SCHEMATIC DESIGN

NORMAN DISNEY & YOUNG

Acoustic Services

Revision: A - For Comment
Issued: 2 July 2009

Penrith Health Campus Redevelopment
Nepean Hospital

Hassell Pty Ltd

CONFIDENTIAL

NORMAN DISNEY & YOUNG
Consulting Engineers

NDY Management Pty Ltd
ABN: 29 003 234 571
60 Miller Street
North Sydney NSW 2060

Telephone: +61 2 9928 6800
Facsimile: +61 2 9955 6900

www.ndy.com

OFFICES

Australia:	Sydney, Melbourne, Brisbane, Perth, Canberra, Adelaide
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Authorisation By: 

Verification By: 

Project Co-ordinator: Olivier Gaussen
Project Engineer: Olivier Gaussen

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1 EXECUTIVE SUMMARY

This document presents the acoustic performance requirements following the NSW Health Guidelines Technical Series TS-12 for the Schematic Design of the refurbishment of the ICU and new East Block building of the Penrith Health Hospital Campus redevelopment.

The document presents the internal background noise levels target for the mechanical services and the maximum vibration levels permitted within the building generated by mechanical services.

The document also presents external noise criteria for mechanical services at the boundary of the nearest residential premises.

The Schematic Design establishes construction phase management introducing acoustic grade rating system for the acoustic isolation performance of the partitions, doors and penetrations.

This document presents preliminary construction arrangements and recommendations for the building envelope allowing the Quantity Surveyor to adjust and refine project costing.

2 INTRODUCTION

This report has been produced following Norman Disney and Young's proposal of 19 May 2009.

The report presents the schematic design for the proposed refurbishment of the area located in the West Block and development of a new East Block at the Penrith Health Campus (Nepean Hospital), located on Somerset Street, Penrith. This report presents the Acoustic Performance Requirements Brief proposed by NDY Sound, in agreement with Hassell, for the Penrith Health Campus redevelopment and refurbishment, located in Penrith.

The proposed project presents the following key acoustic issues that have the potential to impact on the Nepean Hospital building design:

- Noise generated by the adjacent driveway and access ramp of the loading dock to the East Block.
- External or internal Impact of mechanical plant of the East Block on the surrounding area.
- Control of internal sound isolation and plant noise.
- Control of acoustic environment in larger public spaces.

The report summarises and identifies potential acoustic issues including internal and external noise sources, and also noise emitted by mechanical plants servicing the building. Particular considerations have been made in this report to address potential noise intrusion from the railway line located north of the site.

Some concept and in principle advice regarding the acoustic grade rating of walls and ceiling has been provided for cost planning. Following the same purpose, airflow velocities within different arrangements have also been specified in the different spaces of the existing proposed new building in order to be able to meet the recommended internal background noise levels.

The purpose of the report is to:

- Identify technical standards and regulatory noise criteria currently adopted for the project.
- Provide preliminary construction guidelines appropriate for the performance standards proposed by the brief.
- Assist preliminary design and cost planning for the subsequent building refurbishment and construction.

The guidelines issued in this report should be read in conjunction with the following coded floor plans:

- ICU-SK101_REV 3 dated 29/06/09
- EB-SK100_REV 1 dated 05/06/09
- EB-SK101_REV 2 dated 29/06/09
- EB-SK102_REV 2 dated 29/06/09
- EB-SK103_REV 1 dated 50/06/09

Due consideration would be required to be given to the building façade facing the access ramp to the loading dock and internal driveway to take into account traffic noise intrusion within the new building.

Other aspects need to be consider regarding potential acoustic issues, including:

- The railway line located North of the East Block, this line is used by freight trains that are a lot noisier than passenger trains and are operating during the night.
- The mechanical plant item of adjacent building, especially the central plant area located West of the proposed new East Block.

This report shall not be relied upon as providing any warranty or guarantee of the building, it's services or equipment.

2.1 PURPOSE

The purpose of the report is to:

- Identify technical standards currently adopted for the project.
- Provide preliminary construction guidelines appropriate for the performance standards proposed by the brief.
- Assist preliminary design and cost planning for the subsequent building construction.

2.2 AUTHORITY

Authority to undertake this report was provided by Brian Cunningham of Hassell Pty Ltd on Friday, 15 May 2009.

3 BACKGROUND

3.1 INFORMATION SOURCES

1. Design Brief: NSW Health Department Technical Series TS-12 Internal Walling Systems for Health Care Buildings
2. Floor Plan

3.2 REVISION HISTORY

	Date Issued	**Comment**
A	2 July 2009	For Comment

4 PROJECT DESCRIPTION

4.1 SITE DESCRIPTION

The proposed redevelopment of the Nepean Hospital is located north of Derby Street, and south of the Great Western Highway, Penrith. The site is bordered by Parker Street to the west and by residential areas to the east and south of the site. Residential areas are situated along Somerset Street and Derby Street. Figure 1 and Figure 2 provide details of the site, surrounding area and identify noise sensitive locations.

The nearest potentially affected residential locations were identified as:

1. Residences on Somerset Street (Location 1) approximately 150 metres east of the site.
2. Residences on Derby Street (Location 2) approximately 180 metres south west of the site.

Figure 1: Aerial Photo of the Area

Source: iPlan provided by the NSW Department of Infrastructure, Planning and Natural Resources
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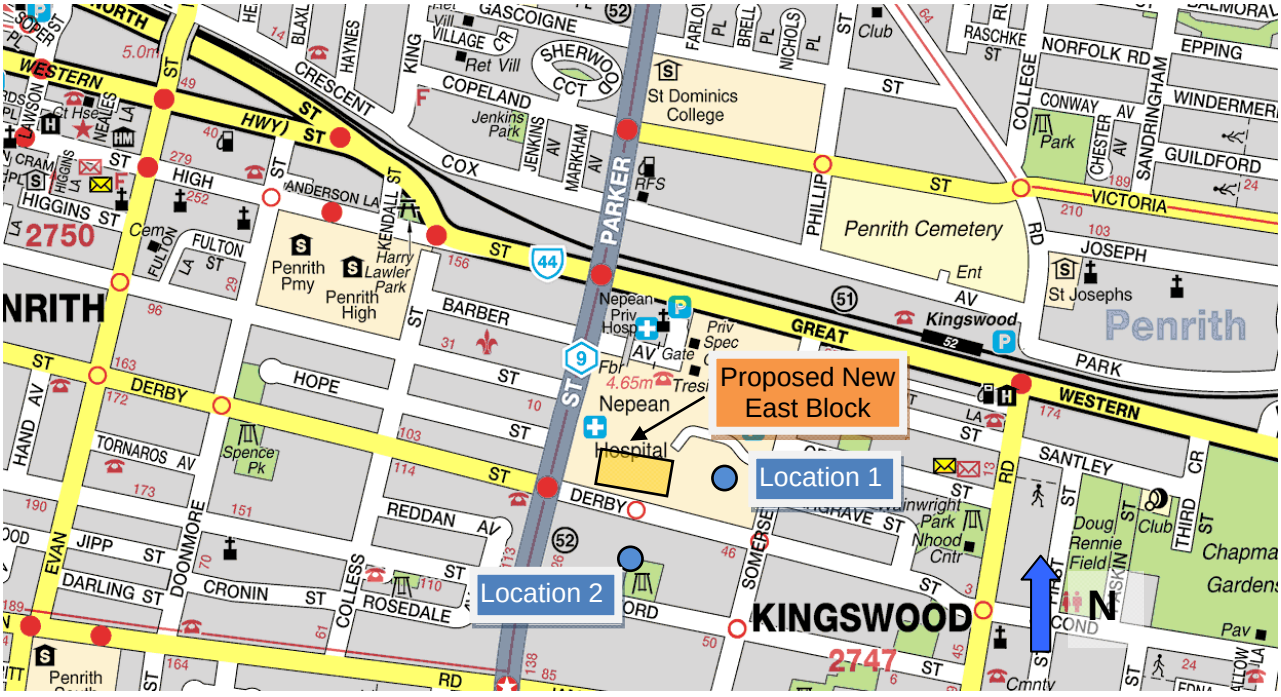
Figure 2: Site Location and Surrounding Area



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4.2 Existing Ambient Noise Levels

The local ambient noise is dominated by distant train and traffic noise. The level of background noise varies over the course of any 24-hour period, typically from a minimum at night (from 2:00am to 4:00am) to a maximum during morning and afternoon traffic peak hours (from 8:00 am to 10:00am and from 4:00pm to 6:00pm).

The NSW DECC *Industrial Noise Policy* (INP, Department of Environment and Climate Change) clarifies background and ambient noise for the daytime, evening and night time periods. The NSW DECC INP defines these periods as follows:

Day: is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.

Evening: is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.

Night: is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.

Noise monitoring has been undertaken at 28 Somerset Street, Penrith. This location was situated away from any mechanical plant and considered as representative from the area surrounding the site.

These results have been used to establish the noise criteria at the boundary of the nearest residences so as to determine noise limits from the mechanical plant of the proposed new building.

The results of the site noise level monitoring are presented in Table 1.

Table 1: Ambient & Background Noise Monitoring

Date	Average L_{Aeq} Noise Level - dB(A)			Background Noise Level (L_{A90}) - dB(A)		
	Day (7.00am – 6.00pm)	**Evening** (6.00pm – 10.00pm)	**Night** (10.00pm – 7.00am)	**Day** (7.00am – 6.00pm)	**Evening** (6.00pm – 10.00pm)	**Night** (10.00pm – 7.00am)
Location: 28 Somerset Street, Penrith						
Median Value	56	51	49	51	49	47

- Noise monitoring methodology is presented in Appendix 1.

  Ambient noise surveying was conducted at one measurement location, representative of the ambient noise levels at Location 1 and Location 2, shown in Figures 1 and 2.

- Monitoring location: Backyard of 28 Somerset Street, Penrith, between Wednesday, 13 May and Thursday 21 May 2009.

The measurement location was selected with the following specific objective in mind:

- To provide ambient and background noise data for the day, evening and night time periods to establish the acceptable noise limit at Locations 1 and 2 for the mechanical plant to be located on the eastern side of the proposed new building.

The results of the ambient and background noise monitoring are presented in in the graphs in Figure 3.

Figure 3: Long Term Noise Monitoring Results – Monitoring Location 1 – dB(A)

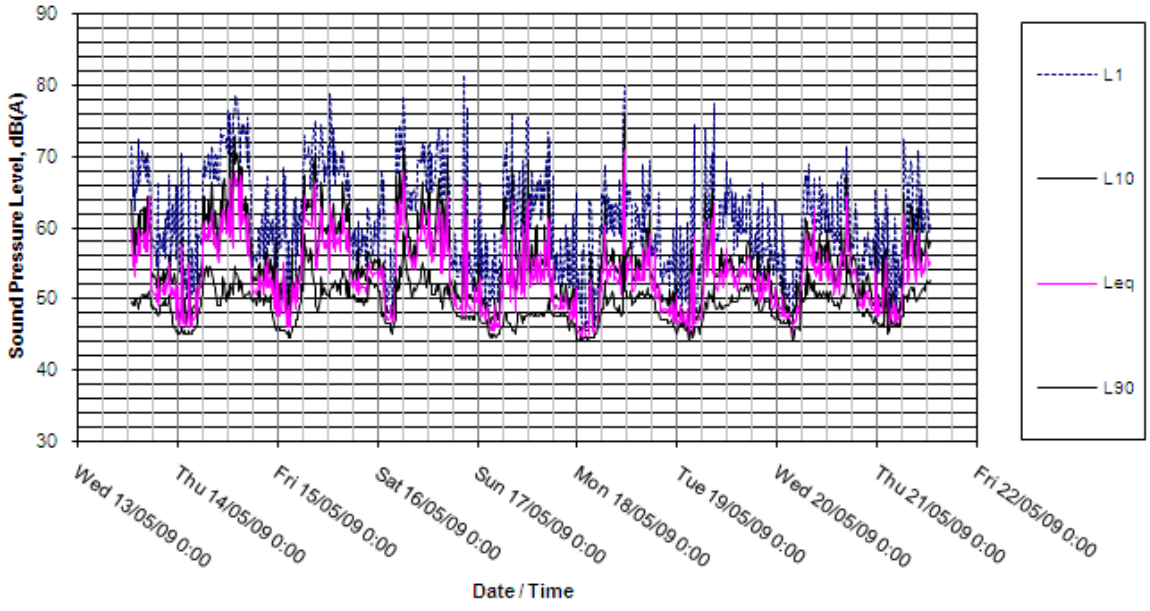


Figure 4: Daily Ambient Noise Distribution

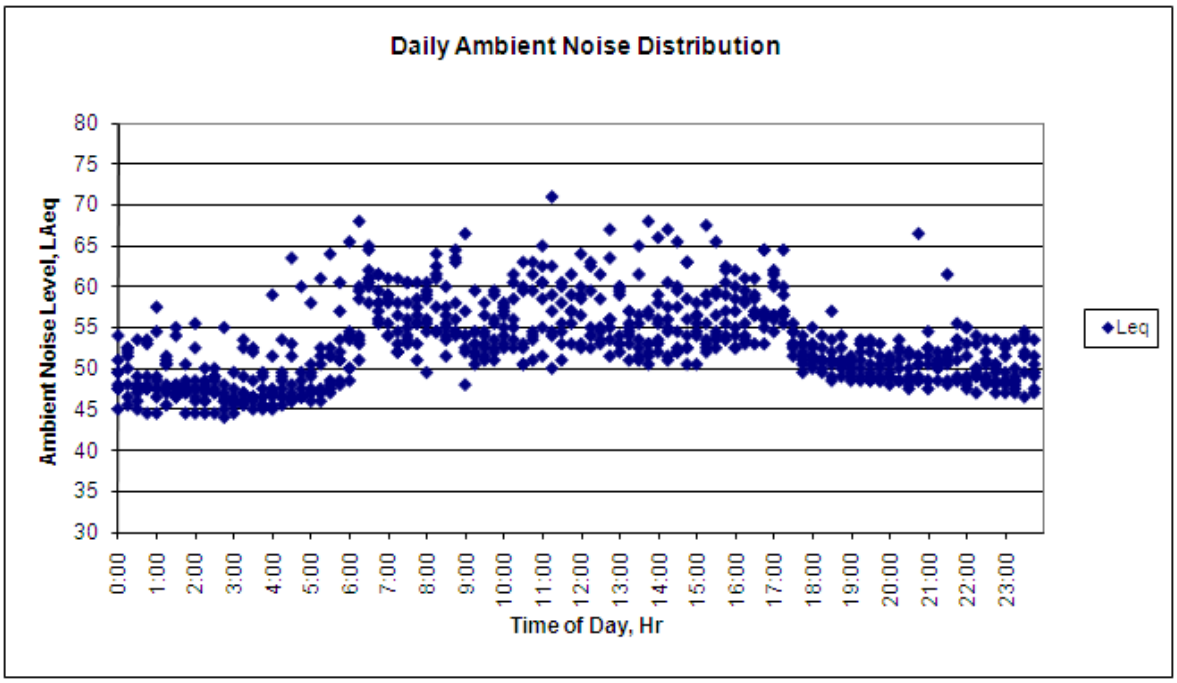
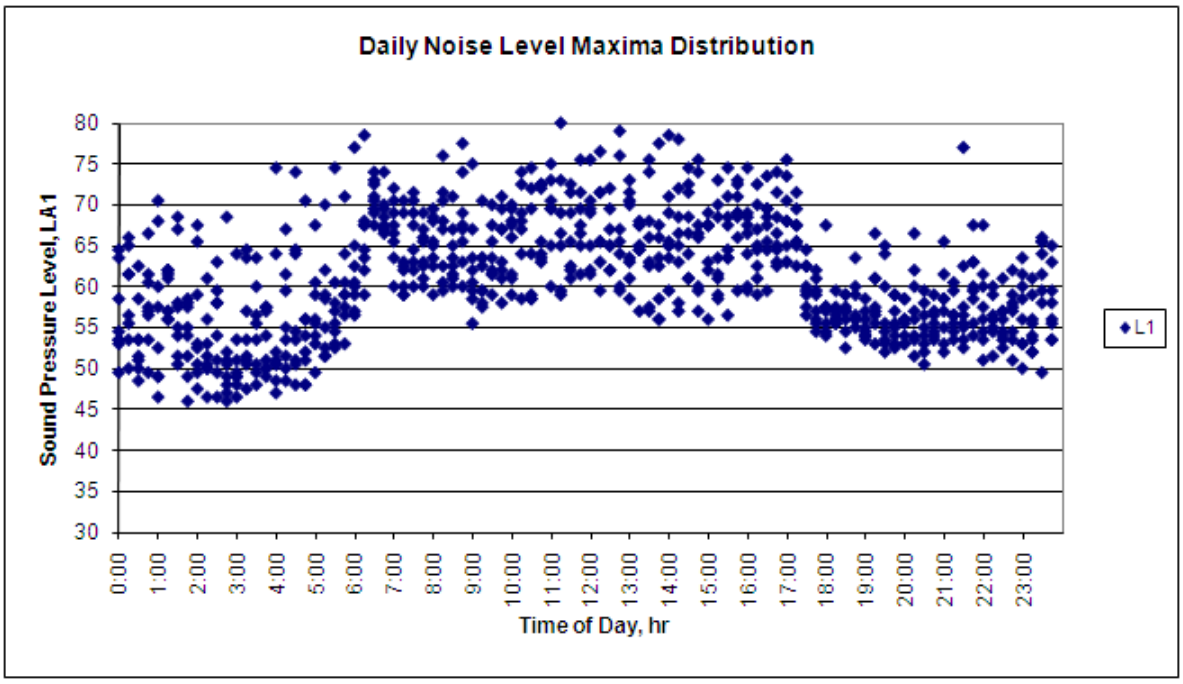


Figure 5: Daily Noise Level Maxima Distribution



4.3 ACOUSTIC BRIEF

Acoustic Performance Requirement Brief was discussed during initial design meeting with Hassell and the design team. The intent of the discussion was to provide noise levels, deemed to occur within different type of rooms of the proposed refurbishment area and new building (Nepean Hospital), on which the resultant level of speech privacy is based on. In addition, specific background noise levels generated by building services, primarily air-conditioning plant, were discussed for most spaces. In order to simplify our recommendations at this early stage of the project, we have provided recommendation for generic type of rooms on each level of the refurbishment area and proposed new building.

The functional requirements for a number of rooms, together with a number of room acoustic design parameters, were also provided. Subject to the endorsement by Hassell of these functional design statements, these will be adopted as the basis for the development of fit-out design and room acoustic performance aspects.

4.4 BACKGROUND NOISE TARGET

With some relatively minor exceptions, the recommended background noise level targets stated in the proposed draft design brief are generally consistent with good practice and the Health Design Guideline Technical Series TS-12, Internal Walling Systems for Health Care Buildings.

Background noise level targets, obtained from Hassell Acoustic Requirements Brief, are scheduled in this report as part of **Table 3** in Section 6.1.

5 SITE SPECIFIC NOISE AND VIBRATION SOURCES

5.1 EXTERNAL NOISE SOURCES

External source of noise affecting the proposed development of the new Nepean Hospital's building (East Block) will include:

- Railway noise during the night time coming from the railway line (freight trains) located east of the site.
- Traffic noise from car using the access ramp adjacent to the East Block to the carpark.
- Additional traffic noise generated by the proposed redevelopment, on Somerset Street, Penrith.
- Carparking activity noise within the carpark adjacent to the proposed East Building.
- Loading dock activity noise.
- Noise from surrounding building services plant.

Each of the above items has been surveyed to confirm appropriate design noise levels on which to base design development.

The findings from the site noise and vibration surveying are presented in the following sections.

5.2 RAILWAY NOISE

The railway track is located approximately 300m North of the façade of the proposed East Block.

It was found through the consultation of the train timetable provided by Railcorp: "Freight Services Standard Working Timetable" version 1.0 effective from May 2009, that freight trains are operating through the night time.

The noise monitoring conducted on the balcony of the existing nurses residence demonstrate that the noise levels (LA1) at the façade of the proposed East Block will reach up to 70 dB(A).

5.3 TRAFFIC NOISE

5.3.1 Traffic Noise Intrusion to Hospital

This section presents an assessment of traffic noise intrusion into the proposed new East Block building.

One of the potential acoustic issues regarding the location of the new building, and especially the western and northern façade of the building, is the proximity to Somerset Street and the internal driveway. Considering the important distance (approximately 100m) of the proposed new building from Somerset St, it is highly likely that the main source of traffic noise will be coming from cars accessing the carpark and other part of the hospital through the internal driveway.

5.3.2 Traffic Noise Impact on the Nearest Residences

The capacity of the carpark on site will remain the same. The development will therefore not create additional traffic noise overall but could create additional traffic noise on Somerset Street as additional carpark are likely to be built in the vicinity of the proposed new East Block.

Cars entering the site will pass by residential areas along Somerset Street once the development will be completed, therefore the potential noise impact from traffic generated by the development should be considered to protect the noise amenity of the nearest residents.

An ambient noise survey was conducted on site to determine the existing levels of traffic noise on Somerset Street on Wednesday, 13 May and Thursday, 21 May 2009.

5.3.3 Traffic Noise Monitoring Results

Attended traffic noise survey was conducted along Somerset Street during peak hour traffic to assess the existing traffic noise passing by the residential areas.

Table 2 presents the results of the noise monitoring conducted along Somerset Street, Penrith.

Table 2: Traffic Noise Monitoring – Along Somerset Street, Penrith

Date and Time	**$L_{Aeq,15min}$ Noise Level dB(A)**
Location: 28 Somerset Street	
Wednesday 13 May 2009	63
Thursday 21 May 2009	62

Traffic noise surveying was conducted at one measurement location, representative of traffic noise levels exposure of residences located along Somerset Street, Penrith.

- Monitoring Location: on the footpath separating of Somerset Street 7m away from the road. The monitoring was performed Wednesday 13 and Thursday 21 May 2009.
- The measurement location was selected with the following specific objective in mind:

  "To provide traffic noise generation records from which to evaluate the additional traffic noise generated by the proposed development along Somerset Street. This Traffic monitoring will also allow to calibrate the calculation of the future traffic noise likely to affect the residents located along Somerset Street"

5.4 CARPARK ACTIVITIES

The entrance / exit of the semi-underground carpark of the proposed new building is to be located on the eastern façade. An access road will be created to access the carpark that would be temporarily located on level 1 of the proposed East Block. The traffic flow transiting through the carpark entrance / exit has the potential to create noise that will have an impact onto the building design envelope. It is also important to consider the fact that the carpark is a single level carpark. Therefore the movements of cars in the carpark could create some noise impact in the spaces located directly above.

At this stage of the project the access path to the carpark is not completely defined, therefore it is important to keep in mind that the traffic noise generated by cars pass-bys has the potential to affect the design of the building envelope adjacent to the driveways.

5.5 MECHANICAL PLANT FROM SURROUNDING BUILDINGS

It is important to assess the noise contribution of other mechanical plants surrounding the proposed new building to ensure that they are included in the design.

During our site inspection and noise survey, special attention has been made to establish the contribution to the ambient noise level of the mechanical plants located on other building roofs.

During the site noise survey, however, only one mechanical plant located on other surrounding buildings was audible. Therefore, at this stage, there is no apparent design requirement associated with other building plant.

6 DESIGN CRITERIA

Sections 6.1 to 5.5 present the relevant noise criteria addressing the major acoustic issues such as traffic, loading dock, carpark, mechanical plant, internal noise isolation, including plant room and public spaces, which have the potential to impact on the project design.

These sections include recommended internal noise levels, vibration criteria, recommended helicopter internal noise levels within the different type of occupancies, and also environmental and traffic noise criteria that have been applied in this partial scheme concept design.

6.1 RECOMMENDED INTERNAL NOISE LEVELS

The AS/NZS 2107:2000 *"Acoustics-Recommended design sound levels and reverberation times for building interiors"* is the Australian Standard that provides the recommended design sound pressure levels and reverberation times inside buildings.

For Office and Health buildings, the standard recommends the design sound levels listed in **Table 3**.

Table 3: Recommended Noise Levels According to AS/NZS 2107:2000

Type of Occupancy / Activity	Recommended Design Sound Level, L_{Aeq}, dB(A)		Recommended Reverberation Time T (s)
	Satisfactory	Maximum	
Health Buildings			
Corridors and lobby spaces	40	50	0.4 to 0.6
Consulting rooms	40	45	0.4 to 0.6
Geriatric Rehabilitation	40	45	0.4 to 0.6
Intensive care wards	40	45	0.4 to 0.6
Kitchens, sterilizing and services area	50	55	0.6 to 0.8
Laboratories	45	50	0.4 to 0.7
Nurses' stations	40	45	0.4 to 0.7
Office areas	40	45	0.4 to 0.7
Pharmacies	45	50	0.4 to 0.6
Wards	35	40	0.4 to 0.7
Waiting rooms, reception areas	40	50	0.4 to 0.7
Office Buildings			
Board and conference rooms	30	40	0.6 to 0.8
Computer rooms	45	50	See note 3
Private offices	35	40	0.6 to 0.8
Public spaces	40	50	0.5 to 1
Rest rooms and tea rooms	40	45	0.4 to 0.6
Toilets	50	55	-
Undercover carparks	55	65	-

Note: "-" means that there is no specific recommended reverberation time to apply.

6.2 NSW DEC ASSESSING VIBRATION: TECHNICAL GUIDELINE (2006)

This document issue by the NSW DEC is based on guidelines contained in BS 6472 – 1992, *"Evaluation of human exposure to vibration in buildings (1-80 Hz)".*

The technical guideline divide the type of vibration sources into two sub-categories:

Continuous and Impulsive Vibration; and

Intermittent Vibration.

In our case the vibration generated by trains is classified as intermittent vibration.

When assessing intermittent vibration, the vibration dose value (VDV) should be used. The VDV accumulates the vibration energy received over the daytime and night time periods.

The vibration dose value is fully described in BS 6472- 1992. Acceptable values of vibration dose are presented in Table 7.

Table 4: Acceptable Vibration Dose Values for Intermittent Vibration (m/s$^{1.75}$)

Location	Daytime[1]		Night - time[1]	
	Preferred Values	**Maximum Values**	**Preferred Values**	**Maximum Values**
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26

Note: [1] The NSW DEC vibration guideline defines the Daytime as the period from 7:00am to 10:00pm and the night time from 10:00pm to 7:00am

[2] Examples include hospital operating theatres and precision laboratories where sensitive operations occur. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas.

Source: BS 6472-1992

6.3 ENVIRONMENTAL NOISE CRITERIA

The environmental noise criteria or project-specific noise level is calculated following the NSW DECC INP guidelines.

The calculation is based on the results of the ambient and background noise unattended monitoring, addressing two components:

- Controlling intrusive noise into nearby residences (Intrusiveness Criteria)
- Maintaining noise level amenity for particular land uses (Amenity Criteria)

Once both criteria are established the most stringent for each considered assessment period (day, evening, night) is adopted as the project-specific noise level.

Table 5: Project-Specific Noise Levels (PSNL)

Period	Descriptor	PSNL
Location 1: 28 Somerset Street, Penrith		
Day	$L_{Aeq,15\ min}$	46 dB(A)
Evening	$L_{Aeq,15\ min}$	45 dB(A)
Night	$L_{Aeq,15\ min}$	40 dB(A)
Location 2: 46 Derby Street, Penrith		
Day	$L_{Aeq,15min}$	46 dB(A)
Evening	$L_{Aeq,15min}$	45 dB(A)
Night	$L_{Aeq,15min}$	40 dB(A)

As the mechanical plant located on the roof of the proposed new building will be operating 24 hours per day, the most stringent noise criterion to meet at the boundary of the nearest residence will be the night time criterion of 40 dB(A).

6.4 TRAFFIC NOISE

The L_{Aeq} noise level or the "equivalent continuous noise level" correlates best with the human perception of annoyance associated with traffic noise.

Road traffic noise impact is assessed in accordance with the *NSW Environmental Criteria for Road Traffic Noise* (ECRTN, Environment Protection Authority 1999).

Table 1 – "*Road Traffic Noise Criteria for Proposed Road or Residential Land Use Developments*" divides land use developments into different categories and lists the respective criteria for each case. Relevant to the facility here is Category 8 of the table and is reproduced in **Table 6**.

Category 8 relates to Somerset Street, located of the site.

Table 6: NSW Environmental Criteria for Road Traffic Noise

Type of Development	Criteria		
	Day, dB(A)	Night, dB(A)	Where Criteria are Already Exceeded
8. Land use developments with potential to create additional traffic on collector road	$L_{Aeq(1\ hr)}$ 60	$L_{Aeq(1\ hr)}$ 55	Where feasible, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments. In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB.

The inherent quality of noise from vehicles on public roads arriving at and departing from the site, would be indistinguishable from other traffic noise on public roads.

Where existing noise levels exceed these limits, then a **2 dB(A)-noise increase on existing noise levels is permissible**, provided it can be shown that traffic noise mitigation here is not feasible and practicable.

6.5 ACOUSTIC DESIGN MANAGEMENT

The following parameters can be measured and can be specified as a requirement under a building trade or construction contract:

1 Noise reduction between spaces and the sound isolation performance of many of the component building elements.

2 Background noise level within a space.

3 Reverberation time within a space.

4 Sound absorption properties of the finishes included in a space.

The following parameters can be inferred but cannot be specified as a responsibility under a building contract:

1 Speech intelligibility level within a space.

2 Speech privacy within a space.

The following parameters cannot be measured and cannot be specified:

1 Acoustic Diffusion.

2 Nuisance or interference.

7 CONSTRUCTION PHASE MANAGEMENT

7.1 BASE BUILDING DESIGN

The general structure for the acoustic design management will be:

- The room uses, activities and numerical design criteria will be developed with input from Hassell, refined and documented on room data sheets.
- Design review of mechanical services and other building services will progress with the developing design so as to maintain appropriate levels of background noise levels, both inside and outside the proposed new and existing building.
- Acoustic design of interior partitions, walls, floors and the building envelope will be progressively developed so as to comply with the acoustic room data sheets. This report uses acoustic grade ratings – a concept proven highly effective in a number of past projects – to identify the level of sound isolation performance for areas of the building. The grade rating system will be utilised to assist co-ordination for some aspects of the future construction contract documentation. The acoustic grade rating system directly correlates with the guideline provided in section 6 of TS12.
- Acoustic design co-ordination will be progressively implemented, in association with the architects, to develop appropriate sound absorptive finishes for offices, public and main circulation areas.

7.2 CONSTRUCTION CONTRACT DOCUMENTATION

It is intended that contract specifications will incorporate the following acoustic controls:

- Background noise levels scheduled by room.
- Sound isolation specifications, using grade ratings, referring to walls, ceiling and doors.
- Quality controls on building junction acoustic seals co-ordinated against grade ratings.
- Quality controls on service penetration seals, including provision for communication cables, co-ordinated against grade ratings.
- Quality controls on hydraulic service pipes co-ordinated against background noise levels.
- Quality controls on duct air velocities.
- Quality planning requirements covering submissions and installation controls and specifying required ‘proof-of-performance’ tests.
- Acceptance criteria – tolerances for background noise levels, partition sound ratings and reverberation times.

7.3 SOUND ISOLATION GRADE RATINGS

- For concept planning, the components most affecting costs will be the sound isolation systems. To simplify this and make provision for as many co-ordination issues as possible and as a basis for defining the performance standards adopted by this partial scheme design, a grade rating system is proposed.
- This consists of a single integer code, to be shown on architectural drawings, as the basis for concept construction design and future construction co-ordination. The grades are, primarily, based on sound reduction index but do also take account of other factors influencing the preferred sound isolation quality, such as resistance to impact noise.

The technical interpretation of the Dw and Rw values represented by a grade rating, using Grade 3 as an example, is:

40	Range of Dw and Rw values corresponding to Grade Number - e.g. Grade 3 (40-45)				45
	Site acceptance criterion Dw		Material/product selection criterion Rw		
⇐	typically 40-43	⇒	⇐	typically 43-45	⇒

The grade rating corresponding to Rw are presented in Table 7. Indicative, in principle construction arrangements are also provided.

For concept design co-ordination, the grade rating might also be used to make cost provision for appropriate door systems using Table 8.

The use of Table 7 for planning assumes that the doors within any wall will occupy 10 to 15 percent only of that wall. It is likely that the detailed door design requirements will not be established until the floor plans and key dimensions are frozen. Sliding doors and pivotal doors are not recommended for grade 2 walls or wall with higher grade rating.

Table 7: Sound Isolation Grades – Concept Construction Arrangements

Grade	Dw - Rw Values	Wall Height / Ceiling Configuration	Typical Drywall Details (No postscript)	Typical Block or Masonry Details (Postscript A)	Precast Panel Details (Postscript B)
0	N/a	Not Relevant	Not critical	Any choice	Any choice
1	30-35	Usually to ceiling only	Usually any choice	Any choice	Any choice
2	35-40	May be slab to slab unless set PB ceiling	Usually includes insulation	Often rendered	Sealed 100mm panel
3	40-45	Slab to slab	Always includes insulation	Rendered	Sealed 150mm panel
4	45-50	Slab to slab	Usually separate studs + insulation	Special blocks or double layer	Pre-cast panel or panel plus secondary liner
5	50-55	May need isolation	Must be separate studs + insulation	Double walls (cavity with insulation)	Pre-cast panel plus secondary liner

Table 8: Sound Isolation Grades – Typical Door Arrangements

Grade	Dw - Rw Values	Typical Arrangement	Typical Leaf Thickness - mm	Typical Frame Seal Details
0	Not applicable	Not relevant	Not applicable	Not applicable
1	20-25	Door leaf fitted on site to standard frames	32mm	Simple seals to frame
2	25-30	Door leaf fitted on site to standard frames	32mm	Simple seals to frame and threshold
3	30-35	Door leaf and frame designed together	40mm	Seals to frame and threshold
4	35-40	Proprietary door/frame assembly	50-70mm	Usually requires proprietary seals
5	40-45	Proprietary door/frame, pre-hung	100mm or more	Always requires proprietary seals

It is important to be aware of the impact that a choice of a type of partition may have on the final design. For example, using a masonry wall may have more implication on services than using dry wall (management of penetration and acoustic seals).

Another implication of the use of masonry walls, for example for staircase, is the impact generated by closing access doors and vibration transmission through the floor and ceiling to internal spaces.

8 RECOMMENDATIONS

8.1 ROOM ACOUSTIC TREATMENT

The new East Block and refurbishment of the existing ICU at the Nepean Hospital Building Schematic Acoustic Design uses internal background noise level as the basic design criterion on which to base the room acoustic design. Good design practice will require the integration of absorptive finishes within office and gathering areas.

For design and cost planning, a 13mm thick plasterboard layer and acoustic tiles (for instance mineral fibre tiles) within wards and other sensitive areas have been adopted as the ceiling construction across the building (Ground Level to Level 3). Typical finishes are likely to involve curtains and other supplementary absorptive finishes on ceilings and walls in order to meet the internal recommended noise levels. The final choice and arrangement of absorption materials will be the subject of design development.

The absorptive material and finishes used within the proposed new and existing building should comply with the Australasian Health Facility Guidelines that recently superseded the NSW Health Facility Guidelines.

8.2 IMPACT ON BUILDING ENVELOPE

Three major sources of noise will need to be considered:

- The car park access ramp.
- Traffic noise from the Great Western Highway.
- The train pass-bys.

Although the railway line is located 325m north of the proposed East Block due consideration should be given to freight trains passing by during the night.

At this stage the results of the noise monitoring at the current nurses residence (where the East Block would be located) showed that no particular consideration for the building facade is required to achieve internal background noise levels. It is expected that a single laminated glass type 6.38mm will be sufficient in order to achieve internal noise levels within the most stringent spaces.

8.3 PRELIMINARY CONSTRUCTION ARRANGEMENTS

The following sketches (Figures 6 to 10), read in conjunction with the coded floor plans appended to this report, identify the sound isolation properties incorporated into the design and within the current cost planning. Where a wall is non-coded, an adequate acoustic performance is considered to be achieved by a partition with no special construction attention, other than good construction practice and a nominally completed construction barrier. For some areas, such as store rooms, no acoustic performance is needed and, similarly, no acoustic grade rating is shown.

A special consideration needs to be made to partitions separating bathroom towards or bathroom to other occupied room. These partitions need to be discontinuous (type staggered stud) to avoid impact noise.

The construction arrangements are preliminary and endeavour to describe the key construction features. In some instances, the sketches indicate the minimum construction slab thicknesses necessary to achieve control of flanking noise transmission.

Figure 6: Grade 1 Construction Arrangement - Drywall

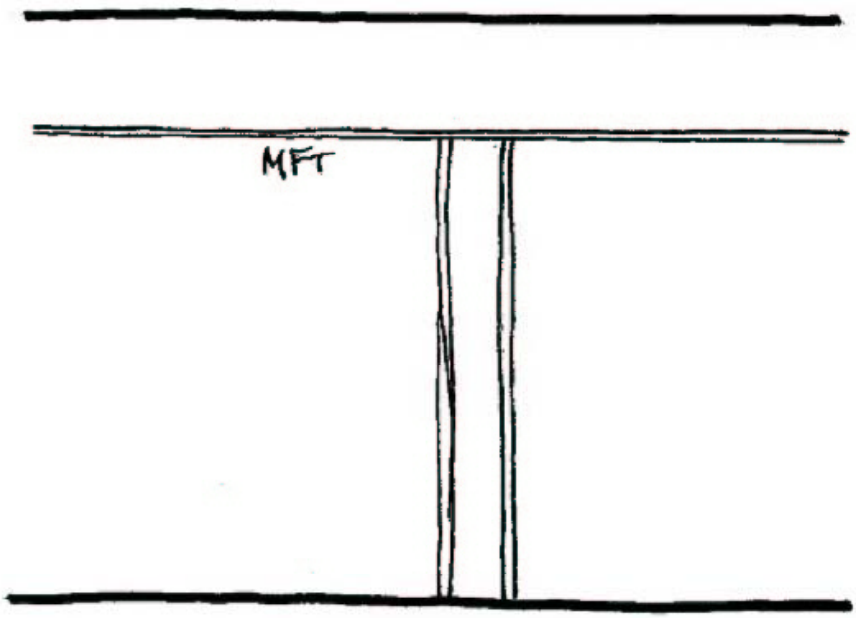


Figure 7: Grade 2 Construction Arrangement Options - Drywall

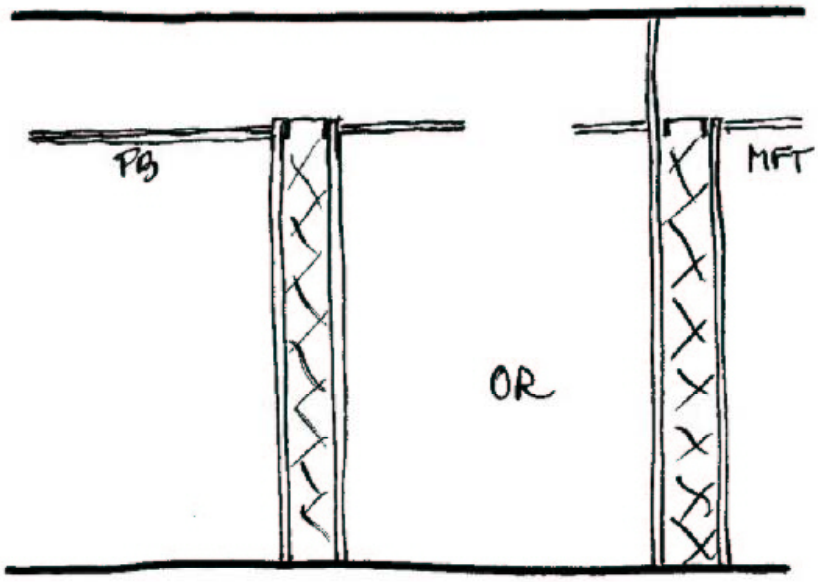


Figure 8: Grade 3 Construction Arrangement Options - Drywall

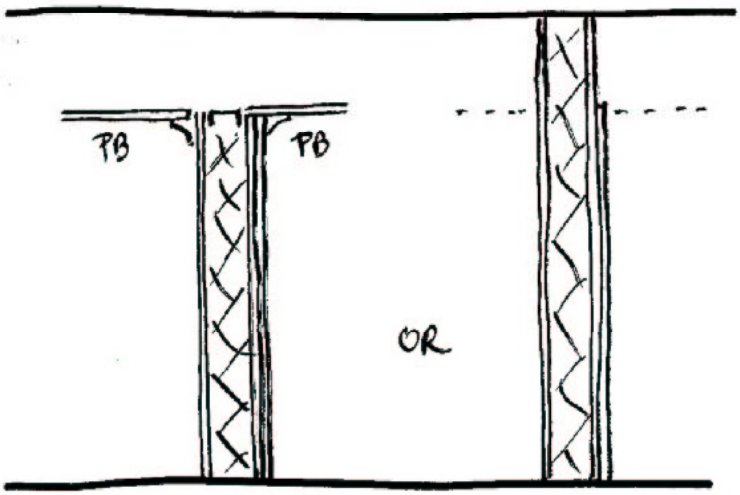


Figure 9: Grade 4 Construction Arrangement Options - Drywall

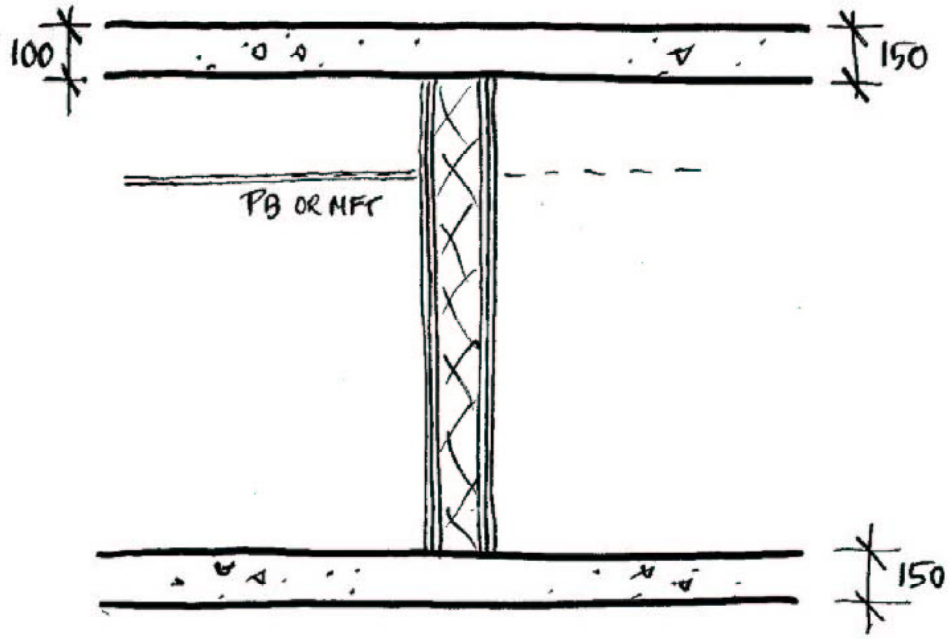
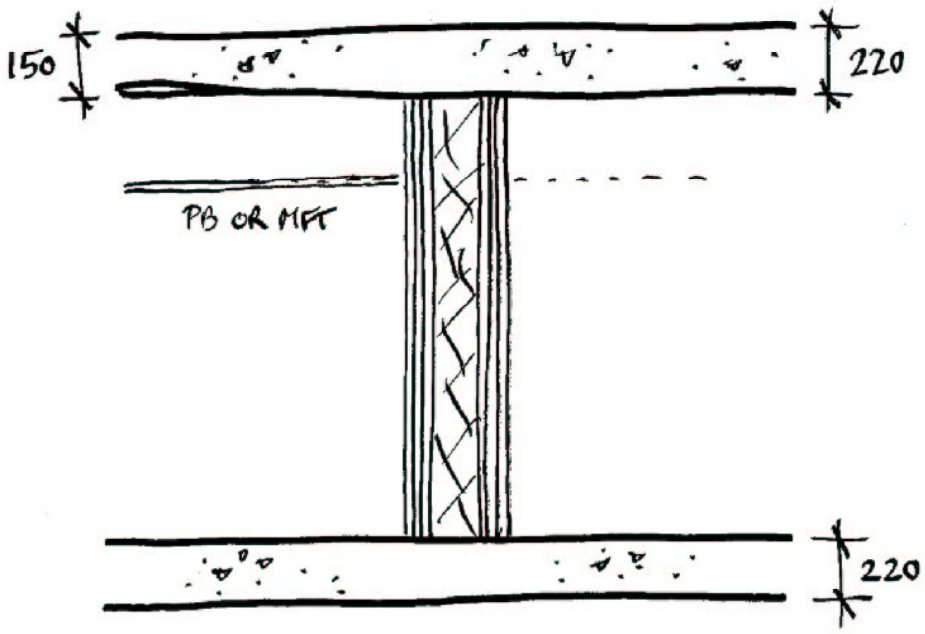


Figure 10: Grade 5 Construction Arrangement options – Drywall



8.4 MECHANICAL SERVICES

8.4.1 Internal

In general, internally insulated ductwork should be anticipated for all meeting, theatre, education and ward areas with primary, and in some cases secondary, silencers within ducting, with independent duct distribution systems serving particular sensitive spaces.

Key design parameters required to achieve satisfactory background plant noise levels inside the new building will require incorporation of internal duct insulation to most areas, distribution ducting and the design of ductwork so as to maintain satisfactory air velocities in areas close to the registers. Optimum air velocities can be exceeded when accompanied by strict control of the smoothness of internal duct construction, however the preferred design strategy is to maintain duct velocities within limits that have been proven to be satisfactory under normal construction conditions.

Where practical, ductwork will be dimensioned so as to conform with the maximum airflow velocities given below in Table 9.

Also, where practical, duct distribution will be along corridors with run-out ducts serving each technical space individually.

All internal linings or installation of silencers used within the proposed new building should comply with the Australasian Health Facility Guidelines.

Table 9: Recommended Duct Airflow Velocities, Metre per Second – East Block & ICU

Room Category	Services Noise Rating NR	Plant Room and Riser Duct Velocity m/s	Main Duct Velocity m/s	Branch Duct Velocity m/s	Run Out Duct Velocity m/s	Internal Duct Lining Guide
Level 1 – East Block						
Carpark	NR 50	17	12	9.5	7	Not Required
Level 2 – East Block						
Store Room	NR45	15	10.5	8	6	Not required
Operating Theatre	NR35	11	8	6	4.3	Run-out
Control Room	NR30	9.5	6.8	5	3.5	Branch + Run out
Private Offices	NR30	9.5	6.8	5	3.5	Branch + Run out
Resource Room	NR40	13	9	7	5	Run out Optional
Change Room	NR45	15	10.5	8	6	Not required
Meeting Room	NR25	8	5.6	4.2	2.8	All
Dirty Utility	NR45	15	10.5	8	6	Not required
WC	NR45	15	10.5	8	6	Not required
Consultation Room	NR35	11	8	6	4.3	Run-out
Staff Base	NR35	11	8	6	4.3	Run-out
Reception	NR35	11	8	6	4.3	Run-out
Discharge Lounge	NR35	11	8	6	4.3	Run-out
Interview Room	NR35	11	8	6	4.3	Run-out
Bookings	NR35	11	8	6	4.3	Run-out
Workstations	NR35	11	8	6	4.3	Run-out
Level 3 – East Block						
Meeting Room	NR25	8	5.6	4.2	2.8	All
Staff	NR35	11	8	6	4.3	Run-out
Office	NR35	11	8	6	4.3	Run-out
EQ Store	NR45	15	10.5	8	6	Not required
Therapy	NR35	11	8	6	4.3	Run-out
Wards	NR35	11	8	6	4.3	Run-out
WC	NR45	15	10.5	8	6	Not required
Staff Base	NR35	11	8	6	4.3	Run-out
Handover & Workstation	NR35	11	8	6	4.3	Run-out
Dirty Utility	NR45	15	10.5	8	6	Not required
Patient Lounge	NR35	11	8	6	4.3	Run-out-

ICU						
Disposal Room	NR45	15	10.5	8	6	Not required
Bedroom	NR30	9.5	6.8	5	3.5	Branch + Run out
Clean Utility	NR45	15	10.5	8	6	Not required
Assisted Shower	NR45	15	10.5	8	6	Not required
Reception	NR40	13	9	7	5	Run out Optional
Waiting Room	NR40	13	9	7	5	Run out Optional
WC	NR45	15	10.5	8	6	Not required
Interview Room	NR35	11	8	6	4.3	Run-out-
Report	NR35	11	8	6	4.3	Run-out-
Change	NR35	11	8	6	4.3	Run-out-
CVUS Office	NR30	9.5	6.8	5	3.5	Branch + Run out
Ultra Sound Room	NR35	11	8	6	4.3	Run-out-
Procedure Room	NR35	11	8	6	4.3	Run-out-
Office Num	NR30	9.5	6.8	5	3.5	Branch + Run out
Office Shared	NR30	9.5	6.8	5	3.5	Branch + Run out
Store	NR45	15	10.5	8	6	Not required
Equipment Clean-up	NR45	15	10.5	8	6	Not required
Office Open Plan	NR35	11	8	6	4.3	Run-out-
IT	NR45	15	10.5	8	6	Not required
Pathology	NR35	11	8	6	4.3	Run-out-
Meeting Room	NR25	8	5.6	4.2	2.8	All
Change Room	NR45	15	10.5	8	6	Not required
VICCU	NR35	11	8	6	4.3	Run-out-
Office Registrars	NR30	9.5	6.8	5	3.5	Branch + Run out

Copies of these marked up floor plans attached with this report are located in Appendix 2.

Further review of mechanical sources schematics shall be conducted as design develops.

8.4.2 External

The proposed new development of the Penrith Health Campus (Nepean Hospital East Block) building site and proposed layout suggest that most of the plant equipment will be located on ground level and on the roof of the building on the southern side.

At this stage of the project it is difficult to assess the potential impact of the mechanical plant on the nearest receiver locations, as the plant specifications are unknown.

For cost planning, an allowance should be made for noise control measures at roof level to improve noise attenuation. This provision includes material for the plant room such as screens or barriers, internal insulation, attenuators and acoustic louvers.

9 APPENDIX 1

9.1 GLOSSARY

NOISE

Acceptable Noise Level: The acceptable L_{Aeq} noise level from industrial sources, recommended by the EPA (Table 2.1, INP). Note that this noise level refers to all industrial sources at the receiver location, and not only noise due to a specific project under consideration.

Adverse Weather: Weather conditions that affect noise (wind and temperature inversions) that occur at a particular site for a significant period of time. The previous conditions are for wind occurring more than 30% of the time in any assessment period in any season and/or for temperature inversions occurring more than 30% of the nights in winter).

Acoustic Barrier*:* Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc used to reduce noise, without eliminating it.

Ambient Noise: The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.

Assessment Period: The period in a day over which assessments are made.

Assessment Location : The position at which noise measurements are undertaken or estimated.

Background Noise: Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the $\mathbf{L_{90}}$ noise level.

Decibel [dB]: The units of sound pressure level.

dB(A): A-weighted decibels. Noise measured using the A filter.

Extraneous Noise: Noise resulting from activities that are not typical of the area. Atypical activities include construction, and traffic generated by holidays period and by special events such as concert or sporting events. Normal daily traffic is not considered to be extraneous.

Free Field: An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground.

Frequency: Frequency is synonymous to pitch. Frequency or pitch can be measured on a scale in units of Hertz (Hz).

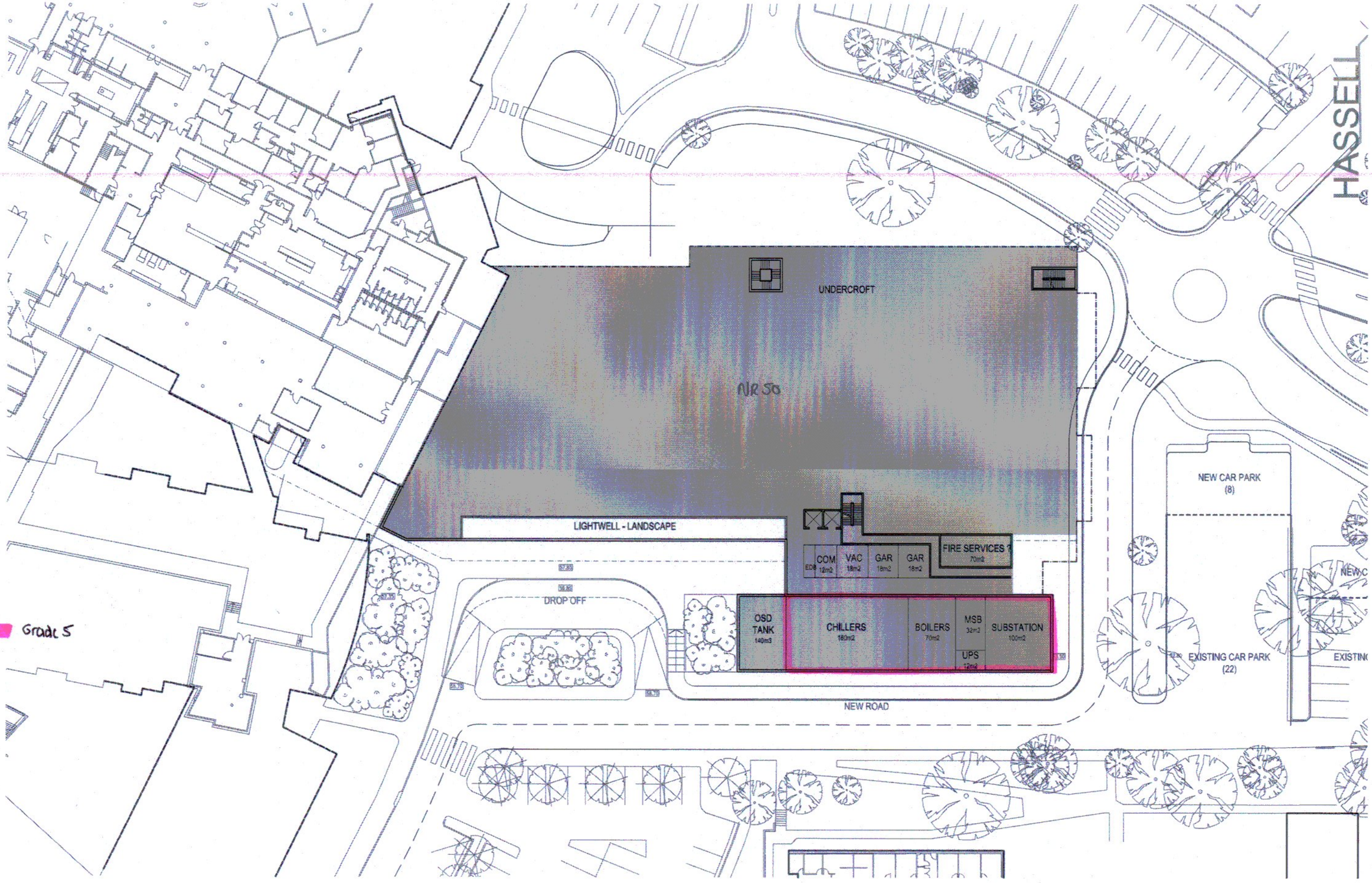
Impulsive Noise:	Noise having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent Noise:	Level that drops to the background noise level several times during the period of observation.
L_{Amax}	The maximum sound pressure level measured over a period.
L_{Amin}	The minimum sound pressure level measured over a period.
L_{A1}	The sound pressure level that is exceeded for 1% of the time for which the sound is measured.
L_{A10}	The sound pressure level that is exceeded for 10% of the time for which the sound is measured.
L_{A90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L_{90} noise level expressed in units of dB(A).
L_{Aeq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection:	Sound wave changed in direction of propagation due to a solid object meets on its path.
R-w:	The Sound Insulation Rating R-w is a measure of the noise reduction performance of the partition.
SEL:	Sound Exposure Level is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound Absorption:	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter:	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level:	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level:	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise:	Containing a prominent frequency and characterised by a definite pitch.

VIBRATION

Annoyance:	Type of reaction felt by humans in response to vibration. The degree of annoyance felt by an individual may be assessed by using social survey techniques.
Comfort:	Subjective state of wellbeing in relation to an induced environment such as mechanical vibration (or shock). Comfort connotes the absence of disturbing or intrusive factors.
Crest Factor:	The ratio between the peak level and the rms value of a signal.
DEC:	Department of Environment and Conservation.
eVDV:	Estimated vibration dose value.
Resonance:	Resonance of a system in forced oscillation exists when any change in the frequency of excitation causes a decrease in a response of the system.
Rms:	Root mean square.
VDV:	Vibration dose value.
Vibration Isolator:	A support whose function is to attenuate the transmission of vibration in a frequency range.
x-axis vibration:	(*Pertaining to whole-body vibration*) - Mechanical vibration acting along the postero-anterior (back-to-front) axis of the human body.
y-axis vibration:	(*Pertaining to whole-body vibration*) - Mechanical vibration acting laterally (sideways) upon the body.
z-axis vibration:	(*Pertaining to whole-body vibration*) - Mechanical vibration acting along the caudocephalic (foot-to-head) axis of the human body.

10 APPENDIX 2

10.1 MARKED-UP DRAWINGS



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Aurora Projects	Penrith Health Campus Redevelopment	East Block Plan - Level 1	EB-SK100_REV 1	PSA7717	05.06.2009	1:500 @ A3	MC

Grade 1
Grade 2
Grade 3
Grade 4
Grade 5

HASSELL

COURT
1
2
COURT
3
4
5
6
RELOCATED ANAES. STORE 28M2
VOID
STAGE 1
STAGE 1 STORE
CLEAN UTILITY
STAFF BASE
TB
STAGE 2
DIRTY UTILITY 12M2
OPEN REV BAY 8M2
STAFF BASE 8M2
CLEAN UTILITY 24M2
STAFF BASE 8M2
EQUIPMENT STORE 28M2
CL
SOILED
ACC WC
SH
WC
ES
SH
ES
PRE + POST OP
EDO
DISPOSAL ROOM 8M2
OU
SOILED
ENTRY
LINK
TB
CONTROL
NEW CAR PARK
(8)
EXISTING CAR PARK
(22)
DROP OFF
NEW ROAD
57.85
57.35
56.85
56.70
56.70
62.80

Client	Project	Drawing	Drawing No	Project No	Date	Scale	Drawn By
Aurora Projects	Penrith Health Campus Redevelopment	East Block Level 2 Plan	EB-SK101_REV 2	PSA7717	29.06.2009	1:200 @ A1	MC

HASSELL

Grade 1
Grade C
Grade 3
Grade 4
Grade 5

VOID

ROOF

VOID

PLANT

COURT

TOTAL AREA =
2359M2

ROOF

DROP OFF

NEW ROAD

NEW CAR PARK
(8)

EXISTING CAR PARK
(22)

57.85
67.35
56.85
56.70
56.70
53.50
62.80

Client	Project	Drawing	Drawing No	Project No	Date	Scale	Drawn By
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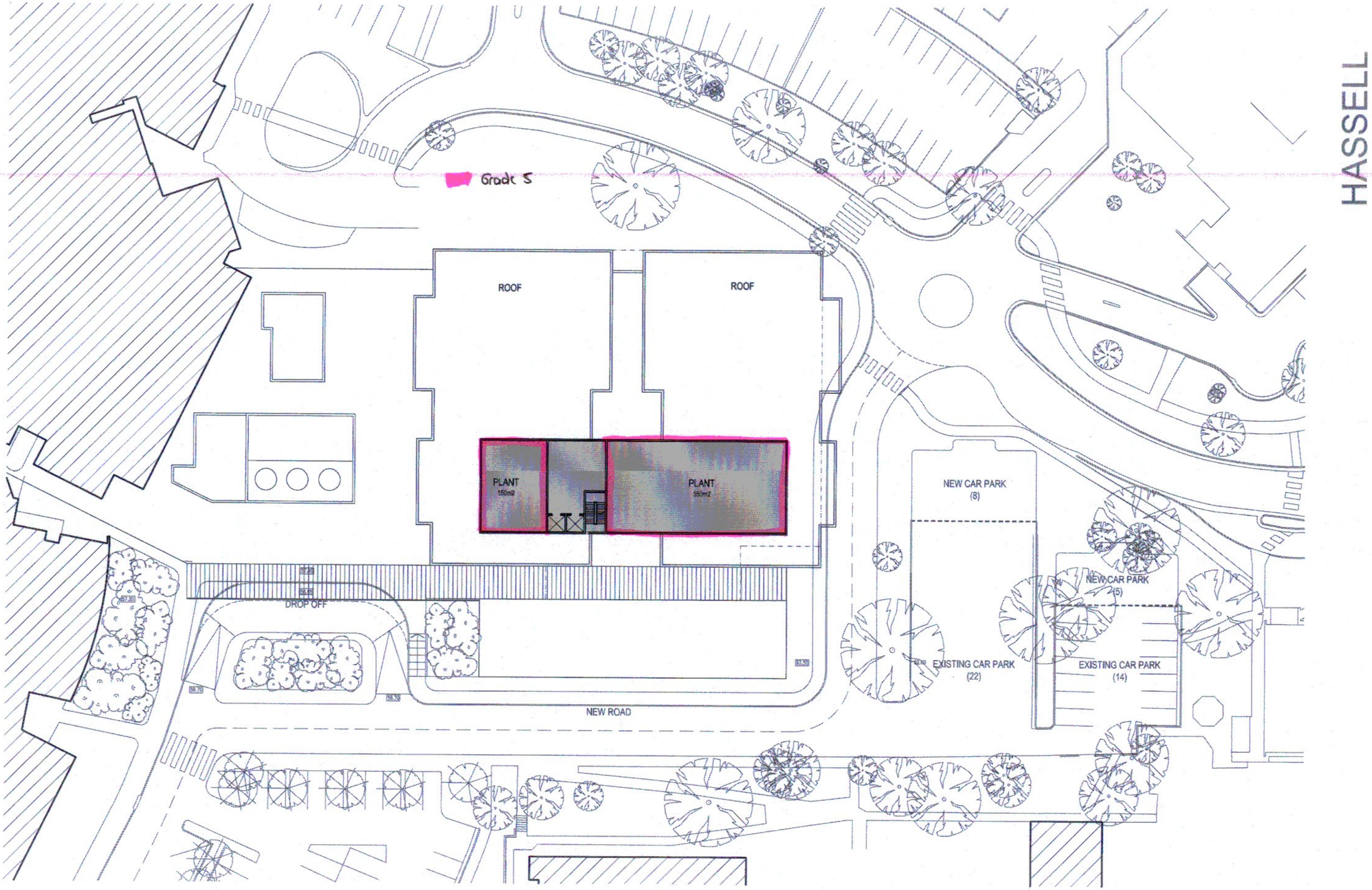

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HASSELL

Grade 1
Grade 2
Grade 3
Grade 4
Grade 5

Client	Project	Drawing	Drawing No	Project No	Date	Scale	Drawn By
Aurora Projects	Penrith Health Campus Redevelopment	ICU Level 2 Plan - OPTION 10	ICU-SK101_REV 3	PSA7717	29.06.2009	1:200 @ A1	NH