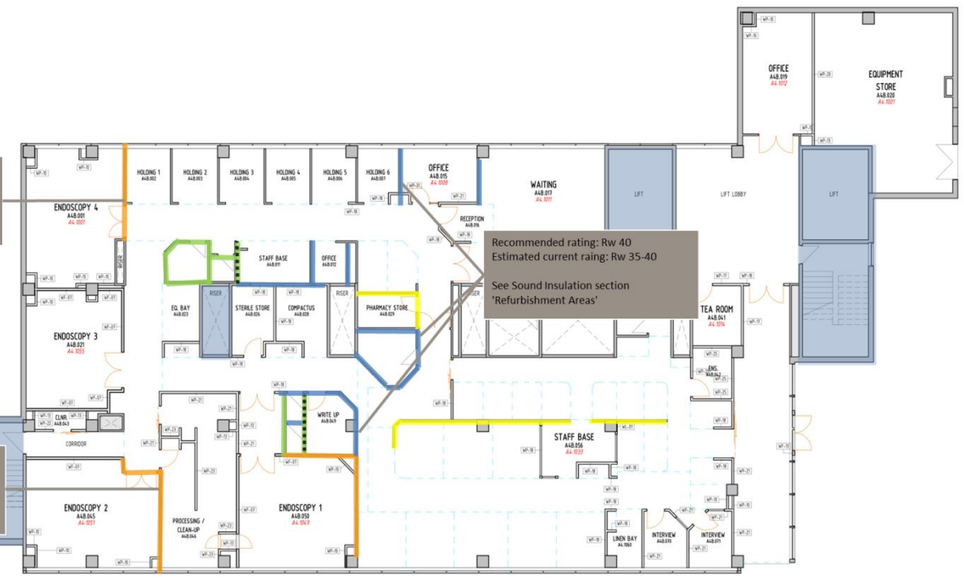
Royal Hobart Hospital - Level 9 Acoustic Markup



Royal Hobart Hospital - Level 10 Acoustic Markup

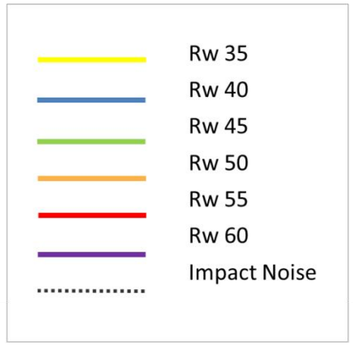


Acoustic Ratings for New Partitions

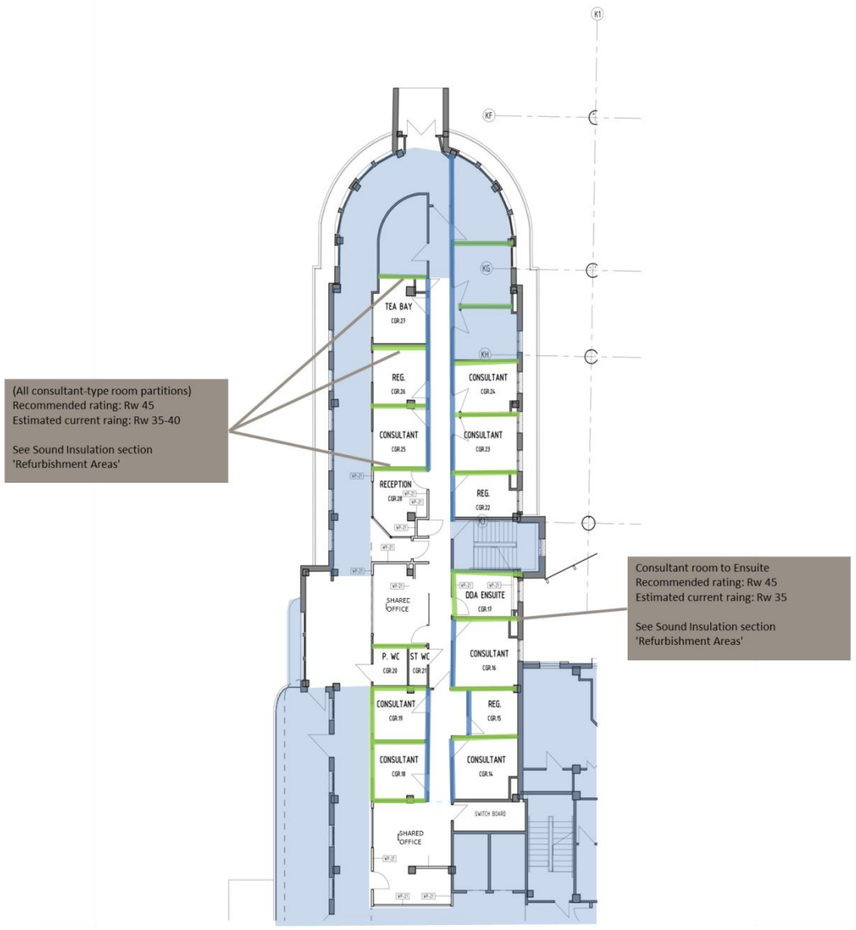


Acoustic Ratings and Notes for Existing Partitions

Royal Hobart Hospital - Building A Level 4 Acoustic Ratings



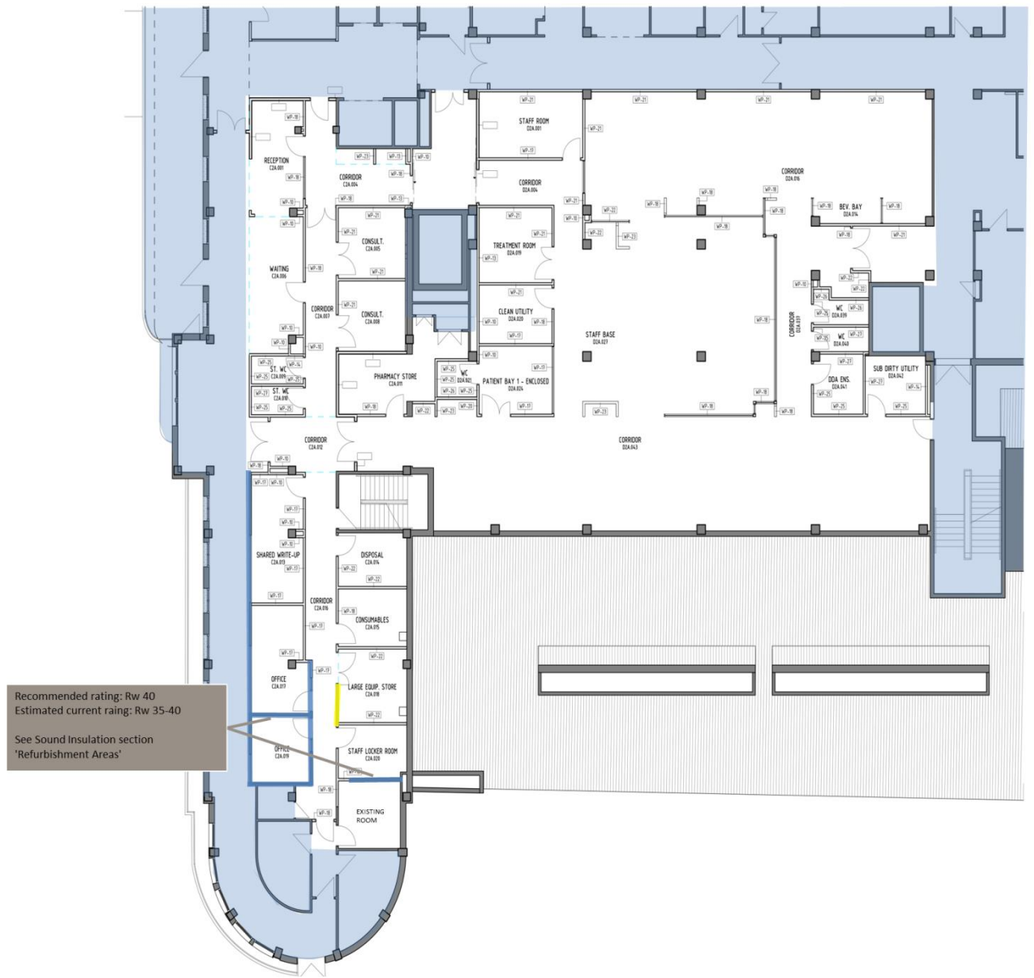
Acoustic Ratings for New Partitions



Acoustic Ratings and Notes for Existing Partitions

Royal Hobart Hospital - Building C&D Level 2 (A) Acoustic Ratings

Acoustic Ratings for New Partitions



Acoustic Ratings and Notes for Existing Partitions

Royal Hobart Hospital - Building C&D Level 2 (B) Acoustic Ratings

Rw 35
Rw 40
Rw 45
Rw 50
Rw 55
Rw 60
Impact Noise

Acoustic Ratings for New Partitions

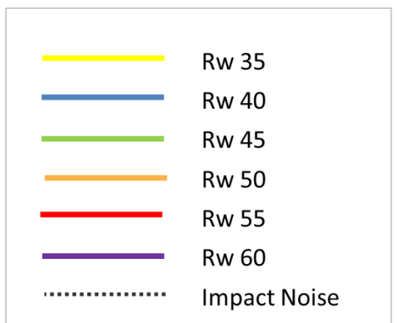
Acoustic Ratings and Notes for Existing Partitions

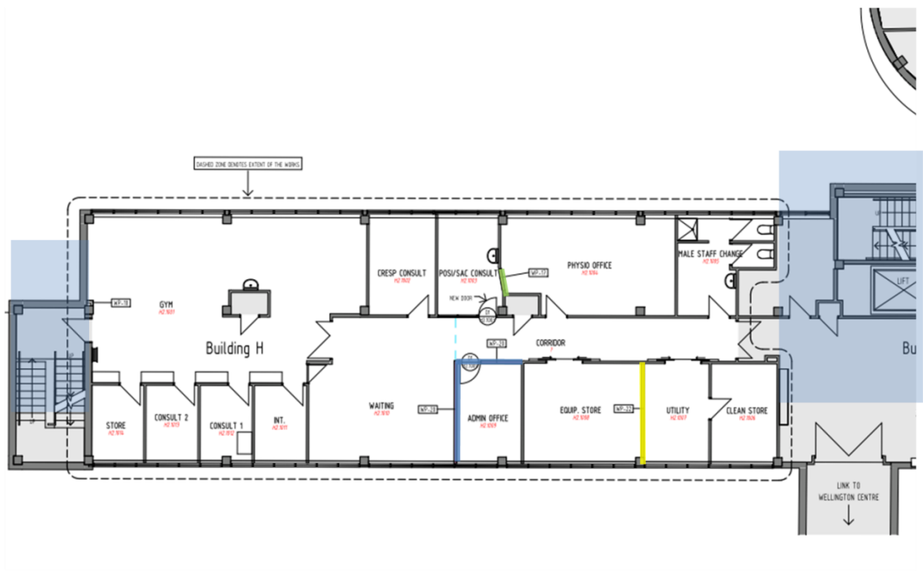
Royal Hobart Hospital - Building C&D Level 3 Acoustic Ratings

Acoustic Ratings for New Partitions

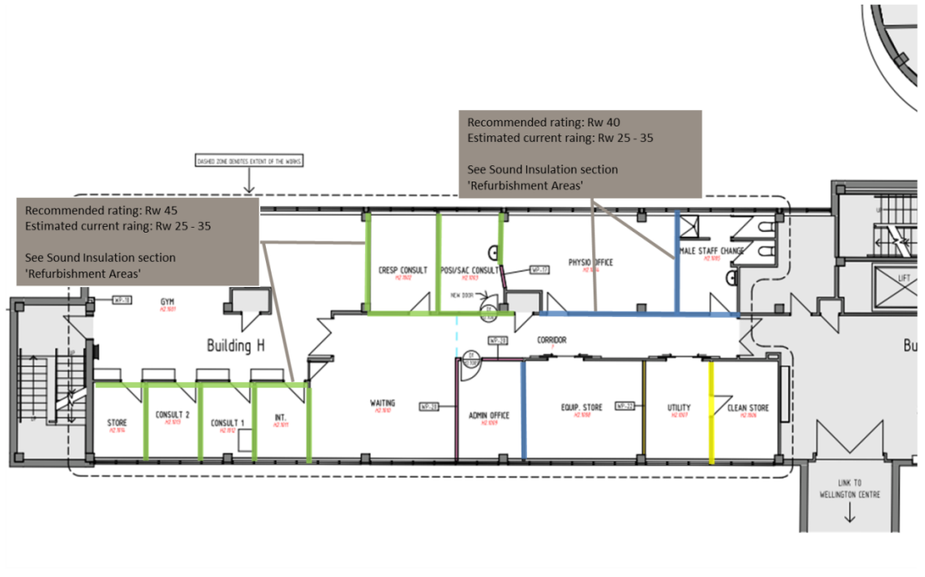
Acoustic Ratings and Notes for Existing Partitions

Royal Hobart Hospital - Building C&D Level 4 Acoustic Ratings





Acoustic Ratings for New Partitions



Acoustic Ratings and Notes for Existing Partitions

Royal Hobart Hospital - Building H Level 2 Acoustic Ratings

5.4 Environmental Noise Emission

To ensure that the acoustic amenity of the external environment surrounding the hospital is not compromised by the hospital redevelopment, the noise emissions from the hospital have been assessed in accordance with the Tasmanian Environment Protection Policy (Noise) 2009 (Tasmanian EPP). The Policy provides guidance on appropriate noise emission levels from the hospital to ensure that nearby noise sensitive receivers are not adversely impacted by the operations of the hospital.

Noise from the rooftop helipad has been assessed in relation to EPA Victoria Publication 1254 'Noise Control Guidelines', in the absence of Tasmanian noise guidelines related to helicopter noise. The 'External Noise' section of this acoustic report discusses the helicopter noise impact on neighbouring buildings.

Section 0 outlines the building services design that will enable the environmental noise criteria to be met.

The following sections outline the environmental noise criteria related to Stage 1 of the project.

5.4.1 Noise Sensitive Receivers

The nearest noise sensitive receivers to RHH Stage 1 are:

- Hotel Collins, 58 Collins Street, southeast of the site
- Theatre Royal Hotel, 31 Campbell Street, northeast of the site
- Various apartments bounded by Campbell Street, Collins Street, Liverpool Street and Brooker Avenue.
- Internal areas of the Royal Hobart Hospital

The internal areas of the hospital are the closest noise-sensitive receivers.

5.4.2 Tasmanian EPP 2009

The Tasmanian EPP is based on information from the World Health Organisation (WHO) *Guidelines for Community Noise* 1999 and the Australia's EnHealth Council report *The health effects of environmental noise - other than hearing loss* (Commonwealth of Australia, 2004)

The Tasmanian EPP states the following requirements for Commercial and Industrial Activities:

1. Regulatory authorities should assess, manage and regulate proposed commercial and industrial activities that are sources of noise with the objective of protecting the environmental values.
2. Best practice environmental management should be employed in every activity to reduce noise emissions to the greatest extent that is reasonably practical.
3. Dominant or intrusive noise characteristics of noise emissions from an activity should be reduced to the greatest extent that is reasonably practical.
4. To retain a reserve capacity in the acoustic environment at a particular location, no activity should be permitted to emit noise at a level or in a manner that, allowing for other reasonable emissions of noise in the vicinity, would prejudice the protection of the environmental values at that location.
5. Notwithstanding sub-clause (4), regulatory authorities may determine not to require a reserve capacity if –

   a. (i) best practice environmental management is employed in the activity; and

      (ii) it is highly unlikely that there will be significant additional sources of noise in the vicinity; or

   (b) this would prevent a proposal that is clearly in the public interest from proceeding.

6. It is acknowledged that, even where best practice environmental management is employed, noise emissions from an activity may –

(a) prejudice the protection of the environmental values; or

(b) provide insufficient reserve capacity to comply with sub-clause (4).

7. Where sub-clause (6)(a) or (b) applies, the responsible regulatory authority should ensure that –

(a) reviews of the activity take place at appropriate intervals to assess whether noise emissions can be reduced until –

(i) the environmental values are protected; and

(ii) where appropriate, sufficient reserve capacity is provided; or

b. appropriate statutory tools are prepared to avoid or reduce conflict with noise sensitive use or development.

The Tasmanian EPP also notes that social and economic needs of the community should be taken into account while considering noise issues.

Tasmanian EPP outlines 'Acoustic Environment Indicator Levels' which provide indicative noise levels to be used as a guide when assessing noise emission. The Acoustic Environment Indicator Levels are based on the WHO Guidelines.

The Acoustic Environment Indicator Levels applicable to this project are shown in Table 7. These Levels will apply to noise from mechanical services associated with the project.

Table 7 – Acoustic Environment Indicator Levels

Specific Environment	Critical Health Effect(s)	L_{Aeq} [dB(A)]	Time Base	L_{Amax} [dB(A)]
Hospital, ward rooms, indoors	Sleep disturbance, night time	30	8	40
	Sleep disturbance, day time and evenings	30	16	-
Dwelling, indoors (for consideration for hotels and residences)	Sleep disturbance, night time	30	8	45

5.4.3 Helicopter Noise

Similarly to the requirements for spaces within a hospital development that includes a helipad facility, there are no definitive criteria for buildings located near a hospital that includes a helipad facility.

Furthermore, there are no mandatory requirements in Australia to control noise from emergency helicopters.

The criteria outlined in the previous sections may be considered too stringent for helicopter noise to adjacent non-hospital buildings, considering the infrequent nature of the events, and the community benefit associated with the hospital helipad.

In the absence of Tasmanian noise guidelines related to helicopter noise, the Victorian noise control guidelines is considered in relation to helicopter noise to residential areas. EPA Victoria Publication 1254 – "*Noise Control Guidelines*", Section 16, gives reference to helicopter noise, and states:

The criteria comprise three separate components, each of which should be satisfied at the nearest affected buildings:

- *The measured $L_{Aeq,T}$ (measured over the entire daily operating time of the helipad) shall not exceed 55dB(A) for a residence.*

- *The measured maximum noise level L_{Amax} shall not exceed 82dB(A) at the nearest residential premises (See Note below).*
- *Operation outside the hours between 7am and 10pm shall not be permitted except for emergency flights.*

Note: These levels will generally be met by a separation between the landing site and the residential premises of 150m for helicopters of less than two tonnes all-up-weight, and 250m for helicopters of less than 15 tonnes all-up-weight.

The guidelines above relate to outdoor areas in residential areas, such as the outdoor areas associated with the residential area to the northeast of the Hospital. The predicted noise levels at the neighbouring noise-sensitive buildings are presented and discussed in the following sections.

6.0 EXTERNAL NOISE

Noise from the external environment has the potential to impact on the acoustic amenity of spaces within the building. The following sections detail the noise measurements and predictions that have been undertaken with respect to external noise, particularly road traffic, external plant, and helicopters.

6.1 Road Traffic Noise

Traffic noise measurements were conducted at Campbell Road, adjacent to the proposed Building K, on 16 March 2012 to quantify the potential noise impact from road traffic. It was noted at the time of the measurements that Campbell Street carries heavy traffic comprising many large trucks. The traffic along Campbell Street was the dominant noise source during the noise measurement period.

Noise levels were measured at approximately 9:30am using a calibrated Bruel & Kjaer 2250 sound level meter. The noise measurements were conducted at approximately 5 metres from the road, with results as follows:

- 68 dB(A) $L_{Aeq,5\text{-minute}}$
- 87 dB(A) $L_{Amax,\ 5\text{-minute}}$

These measurements were conducted in the vicinity of a reflecting façade; therefore the noise level predictions have included an adjustment of -3 dB(A) to account for the reflection from the façade. The L_{Amax} result is for a particularly noisy truck pass-by, which would represent a typical worst-care scenario in terms of noise impact from truck pass-bys.

6.2 Building K Helipad

The following sections outline the details of the location and operation of the proposed helipad associated with Building K, and the predicted noise impact to surrounding areas.

6.2.1 Position of Helipad

The helipad is proposed to be positioned on the northwest corner above Building K at Royal Hobart Hospital, at an elevation of approximately 65 metres above ground level. Figure 1 below shows the helipad position above the rooftop at Building K.

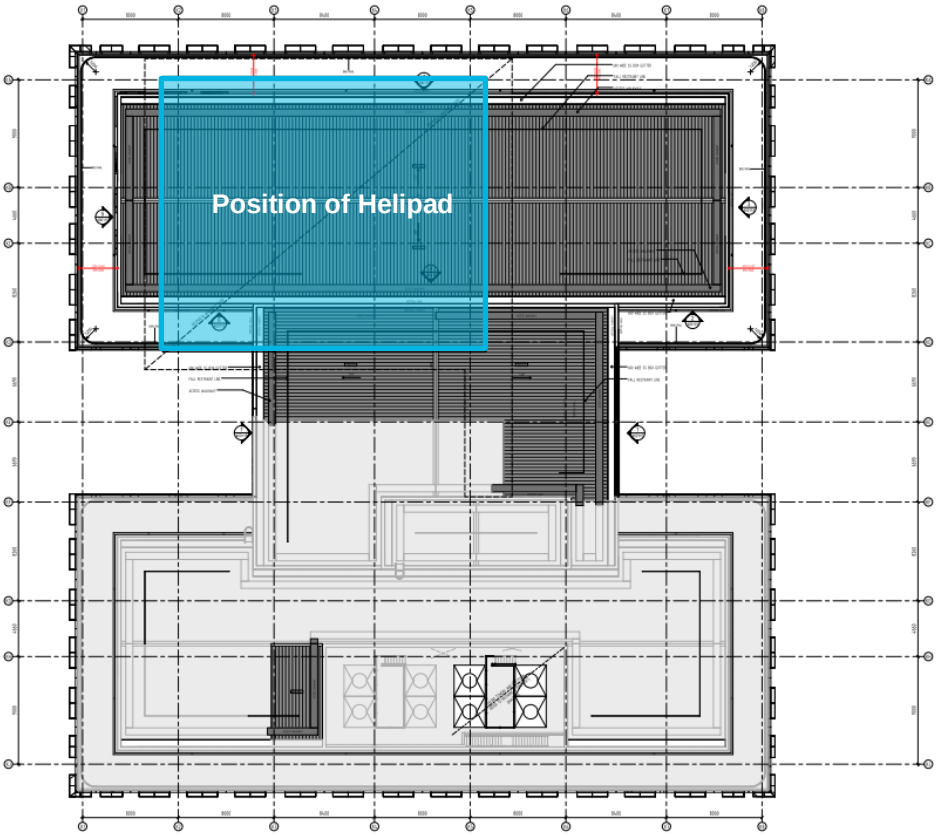


Figure 1 – Helipad position above Building K rooftop at Royal Hobart Hospital

6.2.2 Approach / take-off

It has been advised that the approach of helicopters to the RHH Helipad will typically be from the southeast, and take-off will typically be toward the northwest. This direction of travel was used to determine the distances from buildings that were used in the noise assessment. This direction of approach and take-off results in the east and west facades (Collins St and Liverpool Street respectively) having the most direct line-of-sight to the helicopters, and the north and south (Campbell and Argyle Street) facades being partially shielded from the helicopters.

The take-off and approach profiles of the assessed helicopters are as shown in Figure 2 below.

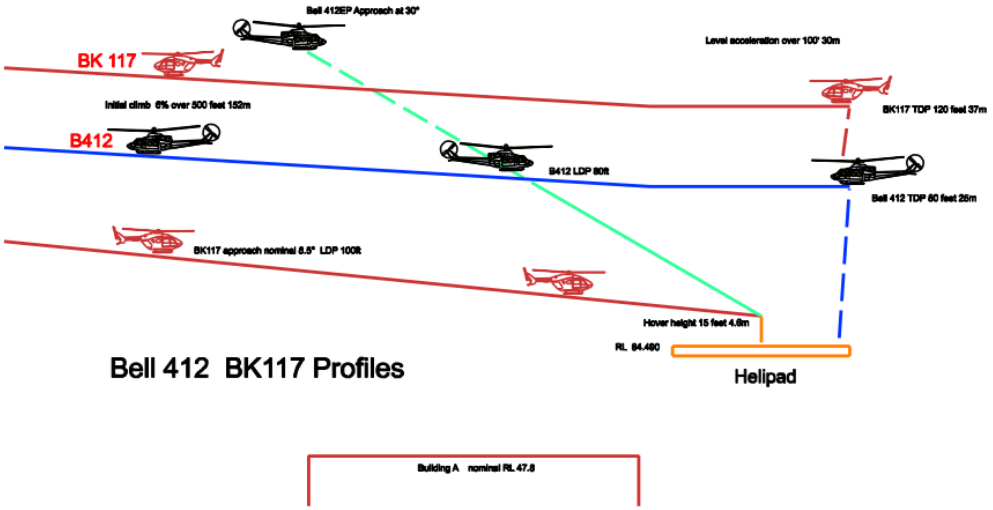


Figure 2 - Take-off and approach profiles of helicopters (PSNK Aeronautical Services, 1 October 2014)

6.2.3 Type of helicopter

It has been advised that the helicopters under consideration are the BK117-B2, Bell 412EP, and AW139.

The Bell 412EP type helicopter is noted to be the loudest of the three helicopters under consideration for both approach and take-off. The noise assessment has therefore been based on a Bell 412EP helicopter to represent the worst-care scenario in terms of noise emission from a helicopter..

Measurements undertaken by AECOM of the Bell 412EP helicopter have been used as the source noise levels for this assessment. The following Sound Power Levels were assumed for the Bell 412EP during take-off and approach:

Table 8 – Sound Power Level of Bell 412EP Helicopter

Event	Sound Power Level (dB L_{max}) Octave Band Centre Frequency (Hz)							Overall (dB(A))
	63	125	250	500	1k	2k	4k	
Approach	146	141	135	139	137	134	128	141
Take-off	143	141	132	136	134	131	125	138

6.2.4 Noise Impact at Neighbouring Buildings

The following table outlines the predicted maximum noise levels outside the neighbouring buildings, and the estimated noise levels inside the neighbouring buildings. Also shown is the predicted maximum noise levels that would be expected due to an emergency road vehicle such as a fire engine or ambulance, for comparison.

Note, the estimated noise levels inside the neighbouring (non-hospital) buildings are conservative, as a detailed analysis of the façade and roof construction of these buildings has not been undertaken to identify noise ingress paths.

If deemed necessary, further investigation can be undertaken to predict the noise levels inside the nearby buildings. This would require inspection of the façade and roof construction of the building under consideration.

Table 9 – Predicted noise levels in neighbouring buildings

Building	Helicopter Noise	Emergency Vehicle Siren Noise
Hotel Collins	• 90 dB(A) L_{Amax} outside, 65 dB(A) L_{Amax} inside a typical bedroom	• 95 dB(A) L_{Amax} outside, 70 dB(A) L_{Amax} inside a typical bedroom
Royal Theatre	• 95 dB(A) L_{Amax} outside, 70 dB(A) L_{Amax} inside	• 95 dB(A) L_{Amax} outside, 70 dB(A) L_{Amax} inside
Campbell Street residences	• 54 dB(A) $L_{Aeq,24\text{-}hr}$* • 92 dB(A) L_{Amax} outside, 67 dB(A) L_{Amax} inside	• 95 dB(A) L_{Amax} outside, 70 dB(A) L_{Amax} inside

*Corresponds to one helicopter movement, lasting 5 minutes, occurring in a 24-hour period. It has been advised that there would typically be less than one helicopter movement in a 24-hour period, on average.

Therefore, the noise levels due to helicopters are expected to be of a similar noise level to those currently experienced when emergency vehicles pass with their sirens on.

The character of the noise, however, would be dissimilar. The sirens have a higher frequency which is more audible (as per their purpose), and the helicopter noise will be predominantly low frequency rumbling.

The noise levels inside the Hotel bedrooms are predicted to be audible, and may cause sleep disturbance. The noise level, however, no more than one helicopter event per night is expected.

The noise levels inside the Royal Theatre are predicted to be audible, and may be intrusive if the helicopter noise event occurs during a particularly quiet theatre event.

The $L_{Aeq,\ 24\text{-}hr}$ noise level outdoors at the residential area complies with the Noise Control Guideline level of 55 dB(A) $L_{Aeq,T}$ measured over a 24-hour period. The L_{Amax} noise level, however, may exceed the requirements of the Noise Control Guidelines at the residential locations. Given the infrequent nature of the helicopter noise events, and the community benefit associated with the Hospital helipad, these noise levels may be considered acceptable.

6.2.5 Noise Impact at Existing Hospital Buildings

The existing buildings at Royal Hobart Hospital will also be subjected to helicopter noise. The following table outlines the predicted maximum noise levels in the existing buildings at Royal Hobart Hospital.

When predicting the helicopter noise levels in internal spaces, the sound insulation performance of the facades of the existing buildings have based on visual inspection of the facades and window types. A detailed investigation of the acoustic performance of the facades of the existing buildings has not been undertaken. Therefore, the predicted noise levels should be regarded as indicative only.

Areas in existing buildings that are not outlined in the Table below are predicted to be less than the noise levels shown for the building under consideration, and less than the criteria outlined in Table 3.

Table 10 – Predicted noise levels in existing buildings, Royal Hobart Hospital

Building	Predicted Noise Level L_{Amax}
Building A	• Level 9 Wards: 80 dB(A) • Level 8 Treatment Room: 80 dB(A) • Level 7 Treatment Rooms: 76 dB(A) • Level 5 & 6 Wards: 75 dB(A) • Level 4 Operating Theatres: 74 dB(A) • Level 1 to 3 Wards: 73 dB(A)
Building C	• Level 3 & 4 Consulting suites: 76 dB(A) • Level 1 & 2 Consulting suites, Chapel: 74 dB(A)
Building D	• All areas: Less than 50 dB(A)
Building E	• All levels, (Offices): Less than 70 dB(A)
Building F	• All levels, (laboratories): Less than 70 dB(A)

6.2.6 Noise Impact at the new Building K

Helicopter noise ingress to Building K will be controlled via the façade design.

The design of the façade to control helicopter noise ingress to Building K is detailed in Section 0

Mechanical services design, which includes consideration of helicopter noise ingress to the internal areas, is discussed in Section 10.1.

7.0 FAÇADE DESIGN – BUILDING K

The façade of Building K has been designed to control noise intrusion from external noise sources. The major external noise sources that will affect the internal areas of Building K include:

- Helicopter noise associated with the rooftop helipad;
- Externally-located plant and mechanical services equipment associated with the hospital; and
- Road traffic noise.

The impact of road traffic noise was quantified with noise measurements that are discussed in Section 6.0. Helicopter noise impact on the façade has been predicted based on the helipad design assumptions outlined in Section 6.0. Externally located plant and mechanical services noise impact on the façade has been predicted using measured noise levels (for existing plant and equipment) and the mechanical services design outlined in Section 10.1.

The following parameters were considered when predicting internal noise levels in the spaces of Building K and designing the façade construction:

- Internal noise level criteria outlined in Section 5.0;
- Distance from noise sources, which included considering approach / take off profiles of helicopters;
- Window area to each internal space;
- Internal finishes in each internal space;

The following sections outline the acoustic design of the façade for Building K.

7.1 Solid Façade Areas

It is understood that the solid areas of the façade will comprise precast concrete of minimum thickness 175mm. The precast panels will not require any additional acoustic treatment, as the concrete panels will provide an adequate level of acoustic separation from the external environment.

7.2 Glazed Façade Areas

The base glazing type at Royal Hobart Hospital Building K will comprise 6mm glass, 12mm air space, and 10.76mm laminated glass to most façade windows.

It is noted that the abovementioned glass type will achieve compliance with the maximum noise levels in AS2107 in all areas due to traffic noise and mechanical services noise, with no further acoustic treatment. This would provide a better acoustic environment compared to the existing Building B (assuming that the glazing to the existing building comprises 10mm float or toughened glass).

Noise levels due to helicopter noise in the wards and other noise sensitive areas of Building K with the base façade double-glazed unit of 6mm glass, 12mm air space, and 10.76mm laminated glass would up to **80 dB(A)** with no further acoustic treatment.

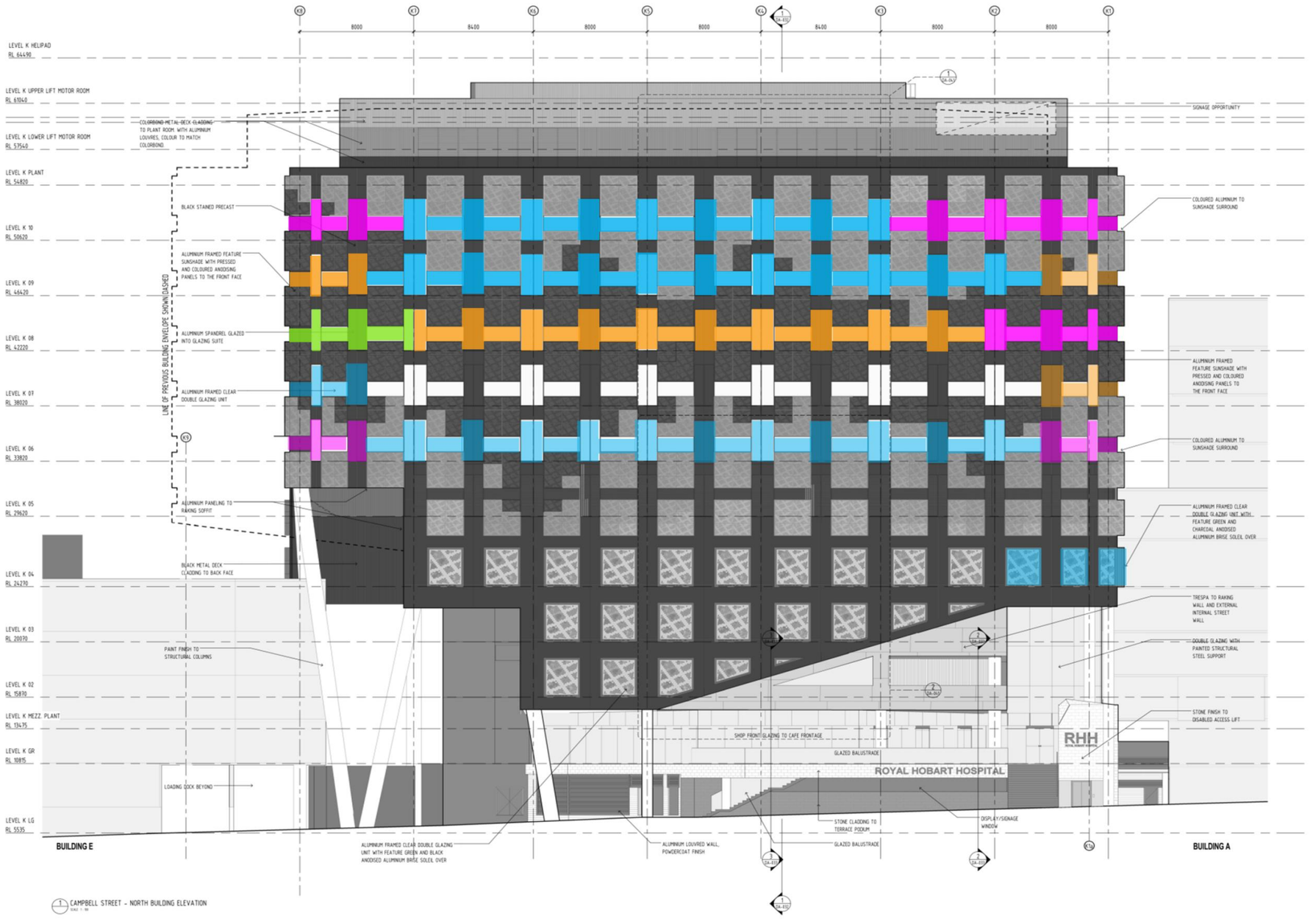
To control helicopter noise ingress, jockey sash glazing will be required to many areas. Due to the varying functional requirements of the spaces, size of the spaces, type of room finishes, and window sizes and types, the type of jockey sash varies across the Building K façade. For instance, areas closer to the helicopter flight path or areas with more stringent internal noise level criteria will require a higher-performing glazing system. Table 11 outlines the acoustic treatment requirements, and should be read in conjunction with the Building K Elevation Markups which are presented overleaf.

The glazing types presented in the Table will reduce internal noise levels to approximately the levels nominated in Table 3. There may be occasions where the noise levels exceed the Table 3 noise levels in some uppermost ward areas, however due to the infrequent nature of the occurrences, this has been considered acceptable by the client.

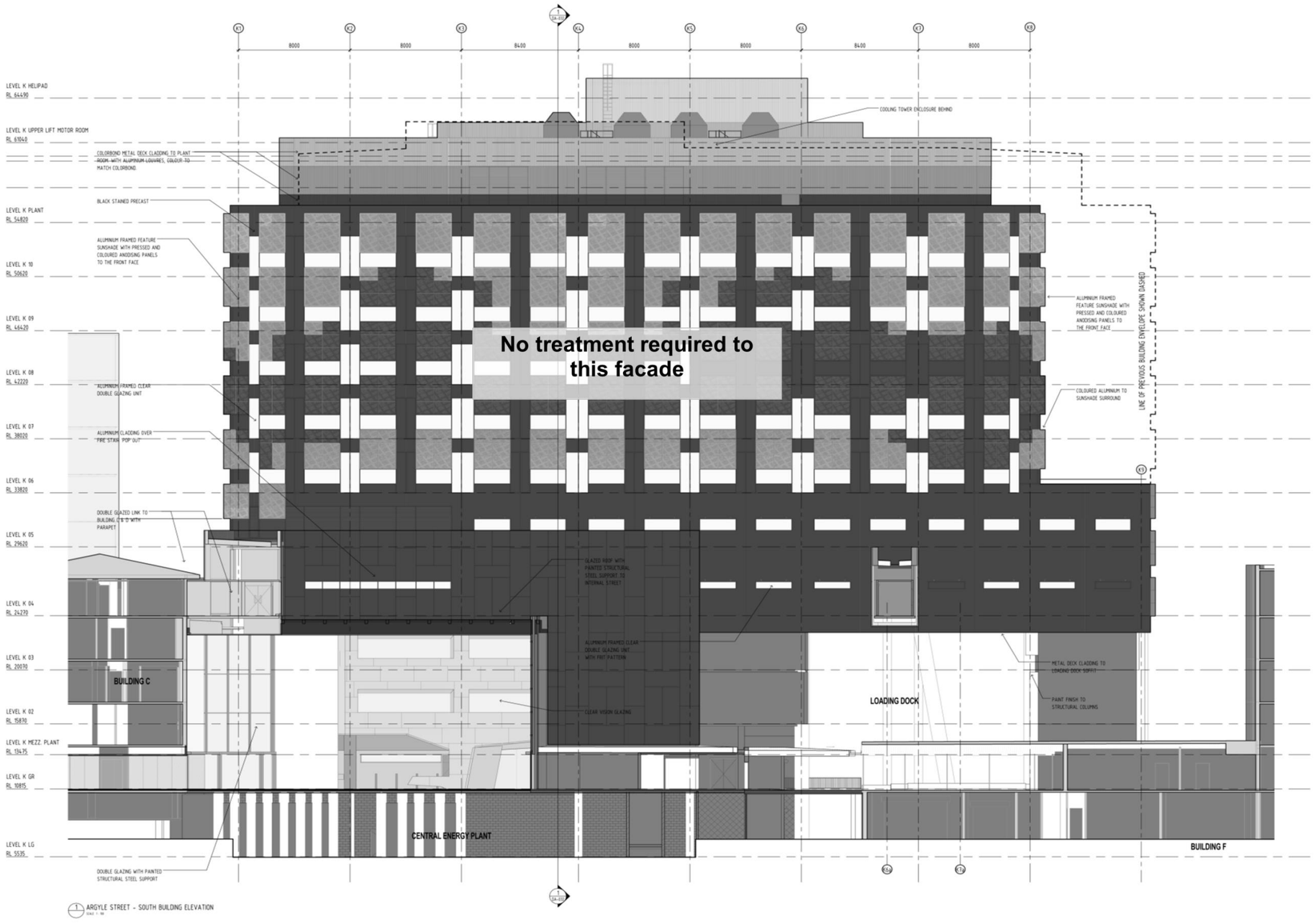
The glazing recommendations include the use of Viridian VLam Hush, which includes an interlayer specially designed to control low frequency noise. Where options for laminated glass or VLam Hush type glass are provided, the VLam Hush option is preferred as it provides superior insulation of low frequency noise and will result in a more suitable noise environment in the internal areas of Building K.

Table 11 – Acoustic treatment to facades of Building K

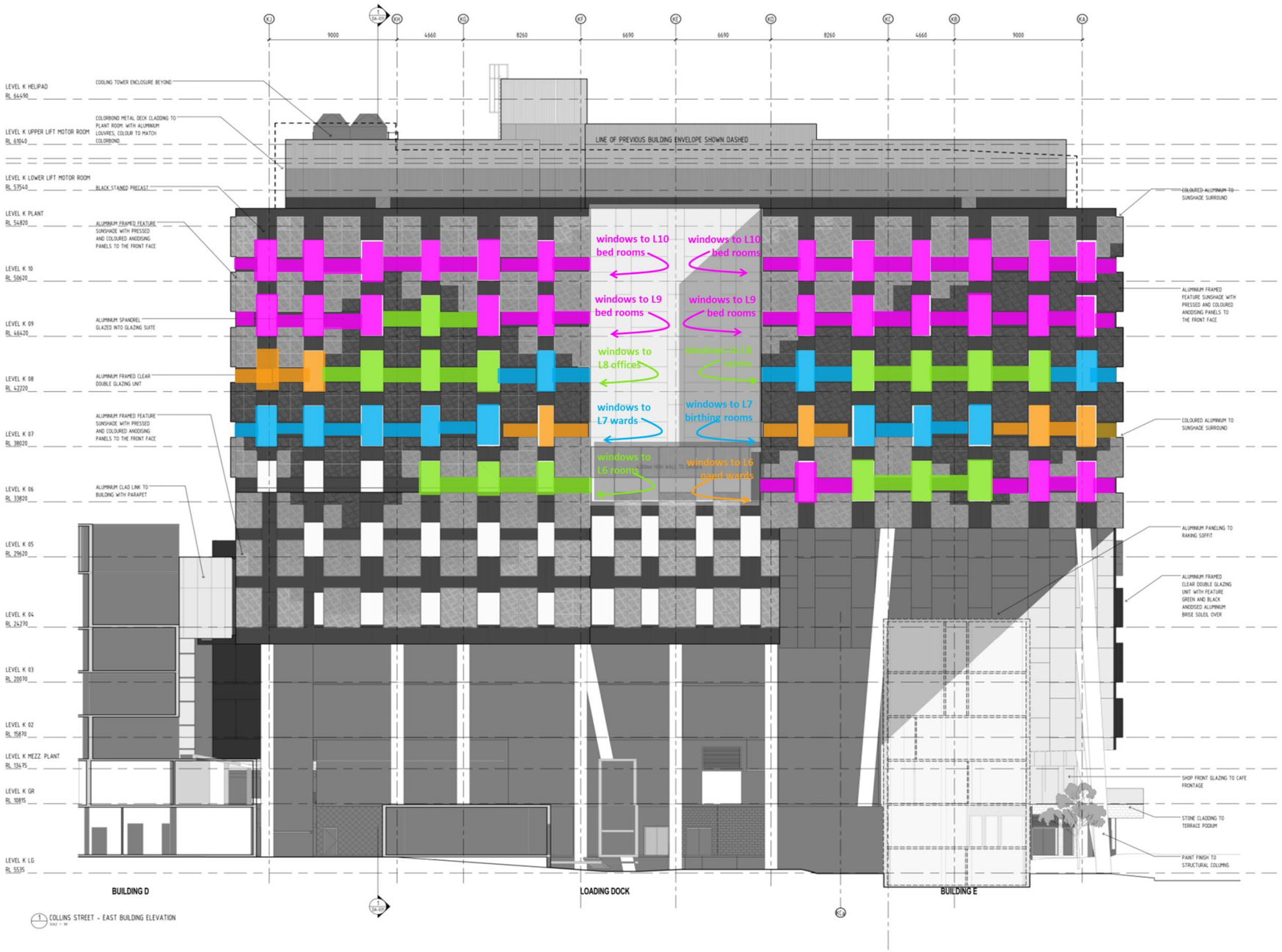
Label	Construction
	Base glazing: • 10.76mm laminated glass, 12mm air space, 6mm glass Jockey Sash: • 6mm thick glass on 150mm air gap
	Base glazing: • 10.76mm laminated glass, 12mm air space, 6mm glass Jockey Sash: • 6.5mm thick VLam Hush or 10.76mm laminated glass on 150mm air gap
	Base glazing • 10.76mm laminated glass, 12mm air space, 6mm glass Jockey Sash: • 10.5mm VLam Hush or 12.76mm laminated glass on 150mm air gap
	Base glazing • 10.76mm laminated glass, 12mm air space, 6mm glass Jockey Sash: • 12.5mm VLam Hush on 150mm air gap



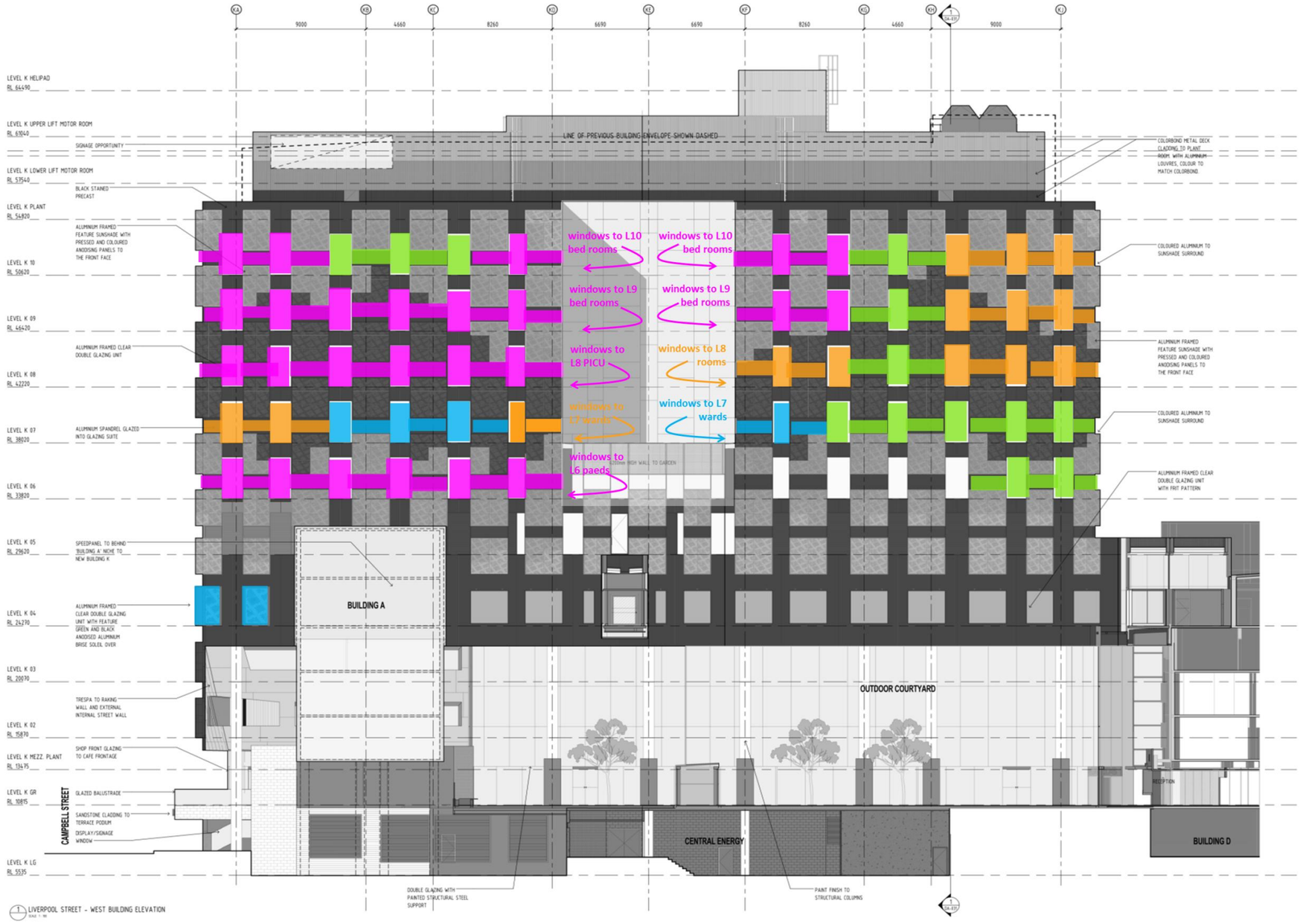
Royal Hobart Hospital - Facade Glazing Acoustic Markup - North Facade



Royal Hobart Hospital - Facade Glazing Acoustic Markup - South Facade



Royal Hobart Hospital - Facade Glazing Acoustic Markup - East Facade



Royal Hobart Hospital - Facade Glazing Acoustic Markup - West Facade

7.3 Window Frames / Mullions

Mullions, seals and frames to windows will require an acoustic review and may require an acoustic upgrade. Possible treatment may include:

- The jockey sash glazed element is located in a separate window frame to the external double-glazed unit, such that the two frames are not rigidly connected.
- Acoustic review of the window frame / sill.
- Where jockey sashes are required to be contained in an openable system, the seals to the perimeter of the pane may constitute an acoustic weakness. The system will be reviewed when further details are available.

7.4 Other Noise Ingress Paths

In addition to upgrading the façade to control helicopter noise, other paths of noise must be considered to enable compliance with the nominated criteria, such as:

- Mechanical services ductwork that passes from noise-sensitive areas to the external environment will require review and potential treatment to attenuation noise ingress. Acoustic attenuators will be allowed for where ductwork passes through noise-sensitive areas, including ceiling spaces, directly to roof level.

8.0 SOUND ISOLATION

To ensure that an acceptable level of noise isolation is provided between internal areas of the hospital, sound insulation criteria have been established for the internal areas, and partition, door, glazing and ceiling constructions have been nominated to achieve the sound insulation criteria. The following sections outline the sound insulation design of the project.

8.1 Partitions

Table 12 provides a set of example partition constructions that will achieve the nominated R_W ratings in Table 6. Also shown in the Table are the ceiling treatments that would be required where partitions do not extend to full height. A full-height construction refers to a wall that extends from the floor slab to the slab soffit above.

Royal Hobart Hospital will comprise Fiberock (formerly Powerscape) type wall linings and plasterboard linings. Therefore, options for using Fiberock wall linings or plasterboard linings have been provided in Table 12.

Some partitions within RHH Stage 1 require additional construction elements for functionality, such as:

- Copper or lead lining to walls and ceiling for RF shielding (EEG, EMG rooms)
- Plywood linings for impact protection (PICU areas)
- Water-resistant linings for wet areas (amenities)
- Concrete elements for structural requirements
- Impact noise isolation is provided via either staggered or double studs, or acoustic resilient mounts.

Table 12 – Example Wall Constructions

Acoustic Rating	Partitions (Option for Plasterboard or Fiberock construction)	Glazed Partition	Ceiling Treatment (where partition is not full height)
R_W 35	*PLASTERBOARD* • 1 layer of 13mm plasterboard to both sides of; • 64mm steel studs *FIBEROCK* • 1 layer of 10mm Fiberock to either side of the wall; • 64mm steel studs	• 10.38 mm thick laminated glazing	*FLUSH PLASTERBOARD CEILING* No further treatment required *CEILING TILES* • The R_W 35 partition should extend up to ceiling height, forming a join between the ceiling and plasterboard wall lining. • Install a layer of 50mm thick Glasswool Partition Batts over the top of the partition, extending 1200mm each side of the partition
R_W 40	*PLASTERBOARD* • 1 layer of 13mm plasterboard to both sides of; • 64mm steel studs; • 50mm thick, 14kg/m^3 acoustic insulation in the wall cavity *FIBEROCK* • 1 layer of 13mm Fiberock to either side of the wall; • 92mm steel studs	• Proprietary acoustic glazing system with an R_W 40 rating, such as 12.5mm Viridian 'VLam Hush'.	*FLUSH PLASTERBOARD CEILING* • The R_W 40 partition extends just past the ceiling height (approx.100mm), forming a join between the ceiling and plasterboard wall lining. *CEILING TILES* • The R_W 40 partition should extend just past the ceiling height (approx. 100mm), forming a join between the ceiling and plasterboard wall lining. • Install a layer of 50mm thick Glasswool Partition Batts over the top of the partition, extending 1200mm each side of the partition
R_W 45	*PLASTERBOARD* • 1 layer of 13mm plasterboard; • 64mm steel studs, with: • 50mm thick, 14 kg/m^3 acoustic insulation in the wall cavity; • 2 layers of 13mm plasterboard *FIBEROCK* • 1 layer of 13mm Fiberock to either side of the wall; • 92mm steel studs, with: • 75mm thick, 32 kg/m^3 acoustic insulation in the wall cavity	• Double glazing consisting of 6.38 mm laminated glazing – 50 mm air gap – 10.38 mm laminated glazing. A moisture absorbing desiccant may be included within the cavity to ensure that there is no condensation.	*FLUSH PLASTERBOARD CEILING* • The R_W 45 partition should extend just past the ceiling height (approx.100mm), forming a join between the ceiling and plasterboard wall lining. • Install a layer of 50mm thick Glasswool Partition Batts over the top of the partition, extending a minimum 1200mm each side of the partition *CEILING TILES* • The R_W 45 partition should extend just past the ceiling height (approx.100mm), forming a join between the ceiling tile and plasterboard wall lining. The ceiling grid should not be continuous over the top of the partition, i.e. the ceiling grid may need to be cut to butt up against the partition. • Install a barrier of Autex 'Baffleblock'[2] 600mm wide over the line of the partition, compressed by 30%.

[2] http://autex.com.au/products/Insulation/QuietStuf/BaffleBlock-Sound-Control

Acoustic Rating	Partitions (Option for Plasterboard or Fiberock construction)	Glazed Partition	Ceiling Treatment (where partition is not full height)
R_w 50	*PLASTERBOARD* • 2 layers of 13mm fire-rated or acoustic-rated plasterboard both sides of: • 92mm steel studs; with • 50mm, 14 kg/m^3 insulation in cavity *FIBEROCK* • 2 layers of 13mm Fiberock to one side of the wall; • 92mm steel studs, with: • 75mm thick, 32 kg/m^3 acoustic insulation in the wall cavity; • 1 layer of 13mm Fiberock to other side of the wall	• Double glazing consisting of 6.38 mm laminated glazing – 100 mm air gap – 10.38 mm laminated glazing. A moisture absorbing desiccant may be included within the cavity to ensure that there is no condensation.	Partition must extend to full height, i.e., slab to slab.
R_w 55	*PLASTERBOARD* • 2 layers of 13mm fire-rated or acoustic-rated plasterboard both sides of: • 64mm staggered studs in a 92mm track, with: • 50mm, 14 kg/m^3 insulation in cavity *FIBEROCK* • 2 layers of 13mm Fiberock to both sides of the wall; • 92mm steel studs, with • 75mm thick, 32 kg/m^3 acoustic insulation in the wall cavity	Not practicable	Partition must extend to full height, i.e., slab to slab.
R_w 60	*PLASTERBOARD* • 2 layers of 16mm fire-rated or acoustic-rated plasterboard both sides of: • 2 rows of studs, with a total air cavity of at least 200mm (no connection between studs, i.e. minimum gap of 10mm), with: • 50mm, 14 kg/m^3 insulation in cavity *FIBEROCK* • 2 layers of 16mm Fiberock to both sides of the wall; • 64mm staggered studs in a 92mm track, with • 75mm thick, 32 kg/m^3 acoustic insulation in the wall cavity	Not practicable	Partition must extend to full height, i.e., slab to slab.
Impact Noise Isolation	• Incorporate either: • Staggered or double studs in place of one row of studs (preferable) or • Rubber isolation resilient mounts between studwork and plasterboard sheet	N/A	N/A

8.2 Doors

The inclusion of a door into a partition will typically result in a reduction in the overall sound insulation provided by the partition, as it is generally not economical or practical to install a door assembly that matches the sound insulation performance of a partition.

The doors must not incorporate air relief grilles and must not be undercut, as this will severely compromise the acoustic integrity of the door.

Table 13 outlines the door types that should be incorporated into partitions with acoustic ratings. Doors to typical wards with partitions of acoustic rating R_W 45 have been deemed suitable with the door construction for R_W 40 partitions in Table 13.

Table 13 – Door Constructions

Partition Rating	Door	Perimeter Seals	Bottom Seals	Viewing Panel
R_W 40 Offices, Staff Areas, Education Areas **Includes Typical Wards**	Minimum 40mm thick solid-core double door set, with a glazed viewing panel to the large door leaf.	Raven RP510 or RP550 seals, or Kilargo IS1005si or IS1046si seals to the perimeter of the door. Raven RP71 or Kilargo IS7071 to the meeting stile.	The gap underneath the door should be minimised to 5mm or less. A drop-seal to the bottom of the door would not be required for these doors.	The viewing panel should comprise a minimum of 6mm thick glass and the area of the vision panel should be minimised.
R_W 45 Consultation Rooms, Interview Rooms **Excludes Typical Wards**	Minimum 40mm thick solid-core door set	Raven RP10 or Kilargo IS7080 to the perimeter of the door.	Raven RP8si or Kilargo IS8010si installed to the bottom of the doors.	The viewing panel should comprise a minimum of 6mm thick glass and the area of the vision panel should be minimised.
R_W 50 Operating Theatres, Comms Rooms	Minimum 42mm thick solid-core double door set.	Raven RP10 or Kilargo IS7080 seal to the perimeter of the door. Raven RP71 or Kilargo IS7071 to the meeting stile of the door.	Raven RP8si or Kilargo IS8010si installed to the bottom of the door.	Where required, the viewing panel should comprise a minimum of 10mm thick glass and the area of the vision panel should be minimised.
R_W 55 Birthing Suites / Delivery Rooms	Minimum 45mm thick solid-core double door set	Raven RP150 & RP24 or Kilargo IS1515 & IS7095si seal to the perimeter of the door. Raven RP71 or Kilargo IS7071 to the meeting stile of the door.	Raven RP38 or Kilargo IS8090si installed to the bottom of the doors.	Where required, the viewing panel should comprise a minimum of 10mm thick glass and the area of the vision panel should be minimised.

Door seal manufacturer Kilargo has a range of Antimicrobial Silicone seals that reduce the growth of harmful bacteria, mould and fungi, and are ideally suited for buildings that require superior infection control, including hospitals. Most Kilargo seals are available with Antimicrobial Protection.

8.3 Installation Details

The following advice should be considered when installing partitions, doors, and ceilings.

8.3.1 Wall Sheeting

Joins in wall sheets are to be offset by a minimum 300 mm on opposing sides when not backed by a nogging, and for two-layer sheeting the joints on the second layer are to be offset by 300 mm from the joints of the first.

All joints between sheets, or between sheets and any adjoining construction must be taped and set, or sealed using a non-hardening flexible caulking compound.

8.3.2 Wall Sealing

An airtight seal should be provided between partition edges and other building elements by means of a flexible caulking compound.

All acoustically rated walls should be sealed at the head and base with flexible caulking compound and backing rods as required. The flexible caulking compound may be acrylic, polyurethane or silicone.

8.3.3 Door Seals

To ensure that the seals perform as required, the seals should press firmly against the door when the door is closed. There should be no gap between the door and perimeter frame seal when the door is closed, and no gap between the bottom door seal and the finished floor level.

Ensure that acoustically rated doors do not have air relief door grilles in them and are not undercut, as this will severely compromise the acoustic integrity of the system.

8.3.4 Penetrations through Full Height Walls

All penetrations through full-height walls (floor to slab soffit above) need to be acoustically treated.

There should be no flexible mechanical services ductwork penetrations installed through acoustic-rated walls, and gaps around any rigid duct penetrations should be treated as follows:

- The hole cut into the plasterboard partition for the ductwork should have a nominal clearance of 10mm around the ductwork. Where a larger hole exists, a plasterboard ‘flange’ may be built up to the penetration such that the gap around the perimeter may be caulked.
- Acoustically seal to the perimeter of the ductwork such that an airtight seal is achieved, as shown in Figure 3.
- The ductwork should not have direct contact with the plasterboard partition.

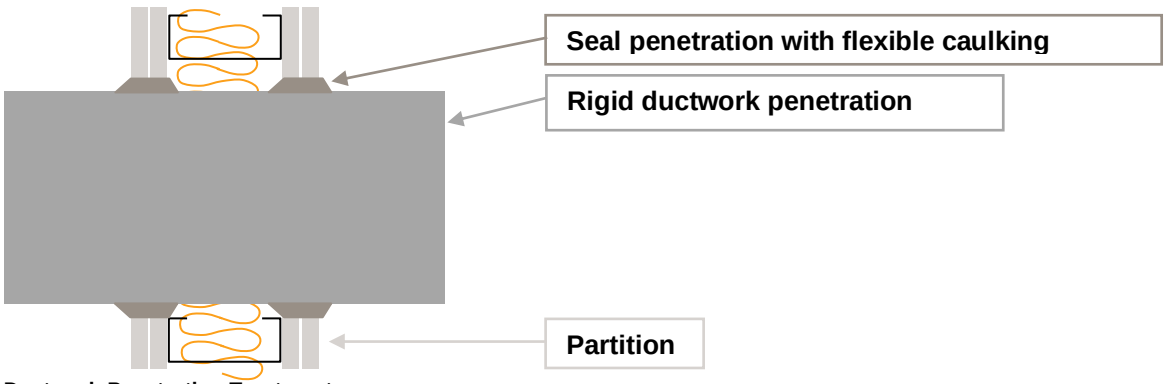


Figure 3 –Ductwork Penetration Treatment

Electrical services penetrating acoustic-rated walls should be treated as follows:

- For single wiring, ensure that the penetration is as small as possible and seal airtight with flexible caulking compound, as shown in Figure 4.
- Cable trays should stop short of the partition penetration where practicable, and cables should be bundled and fed through a cable conduit pipe, which should be treated as shown in Figure 5.
- For wiring housed in pipes, ensure that the pipe extends at least 50 mm either side of the partition. Also, ensure that the penetration to accommodate the pipe is as small as possible and pack inside the pipe—between the wires with tightly wad acoustic insulation with a density of at least 32 kg/m^3. Acoustically seal the ends of the pipe, and the gaps between the conduit pipe and the partition with a non-hardening flexible caulking compound. This acoustic treatment is shown in Figure 5.

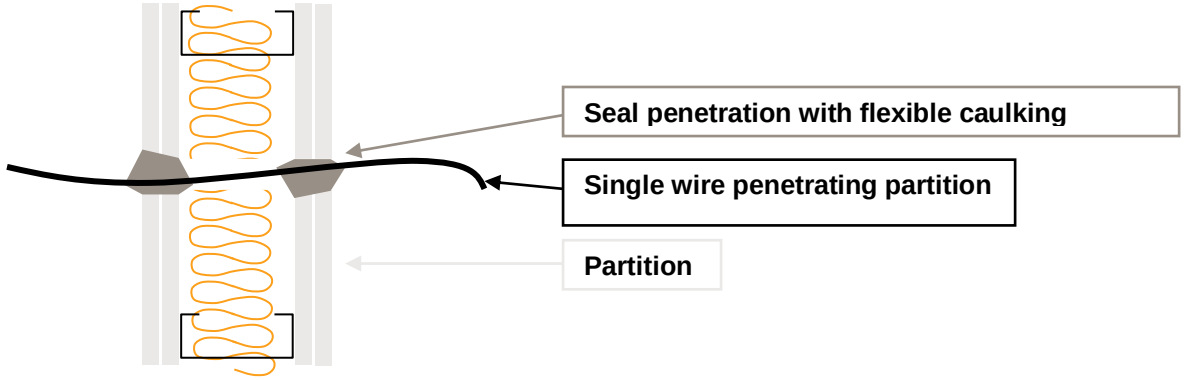


Figure 4 – Single Wire Penetration

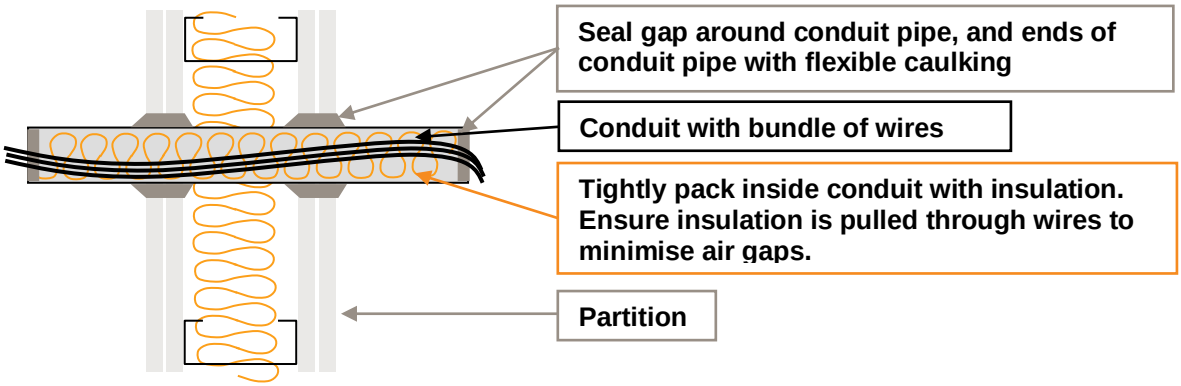


Figure 5 –Wire Penetration in Conduit Pipe

Where cable trays need to penetrate acoustic-rated walls, the following treatment should be implemented:

- Ensure that the penetration to accommodate the tray is as small as possible
- Implement a 'fire pillow' product such as Pyropanel P4 Fire Pillows[3], ensuring that the Fire Pillows are adequately compressed – typically to a width of 30mm.
- Pack the material tight around pipes and cables in the cable tray
- Fill all gaps using a non-hardening flexible caulking compound.

[3] http://www.pyropanel.com.au/Other/Pyropanel/PDF%20tech%20sheets/PAS-11_P4_Fire_Pillows_tech.pdf

Where cable trays penetrate walls with an acoustic rating of less than R_W 45, ensure that the penetration to accommodate the tray is as small as possible and pack around the tray with tightly wad acoustic insulation with a density of at least 32 kg/m^3.

For partitions with an acoustic rating of R_W 45 or higher, ensure that electrical outlets on either side of the wall are:

- Offset back-to-back electrical outlets by at least 300 mm, **OR**
- Install a proprietary product that is designed for acoustically treating electrical boxes, such as Nullifire F0100 Putty Pads[4].

8.3.5 Mullions

The construction requirements for perimeter wall infill panels are presented in Table 14.

Table 14 – Construction Requirements for Perimeter Wall Infill Panels

Partition Acoustic Rating	Acoustic Performance
R_W 35	• Infill panel of 9 mm medium density fibreboard (MDF). • Joins between the mullion and partition edge to be sealed airtight with a flexible caulking compound.
R_W 40	• Infill panel of 18 mm medium density fibreboard (MDF). • Joins between the mullion and partition edge to be sealed airtight with a flexible caulking compound.
R_W 45	• Infill panel 2 layers of 18 mm MDF • Joins between the mullion and partition edge to be sealed airtight with a flexible caulking compound.
R_W 50 and above	• Infill panel to consist of 2 layers of 18 mm MDF on either side of the mullion extending from the partition end to the façade glazing with insulation in the cavity. • Joins between the mullion and partition edge to be sealed airtight with a flexible caulking compound.

[4] http://www.remedial.com.au/fire-rating-solutions/fire-rating-putty-pads

8.4 Medical Services Panels

Medical Services Panels (MSPs) are proposed to be installed into the bed head in each room as a prefabricated unit that will be installed to an opening in the partition between 1-Bed Rooms.

Acoustic treatment will be required to the MDF Bed Head carcass in the following steps:

1. Install the MDF Bed Head carcass to one partition initially, ensuring that the opening in the plasterboard partition is as small as possible to allow insertion of the MDF bed head. Acoustically seal all joins to the ceiling and partition with a non-hardening flexible caulking compound. The seals should be airtight at all joins, as shown in Figure 6.

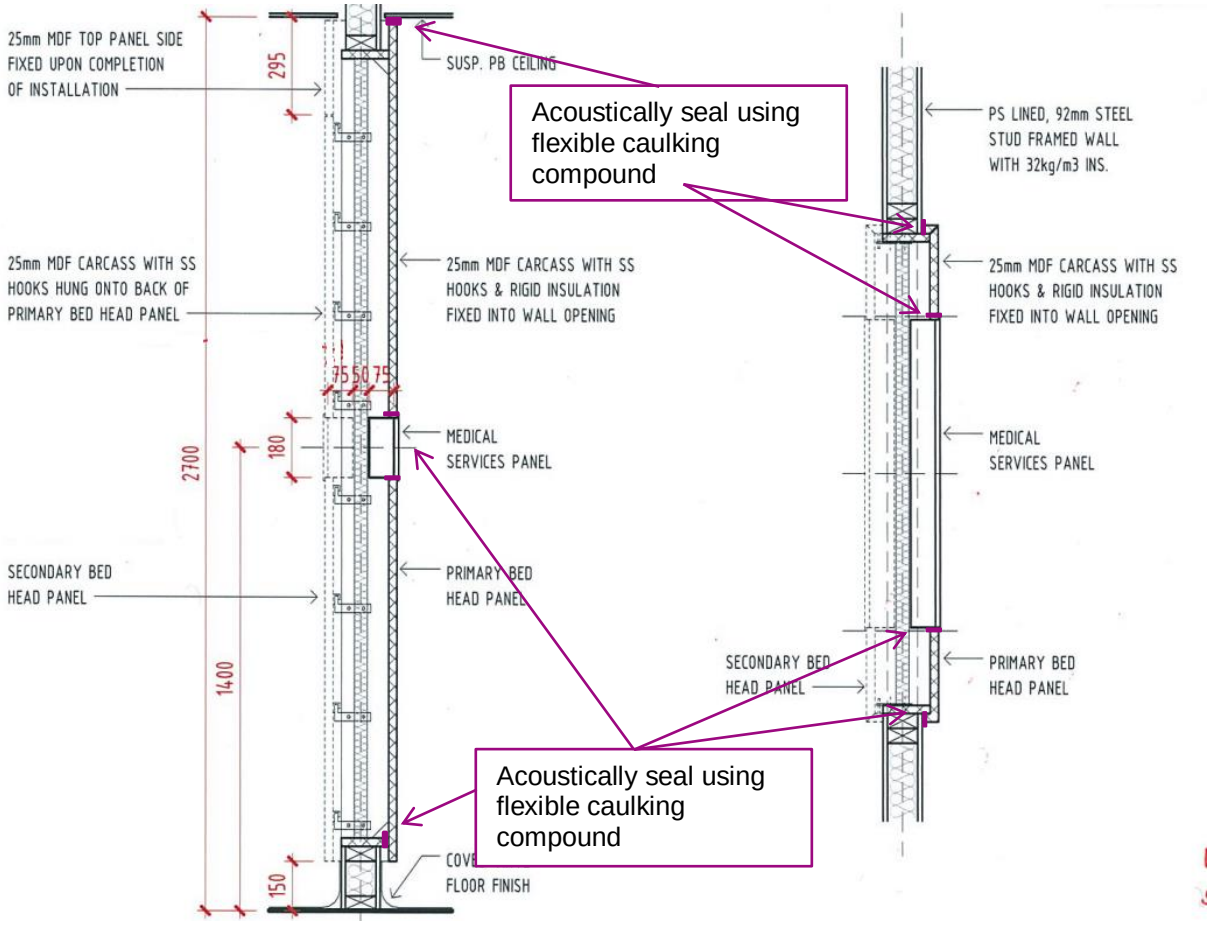


Figure 6 – Acoustically seal joins between MDF Bed Head and Partition (Left image: Section detail; Right image: Plan detail)

2. Install a layer of mass-loaded vinyl that will create a barrier between the two back-to-back MSPs. The vinyl barrier should cover the entire MSP with at least a 300mm overlap, or to the edge of the bed head on all sides, as shown in the Figures below. The vinyl sheet should be fixed to the rear of the MDF bed head panel on all sides of the MSP, and sealed using a flexible caulking compound.

   The mass-loaded vinyl barrier is only required to be installed to one of the two back-to-back MSPs. Suitable mass-loaded vinyl product would be Pyrotek Wavebar 4525c:

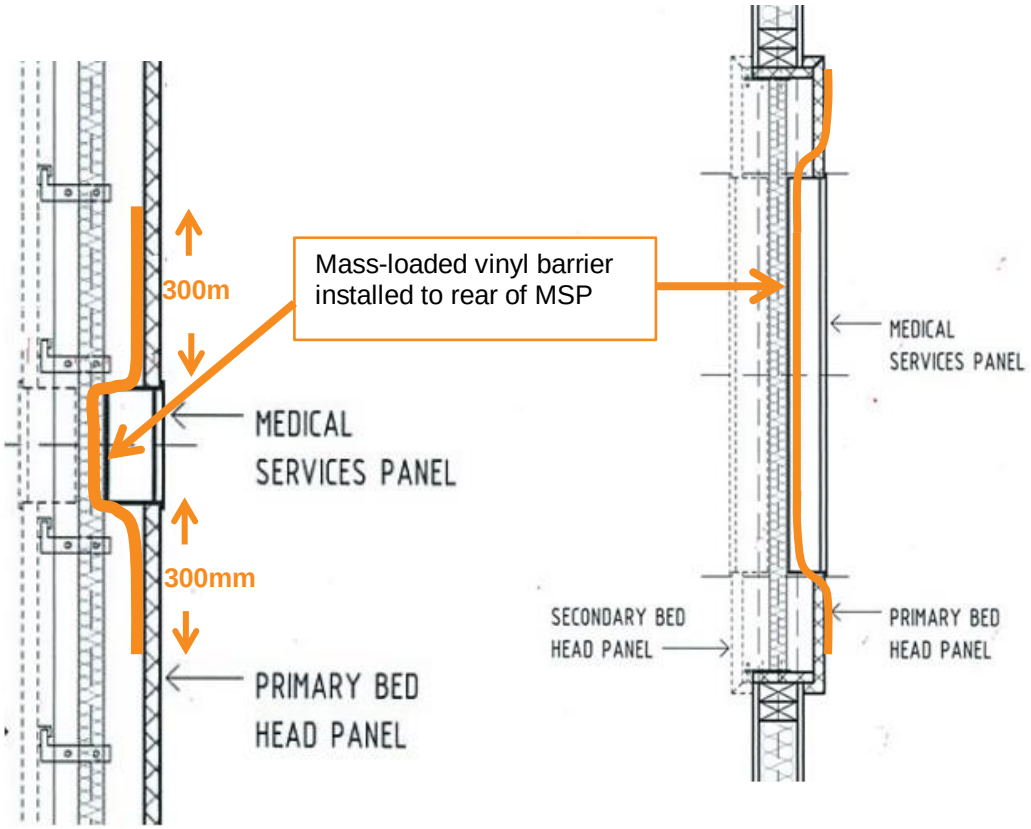


Figure 7 – Mass-Loaded Barrier to MSP (Left Image – Section; Right Image – Plan)

Where services exit from behind the vinyl barrier, they should be sealed by packing insulation into the cavity created between the vinyl barrier and the services, as shown in Figure 8.

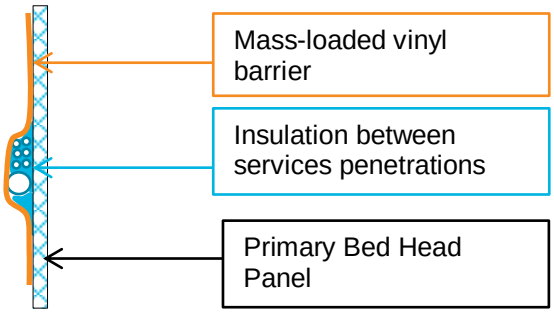


Figure 8 – Treating services penetrations exiting from under barrier

3. Install a layer of 25mm rigid insulation comprising at least 32 kg/m^3, positioned between the MSPs.
4. Install the MSP to the other side of the partition, ensuring that all joins are carefully acoustically sealed, as described in Step 1.

8.5 Mechanical Services

To ensure that the partition ratings are not compromised by mechanical services installations, the following items have been reviewed, and incorporated into the mechanical services design:

- Cross-talk noise transfer, which can be via ductwork that passes through the ceiling void of adjacent noise-sensitive spaces – this has been controlled by acoustic design of transfer ducts, and acoustic lagging of ductwork where required.
- Noise transfer via mechanical services penetrations - this has been addressed via advice for acoustic sealing of penetrations, which is outlined in Section 8.3.4.

8.6 Floor / Ceiling Construction

Concrete slabs between floors will be at least 170mm thick.

This concrete slab thickness, in conjunction with the proposed ceiling types to noise-sensitive areas, will provide adequate noise control for airborne noise and impact (footfall) noise to the most noise-sensitive spaces below, such as sleeping areas.

Therefore, no further acoustic treatment is required to control noise through the floor / ceiling construction.

8.7 Refurbishment Area Design

Stage 1 of the project includes the refurbishment and decanting of Buildings A, C, D, and H.

Some refurbishment areas will retain existing walls following the upgrade. Where existing walls are being retained, an acoustic inspection was undertaken to estimate the current acoustic performance.

Where acoustic inspections indicated that the current wall type may have a lower acoustic rating than recommended, a note is shown on the mark-ups of the floor plans that are presented in Section 5.3, and details are provided in the sections below.

8.7.1 Building A Level 2: Endoscopy 2 to Processing / Clean up

Description

The wall that will separate Endoscopy 2 from Process / clean up area is proposed to be retained. Inspection of the current partition construction showed:

- Plasterboard partition that extends to above the height of the ceiling line (although not to the soffit above)
- Single layer of plasterboard either side of 92mm studs (insulation to cavity not confirmed)
- Flush plasterboard ceilings to both sides of partition
- Some insulation installed over ceilings

Acoustic Rating

Recommended Acoustic Rating: R_W 50

Estimated current Rating: R_W 35 to 40

Recommendation

This partition currently separates two theatre spaces. Considering that the existing use of the spaces is similar to the proposed use of the spaces, the current acoustic performance of the partition may be deemed suitable with no acoustic upgrade. This should be discussed with previous users of the space.

To upgrade the partition such that it achieves an R_W rating of 50 would require the following:

Partition

During construction, the presence of insulation to the wall cavity should be confirmed via a drill hole (which can then be caulked and re-filled upon upgrade).

If insulation is present in the existing partition:

- Install an additional layer of 16mm fire-rated plasterboard to one side of the partition.

If no insulation is present in the existing partition:

- Install two additional layers of 16mm fire-rated plasterboard to one side of the partition, and one layer to the other side, **OR**
- Remove one existing plasterboard wall leaf (either side) and install 50mm, 14kg/m^3 insulation to the wall cavity, and install 2 layers of 16mm fire-rated plasterboard to the side of the wall where the plasterboard was removed.

Ceiling

If the existing ceilings are proposed to be retained, insulation should be installed above the ceiling in each space extending along the partition line at least 1200mm either side of the partition. Existing insulation that is installed in areas may be retained where possible. New insulation that is installed should be a minimum 50mm thick, with a density of 14 kg/m^3.

If new ceilings are installed, they should comprise minimum 10mm plasterboard, and 50mm, 14 kg/m^3 insulation should be laid over the ceiling, extending along the partition line at least 1200mm either side of the partition.

8.7.2 Building A Level 4: Toilets

Description

The toilets that are positioned adjacent to corridors comprised the following construction:

- Plasterboard partition that extends to just above ceiling height
- Single layer of plasterboard either side of 92mm studs (insulation to cavity not confirmed)

- Flush plasterboard to the toilets, perforated steel ceiling tiles to the corridor

Acoustic Rating

Recommended Acoustic Rating: R_W 45

Estimated current Rating: R_W 30

Recommendation

It is recommended that the partitions to these toilets are upgraded. The following acoustic upgrades are recommended:

- Lay 50mm, 14 kg/m^3 over the ceiling space in the toilets.
- Extend at least one leaf of the existing partitions to the soffit above. The extension of the partition could comprise plasterboard, or Pyrotek Wavebar[5] for ease of installation. Any gaps between the extension of the partition, and the soffit above / existing partition must be acoustically sealed using non-hardening flexible caulking compound.

The above recommendations would increase the acoustic separation to at least R_W 40. To increase the rating to R_W 45 (ideal acoustic rating for between Toilets and other spaces) the following acoustic upgrades are recommended:

- Install an additional layer of 13mm plasterboard to one side of the partition that extends from the floor to the soffit above.
- Lay 50mm, 14 kg/m^3 over the ceiling space in the toilets.

8.7.3 Building C Level 2: Consultant Rooms

Description

Many of the partitions between the existing offices and examination rooms in Building C are proposed to be retained. Inspection of the current construction showed:

- Plasterboard partition that extends to ceiling height
- Single layer of plasterboard either side of 92mm studs (insulation to cavity not confirmed)
- Mineral fibre ceiling tiles to both rooms
- Some insulation installed over ceilings

Acoustic Rating

Recommended Acoustic Rating: R_W 45

Estimated current Rating: R_W 35 to 40

Recommendation

These spaces are generally proposed to be used as consulting rooms which is similar to the previous use of the rooms. If the acoustic separation of these rooms has been deemed suitable in the current construction, the existing construction may be retained. This should be discussed with the previous users of the space.

To upgrade the partition such that it achieves an R_W rating of 45, the following upgrades would be required:

Partition

During construction, the presence of insulation to the wall cavity should be confirmed via a drill hole (which can then be caulked and re-filled upon upgrade).

If insulation is present in the existing partition:

[5] http://www.pyroteknc.com/download/wavebar_brochure_W.pdf

- Install an additional layer of 13mm plasterboard to one side of the partition.

If no insulation is present in the existing partition:

- Install two additional layers of 16mm fire-rated plasterboard to one side of the partition, **OR**
- Remove one existing plasterboard wall leaf (either side) and install 50mm, 14kg/m^3 insulation to the wall cavity, and install 2 layers of 13mm plasterboard to the side of the wall where the plasterboard was removed.

Ceiling

If the current ceilings are proposed to be retained, or replacement mineral fibre ceiling tiles will be installed, the following acoustic treatment will be required:

- Install a 600mm wide insulation barrier along the line of the partition, using a product such as Autex Baffleblock[6]. The insulation should be compressed by at least 30%, which will ensure that the stack is stable, and tightly packed against all surfaces include slab, ceiling below, and any services that may be present through the barrier.

If flush plasterboard ceilings are proposed, insulation should be installed above the ceiling in each space extending along the partition line at least 1200mm either side of the partition.

8.7.4 Building C Level 2: Consultant Room to Ensuite

Description

Where ensuites are positioned adjacent to Consulting rooms, the following construction was noted:

- Plasterboard partition that extends to just above ceiling height
- Single layer of plasterboard either side of 92mm studs (insulation to cavity not confirmed)
- Mineral fibre ceiling tiles to one or both rooms
- Some insulation installed over ceilings

Acoustic Rating

Recommended Acoustic Rating: R_W 45

Estimated current Rating: R_W 35

Recommendation

Where a toilet is located adjacent to a Consulting room, the existing acoustic separation should be improved. Proposed improvement would be:

Partition

During construction, the presence of insulation to the wall cavity should be confirmed via a drill hole (which can then be caulked and re-filled upon upgrade.

If insulation is present in the existing partition:

- Install an additional layer of 13mm plasterboard to one side of the partition

If no insulation is present in the existing partition:

- Install two additional layers of 16mm fire-rated plasterboard to one side of the partition, **OR**
- Remove one existing plasterboard wall leaf (either side) and install 50mm, 14kg/m^3 insulation to the wall cavity, and install 2 layers of 13mm plasterboard to the side of the wall where the plasterboard was removed.

[6] http://autex.com.au/products/Insulation/QuietStuf/BaffleBlock-Sound-Control

Ceiling

If the current ceilings are proposed to be retained, or replacement mineral fibre ceiling tiles will be installed, the following acoustic treatment will be required:

- Install a 600mm wide insulation barrier along the line of the partition, using a product such as Autex Baffleblock. The insulation should be compressed by at least 30%, which will ensure that the stack is stable, and tightly packed against all surfaces include slab, ceiling below, and any services that may be present through the barrier.

If flush plasterboard ceilings are proposed, 14 kg/m^3 insulation should be installed above the ceiling in each space extending along the partition line at least 1200mm either side of the partition.

8.7.5 Building C Level 2: Office Areas

Description

Partitions between office areas to the south of Building C were noted to comprise:

- Plasterboard partition that extends to just above ceiling height
- Single layer of plasterboard either side of 92mm studs (insulation to cavity not confirmed)
- Mineral fibre ceiling tiles to one or both rooms
- Some insulation installed over ceilings

Acoustic Rating

Recommended Acoustic Rating: R_W 40

Estimated current Rating: R_W 35

Recommendation

As these areas will be used for similar purposes to their existing use, and the acoustic rating only falls slightly below the recommended acoustic rating, consideration could be given to retaining these walls with no further acoustic treatment. This should be discussed with previous users of the space to identify if any acoustic shortfalls were present.

8.7.6 Building C Level 3: Sleep Studies

Description

The partition that will separate the Sleep Studies rooms from the Pregnancy Assessment Clinic currently separates a waiting room / reception area from offices. The partition construction was noted to comprise:

- Plasterboard partition that extends to ceiling height
- Single layer of plasterboard either side of 92mm studs (insulation to cavity not confirmed)
- Mineral fibre ceiling tiles to both rooms
- Some insulation installed over ceilings

Acoustic Rating

Recommended Acoustic Rating: R_W 50

Estimated current Rating: R_W 35 to 40

Recommendation

These walls will require upgrade to ensure that noise from the Pregnancy Assessment Clinic does not intrude into the Sleep Studies area.

The following upgrade is recommended:

- Remove the plasterboard lining from the Sleep Studies side of the partition.

- Extend the plasterboard lining on the Pregnancy Assessment Clinic side of the partition to full height, i.e., to the concrete soffit above, and seal all plasterboard joins with a non-hardening caulking compound.
- Install a layer 50mm, 14 kg/m^3 insulation between the studs.
- Install a second row of 92mm studs such that there is an air space between the two rows of studs and there is no rigid connection between the two rows of studs.
- To the Sleep Studies side of the wall, install the copper lining on 25mm plywood that is required for RF shielding, and one layer of Powerscape to the internal face of the wall. These linings must extend from the floor to the concrete soffit above.

8.7.7 Building C Level 4: Consult / Exam Rooms

Description

The partitions that will separate consulting rooms on Level 4 of Building C separate existing consulting rooms. The existing partitions that are to be retained were inspected and were noted to comprise concrete blockwork of approximately 140mm width.

Acoustic Rating

Recommended Acoustic Rating: R_W 45

Estimated current Rating: R_W 45

Recommendation

The inspected partitions are expected to achieve the nominated acoustic rating with no further acoustic treatment.
It was assumed that these partitions will extend to full height, i.e., from the floor to the concrete soffit above, however this must be confirmed on site during construction.

8.7.8 Building H Level 2: Consult / Interview Rooms

Many of the partitions between the existing offices and examination rooms in Building H are proposed to be retained. Inspection of the current construction showed:

- Plasterboard partition that extends to ceiling height
- Plasterboard partition (plasterboard quantity and thickness, stud width, and insulation to cavity not confirmed)
- Perforated metal ceiling tiles to each room
- Joins between partitions and windows were noted to have many gaps where noise could easily leak through, as shown in Figure 9.

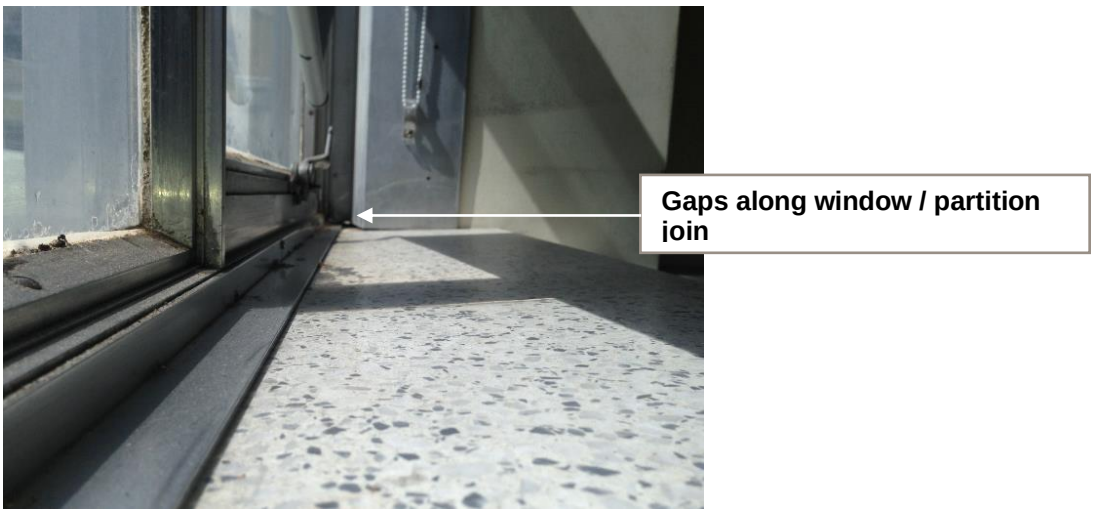


Figure 9 –Window / Partition Join, Building H

The details of the construction above the ceiling tiles was not able to be inspected as the tiles could not be removed. It was assumed that the partitions do not extend to full height (to the soffit above).

The current ceilings are proposed to be retained following the refurbishment.

Acoustic Rating

Recommended Acoustic Rating: R_W 45

Estimated current Rating: R_W 25 to 35

Recommendation

These spaces are generally proposed to be used as consulting rooms which is similar to the previous use of the rooms. If the acoustic separation of these rooms has been deemed suitable in the current construction, the existing construction may be retained. This should be discussed with the previous users of the space.

To upgrade the partition such that it achieves an R_W of 45, the following upgrades would be required:

Partition

During construction, the presence of insulation to the wall cavity should be confirmed via a drill hole (which can then be caulked and re-filled upon upgrade).

If insulation is present in the existing partition:

- Install an additional layer of 13mm plasterboard to one side of the partition.

If no insulation is present in the existing partition:

- Install two additional layers of 16mm fire-rated plasterboard to one side of the partition which extends to the soffit above, **OR**
- Remove one existing plasterboard wall leaf (either side) and install 50mm, 14kg/m^3 insulation to the wall cavity, and replace with 2 layers of 13mm plasterboard.

Both of the above constructions would need to extend to the soffit above to achieve the R_W 45 rating as the perforated steel tiles will not provide any significant acoustic separation. Therefore, additional plasterboard / insulation would be required to be installed above the ceiling if the existing partitions extend only to ceiling height.

The gaps along the window / partition join must be acoustically sealed using a non-hardening flexible caulking compound such that an airtight seal is achieved.

8.7.9 Building H Level 2: Physio Office

Inspection of the construction of the current partition that will separate the Physio Office from the corridor showed:

- Plasterboard partition that extends to ceiling height
- Plasterboard partition (plasterboard quantity and thickness, stud width, and insulation to cavity not confirmed)
- Perforated metal ceiling tiles to each room
- Joins between partitions and windows were noted to have many gaps where noise could easily leak through, as shown in Figure 9.

The details of the construction above the ceiling tiles was not able to be inspected as the tiles could not be removed. It was assumed that the partitions do not extend to full height (to the soffit above).

The current ceilings are proposed to be retained following the refurbishment.

Acoustic Rating

Recommended Acoustic Rating: R_W 40

Estimated current Rating: R_W 25 to 35

Recommendation

These spaces are generally proposed to be used as consulting rooms which is similar to the previous use of the rooms. If the acoustic separation of these rooms has been deemed suitable in the current construction, the existing construction may be retained. This should be discussed with the previous users of the space.

To upgrade the partition such that it achieves an R_W of 40, the following upgrades would be required:

Partition

During construction, the presence of insulation to the wall cavity should be confirmed via a drill hole (which can then be caulked and re-filled upon upgrade).

If insulation is present in the existing partition, no further treatment to the existing partition is required.

If no insulation is present in the existing partition:

- Install an additional layer of 13mm plasterboard to one side of the partition, **OR**
- Remove one existing plasterboard wall leaf (either side) and install 50mm, 14kg/m^3 insulation to the wall cavity, and replace with 1 layer of 13mm plasterboard.

Both of the above constructions would need to extend to the soffit above to achieve the R_W 40 rating as the perforated steel tiles will not provide any significant acoustic separation. Therefore, additional plasterboard / insulation would be required to be installed above the ceiling if the existing partitions extend only to ceiling height.

The gaps along the window / partition join must be acoustically sealed using a non-hardening flexible caulking compound such that an airtight seal is achieved.

9.0 INTERNAL FINISHES

The internal finishes at Royal Hobart Hospital Stage 1 will be selected with consideration to moderating reverberant noise. Section 0 outlines Reverberation Time criteria.

The following sections outline the reverberant noise control treatments that will be incorporated into the design of Stage 1.

Table 15 - Reverberation Time Criteria

Room	Proposed Finishes	Comments
Wards – All Levels	• Flush plasterboard ceiling • Plasterboard and glazed walls • Vinyl flooring	These finishes will result in a slightly reverberant environment in the wards. However, it is common for wards to comprise only acoustically reflective surfaces as cleanability and contamination is of high concern in these spaces. Also to note, the wards are not likely to be subjected to high noise levels, thus the build-up of reverberant noise is not likely to be of a concern. Therefore based on the functional requirements of the rooms, these spaces have been deemed suitable with no further acoustic treatment.
Interview / Consulting Room – All Levels	• Flush plasterboard ceiling • Plasterboard and glazed walls • Vinyl flooring	These finishes will result in a slightly reverberant environment in the Interview / Consulting Rooms. However, it is common for these spaces to comprise only acoustically reflective surfaces as cleanability and contamination is of high concern in these spaces. Therefore based on the functional requirements of the rooms, these spaces have been deemed suitable with no further acoustic treatment.
Waiting Area / Reception – Ground Floor	• Perforated plasterboard ceiling • Plasterboard and glazed walls • Vinyl flooring	These finishes will be beneficial in reducing noise and providing a suitable acoustic environment such that discussions can be held at the booths in Reception. The perforated plasterboard should comprise a minimum of 10% open area of perforations, and a layer of 50mm, 14kg/m^3 insulation should be laid over the entire perforated plasterboard ceiling.
Offices, Meeting Rooms, Education Rooms and Write-Up Rooms	• Ceiling tiles • Plasterboard and glazed walls • Carpet or vinyl flooring	The ceiling tiles that are selected for these spaces will have an NRC value of at least 0.7. Suitable ceiling tiles that are of the ‘clean’ type and will achieve the required NRC rating are shown in the following section of this report.

Room	Proposed Finishes	Comments
Staff Bases, Staff Rooms, Tea Rooms and Reception – All Levels	• Ceiling tiles • Plasterboard and glazed walls • Carpet, or vinyl flooring	The ceiling tiles that are selected for these spaces will have an NRC value of at least 0.7. Suitable ceiling tiles that are of the 'clean' type and will achieve the required NRC rating are shown in the following section of this report.
Family Rooms, Play Rooms and Patient Rooms – All Levels	• Ceiling tiles • Plasterboard and glazed walls • Carpet or vinyl flooring	The ceiling tiles that are selected for these spaces will have an NRC value of at least 0.7. Suitable ceiling tiles that are of the 'clean' type and will achieve the required NRC rating are shown in the following section of this report.
Corridors, other than Level 3 PICU Corridors	• Ceiling tiles • Plasterboard and glazed walls • Carpet or vinyl flooring	The ceiling tiles that are selected for these spaces will have an NRC value of at least 0.7. Suitable ceiling tiles that are of the 'clean' type and will achieve the required NRC rating are shown in the following section of this report.
Corridors to the Level 3 PICU	• Fiberock lining ceiling • Fiberock wall linings and glazed walls • Carpet or vinyl flooring	The areas will comprise flush plasterboard, as this ceiling type is required for functional purposes in this space. In this instance the functional requirements of the space take precedence over the acoustic requirements.
Patient Areas in the PICU Recreation / Breakout	• Flush plasterboard ceiling • Plasterboard and glazed walls • Vinyl flooring	These finishes will result in a slightly reverberant environment in the PICU areas. However, in this instance the functional requirements of the space take precedence over the acoustic requirements, as the spaces are required to be robust and impact-resistant. An option would include installation of acoustic panels to the walls of these spaces, such as 15 square metres of 50mm thick Quietspace panels[7].

[7] http://autex.com.au/products/Wall-Coverings/Quietspace/Panel

Room	Proposed Finishes	Comments
Operating Theatres / Angiography / Catheterisation / CT – Level 4, Endoscopy – Building D	• Flush plasterboard ceiling • Plasterboard and glazed walls • Vinyl flooring	These finishes will result in a reverberant environment in the operating theatres, however it is common for operating theatres to comprise only acoustically reflective surfaces as cleanability and contamination is of high concern in these spaces. Also, the operating theatres are not likely to be subjected to high noise levels, thus the build-up of reverberant noise is not likely to be of a concern. Therefore based on the functional requirements of the rooms, these spaces would be deemed suitable with no further acoustic treatment.
CSSD – Level 5	• Flush plasterboard ceiling • Plasterboard and glazed walls • Vinyl flooring	These finishes will result in a reverberant environment in the CSSD area. It is common for these types of spaces to comprise only acoustically reflective surfaces as cleanability and contamination is of high concern in these spaces. Therefore based on the functional requirements of the rooms, these spaces would be deemed suitable with no further acoustic treatment.
Gym – Level 6	• Ceiling tiles • Plasterboard and glazed walls • Carpet or vinyl flooring	The ceiling tiles that are selected for these spaces will have an NRC value of at least 0.7. Suitable ceiling tiles that are of the 'clean' type and will achieve the required NRC rating are shown in the following section of this report.
Delivery Wards / Birthing Suites – Level 7	• Flush plasterboard ceilings • Plasterboard and glazed walls • Vinyl flooring	These finishes will result in a reverberant environment in the Birthing / Delivery Suites. As cleanability and contamination is of high concern in these spaces, the functional requirements of the space take precedence over the acoustic performance. Therefore based on the functional requirements of the rooms, these spaces will be constructed with no further acoustic treatment.

9.1 Clean Ceiling Tile Types

Ceilings for hospital spaces often have specific requirements for cleanability and moisture resistance. The acoustic ceiling systems shown in Table 16 below have been identified as having potential for use in hospitals. Suitability of use and the performance of these systems should be confirmed with the respective product suppliers prior to selection.

Product suppliers may also be able to provide additional product options. Product supplier details are provided in **Error! Reference source not found.** below.

Table 16 – Acoustic Ceilings suitable for Healthcare Facilities

System Name	Product Name	NRC
Echophon	Hygiene Performance A 40 mm	0.85
	Hygiene Protec A	0.85
	Hygiene Advance A	0.80
Armstrong	Ultima	0.65-0.70
	Clean Room FL – Field Unit	0.55
	Bioguard Acoustic	0.70
USG	Clean Room ClimaPlus Class 10M-100M Panels	0.55
Rockfon	Hygienic / Hygienic Plus	0.80-0.90
	MediCare	0.90
	Sonar	0.85
Eurocoustic	Clinisafe	0.90

Ceiling tiles with a higher Noise Reduction Coefficient (NRC) perform better in terms of controlling reverberant noise within a space.

Therefore in general, a product with a high NRC rating should be selected for optimum acoustic performance in terms of reverberant noise control. Generally, it is recommended that a ceiling tile with a NRC of 0.7 or greater be used.

10.0 BUILDING SERVICES

The following sections detail the acoustic specifications that are applicable to the building services systems serving the hospital, including mechanical services plant and services, hydraulic services and lifts.

10.1 Mechanical Services Design

The mechanical services system has been designed such that the internal noise levels nominated in Table 2, and the environmental noise levels outlined in Table 7 are achieved.

Furthermore, a suitable noise level will be achieved in any public area just outside any plant rooms, mechanical services louvres, and near externally-located mechanical services plant.

The acoustic design and considerations that have been incorporated into AECOM mechanical services drawings and documentation include:

- Ductwork layout design with consideration to acoustics.
- Selection of acoustic attenuators to air handling units, fan coil units, and fans. Attenuators have been used to control noise to the internal spaces of the Hospital, and to external areas where required.
- Position of noise sources (e.g. fans, ductwork, air conditioning and fan coil units) in less noise-sensitive areas, or above acoustically insulating ceilings.
- Cooling tower selection and positioning with respect to shielding from noise-sensitive areas.
- Reverberant noise control in plant rooms.
- Plant room wall design to control noise break-out into adjacent noise-sensitive spaces.
- Vibration isolation of mechanical services plant.

The acoustic design for the mechanical services has been based on the mechanical services equipment selections provided by AECOM. If equipment selections by the mechanical contractor differ from those nominated by AECOM, they should be reviewed by the acoustic consultant to confirm their suitability.

10.2 Hydraulic Services Design

To minimise the transmission of hydraulic services noise to the internal noise-sensitive areas of the hospital, noise control measures will need to be applied to reduce the impact of both airborne noise and structure borne noise.

The following sections outline the required treatment to hydraulic services serving Stage 1. The acoustic treatments described below have been incorporated into hydraulic drawings and architectural drawings as required.

10.2.1 Pipe Insulation

Ceilings

All storm water, and waste water and supply water pipes that pass through the ceiling space of any occupied space will need to be acoustically treated in the form of external acoustic lagging applied to the pipe. An example of an acoustic lagging material would be a 4.5kg/m^2 mass loaded vinyl attached to 25mm thick acoustic foam.

Risers

It is noted that hydraulic risers to the ensuite areas have limited space and there is no room to incorporate acoustic lagging. In the instances of the ensuite risers, the following construction of the riser is required:

- Two layers of 13mm plasterboard to the riser; with
- A layer of 50mm insulation to the inside face of the riser; and
- Bare pipework.

Where acoustic lagging can be applied to pipework, the following construction will be required to risers:

- One layer of 13mm plasterboard to the riser; with
- A layer of 50mm insulation to the inside face of the riser; and
- Acoustic lagging to pipework.

10.2.2 Pipe Isolation

To minimise-structure borne noise being transmitted to the building structure, all pipes should be isolated at support points. Main pipe runs in risers should be supported from the floor slabs only; mounting points on the walls between the slabs should not be used.

All branch and main riser pipes should be supported by rubber lined clips or vibration-isolated hangers. Flexible connections should be fitted to all pipe work subject to vibration from connected plant.

Pipes should only be located in dividing walls if the dividing walls are of discontinuous construction. Pipes in dividing walls should be supported by resilient clamps and only be mounted to the wall leaf adjacent to the room served by the pipe, or the wall leaf adjacent to the least noise sensitive space in the case of common pipework.

10.3 Medical Services Panels

Acoustic design advice to ensure that medical services panels do not constitute an acoustic weakness is outlined in Section 8.4.

10.4 Spa Baths (Birthing Suites)

Spa baths and their associated pumps and pipes should be isolated from the building structure in order to control structure borne noise. The following items should be considered when installing spa baths.

- Install spa baths on resilient isolation pads, for example Embelton Impactamat or equivalent.
- Install pumps on rubber element vibration isolation mounts.
- Select pump vibration isolation mounts to ensure safe and proper operation of the installation, particularly with regard to movement during pump starting/stopping and run-up/run-down.
- Isolate all connected pipe work and fittings for a sufficient length to prevent undue stress in pipe work.

10.5 Lift Services

The presence of noise in noise-sensitive spaces adjacent to lift shafts is typically generated as structure-borne rather than airborne.

The noise is generally one or both of the following:

- Vibration noise from the lift machinery located in the lift motor room or alternatively in the rear of the lift shaft travelling in the lift structure.
- Transit or pass-by noise that is generated by passage of the lift guides along the guide rails. This is usually similar in level from floor to floor and for any given floor reaches its peak or peaks whenever a lift car or counter weight passes by.

To ensure that noise from lifts does not constitute a problem, the following guidelines should be followed:

- All lift carriages and counter weights are to have spring loaded guides.
- All counter weights should be located away from perimeter lift shaft walls.
- Ensure guide rails are ground to give smooth joint transition.
- A noise level and structure-borne vibration warranty should be sought from the lift manufacturer / installing contractor.
- Lift machines and equipment must be mounted on vibration-isolating pads.
- Damping material should be installed to car and landing door panels.

11.0 SUMMARY

AECOM have developed the acoustic design for the Royal Hobart Hospital Redevelopment. This report provides the acoustic design criteria for the Project for the acoustic parameters of internal noise, acoustic reverberation, sound insulation, and noise emission, and discusses their impact on the acoustic performance of the building.

Based on the nominated design criteria, acoustic design for building constructions and noise control treatments have been nominated for the following items:

- Façade construction to control noise intrusion from nearby noise sources.
- Acoustic design of mechanical, electrical, medical and hydraulic services.
- Internal surface finishes within the spaces to control reverberant noise.
- Construction of internal partitions, doors and ceilings to achieve the nominated acoustic separation criteria; including medical services panels and building services treatment.
- Environmental noise emission from the building to nearby sensitive locations.