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TABLE OF CONTENTS

1 INTRODUCTION 4
2 SITE DESCRIPTION 5
3 NOISE DESCRIPTORS 6
4 NOISE INTRUSION ASSESSMENT 7
4.1 PROJECT ACOUSTIC OBJECTIVES 7
4.1.1 Australian Standard 2107:2000 7
4.2 ENVIRONMENTAL NOISE MEASUREMENTS 8
4.2.1 Measurement Position 8
4.2.2 Time of Measurements 8
4.2.3 Measurement Equipment 8
4.2.4 Measurement Results 8
4.3 EVALUATION OF NOISE INTRUSION AND RECOMMENDATIONS 9
4.3.1 Glazing Constructions 9
4.3.2 External Walls 10
4.3.3 Roof/Ceiling Construction 10
5 RAILWAY VIBRATION ASSESSMENT 11
5.1 PROJECT VIBRATION OBJECTIVES 11
5.1.1 Tactile Vibration 11
5.2 RAIL VIBRATION MEASUREMENTS 12
5.3 DISCUSSION 12
6 NOISE EMISSION ASSESSMENT 13
6.1 BACKGROUND NOISE MEASUREMENTS 13
6.2 ACOUSTIC OBJECTIVES 14
6.2.1 EPA Industrial Noise Policy 14
7 CARPARK NOISE EMISSION ASSESSMENT 15
7.1 RECOMMENDATION 16
7.2 CARPARK SLEEP DISTURBANCE NOISE LEVELS 17
7.3 SLEEP DISTURCANCE CRITERIA 17
7.3.1 Potential carpark Noise Sources 20
7.4 PREDICTED NOISE LEVELS AT MOST AFFECTED RECEIVERS 20
8 MECHANICAL PLANT TREATMENTS 21
9 CONCLUSION 22

APPENDIX 1: NOISE LOOGING DATA 23

1 INTRODUCTION

This report presents our Noise Impact Assessment for the proposed Gosford Health and Wellbeing Project located in the block bound by Holden Street and Showground Road, Gosford.

In this report we have:

- Conducted an external noise intrusion assessment (primarily traffic and train noise) and recommended acoustic treatments to ensure that a reasonable level of amenity is achieved for future occupants. Environmental noise at the site have been measured and assessed in accordance with Council requirements and Australian Standard 2107:2000 for general office space.

- Carried out background noise monitoring to determine noise emission goals for future use of the development to meet council and NSW EPA acoustic requirements including impacts the surrounding residential receivers.

The assessment is based on architectural drawings provided to this office from Lend Lease.

2 SITE DESCRIPTION

The proposed development includes a multi-story building which includes a carpark and with ancillary hospital uses and hospital and government administration.

The site is located on the land bound by Holden Street to the west and Showground Road to the east, the main northern railway line to the east beyond Showground Road. The reminding of the surrounding area includes residential and commercial uses.

Figure 1 shows the site, monitor and measurement location.

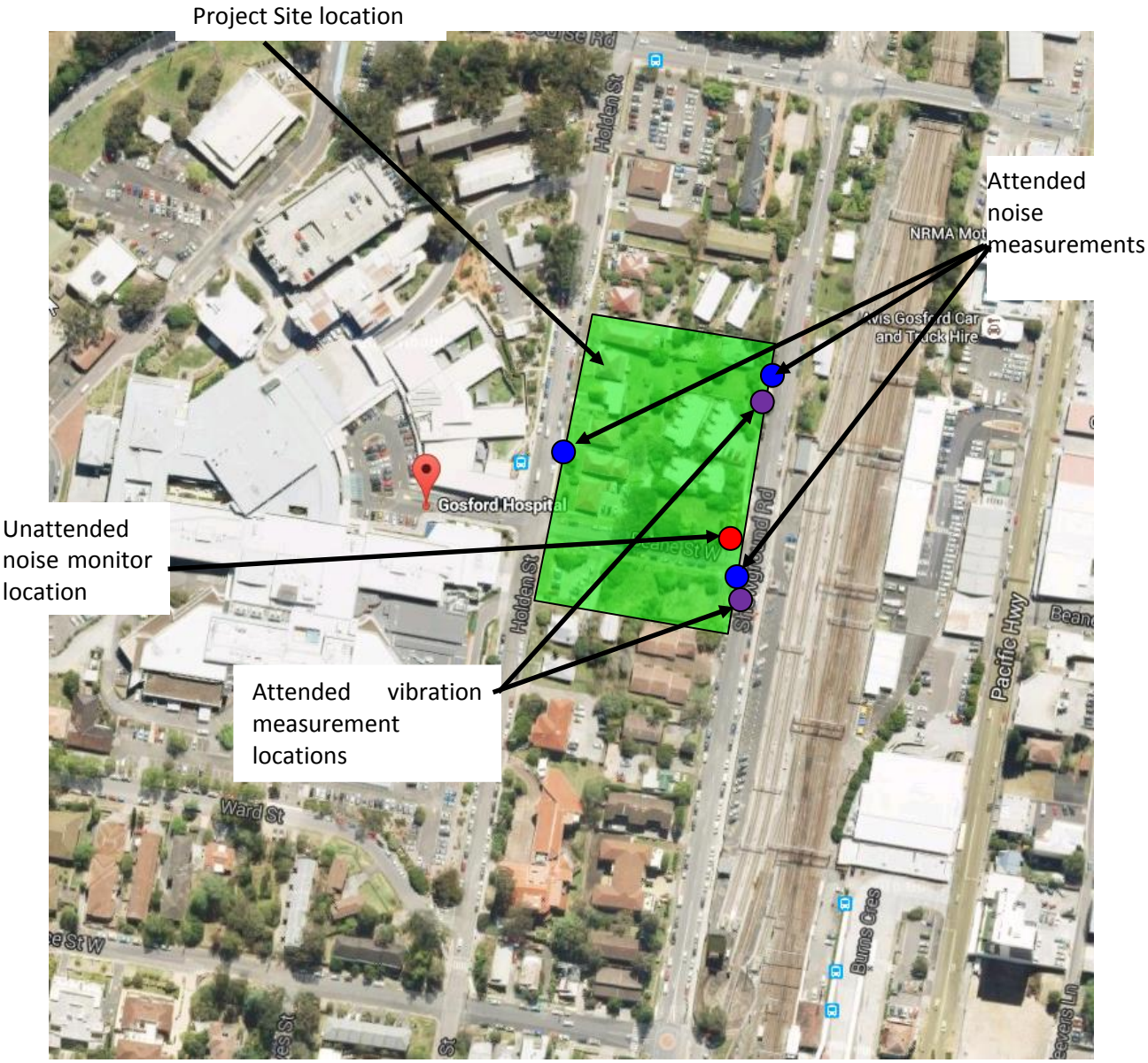

Figure 1: Site Map and Measurement Locations

3 NOISE DESCRIPTORS

Traffic noise constantly varies in level, due to fluctuations in traffic speed, vehicle types, road conditions and traffic densities. Accordingly, it is not possible to accurately determine prevailing traffic noise conditions by measuring a single, instantaneous noise level. To accurately determine the effects of traffic noise a 15-20 minute measurement interval is utilised. Over this period, noise levels are monitored on a continuous basis and statistical and integrating techniques are used to determine noise description parameters. These parameters are used to measure how much annoyance would be caused by a particular noise source.

In the case of environmental noise three principle measurement parameters are used, namely L_{10}, L_{90} and L_{eq}.

The L_{10} and L_{90} measurement parameters are statistical levels that represent the average maximum and average minimum noise levels respectively, over the measurement intervals.

The L_{10} parameter is commonly used to measure noise produced by a particular intrusive noise source since it represents the average of the loudest noise levels produced at the source.

Conversely, the L_{90} level (which is commonly referred to as the background noise level) represents the noise level heard in the quieter periods during a measurement interval. The L_{90} parameter is used to set the allowable noise level for new, potentially intrusive noise sources since the disturbance caused by the new source will depend on how audible it is above the pre-existing noise environment, particularly during quiet periods, as represented by the L_{90} level.

The L_{eq} parameter represents the average noise energy during a measurement period. This parameter is derived by integrating the noise levels measured over the measurement period. L_{eq} is important in the assessment of traffic noise impact as it closely corresponds with human perception of a changing noise environment; such is the character of traffic noise.

Current practice favours the L_{eq} parameter as a means of measuring traffic noise, whereas the L_{10} parameter has been used in the past and is still incorporated in some codes. For the reasons outlined above, the L_{90} parameter is not used to assess traffic noise intrusion.

LA_{max} refers to the maximum noise level occurring during a measurement period, and is used when assessing sleep disturbance impacts.

4 NOISE INTRUSION ASSESSMENT

4.1 PROJECT ACOUSTIC OBJECTIVES

The noise impacts from surrounding environmental noise including traffic movements on roadways and the railway line to the east of the site have been assessed. The assessment of environment noise impacts from surrounding receivers has been conducted in accordance with the following documents:

- Australian Standard 2107:2000 Acoustics – Recommended design sound levels and reverberation times for building interiors

4.1.1 Australian Standard 2107:2000

For the proposed Heath and Wellbeing development the recommended internal noise levels of AS2107 have been used for an office areas which included the following:

Table 1 - AS2107:2000 Internal Noise Criteria (Office areas)

Type of occupancy/activity	Recommended design sound level, $L_{Aeq(Period)}$, dB(A)
General Office Areas	40

For the ground floor retail and restaurant space, AS2107 recommended noise levels are as follows:

Table 2 - AS2107:2000 Internal Noise Criteria (Retail)

SPACE/ACTIVITY TYPE	OBJECTIVES
	Internal Noise Level dB(A) L_{eq}
Retail Shops	45-50

4.2 ENVIRONMENTAL NOISE MEASUREMENTS

Environmental noise level at the site were obtained using attended measurements and unattended noise logging as detailed in this section of the report.

4.2.1 Measurement Position

An untended noise monitor was installed near the future eastern façade of the building, as detailed in Figure 1 above.

Attended measurements are also conducted on site, the locations of measurements are indicated in Figure 1 and included the eastern and western façade including noise from Holden Street, Showground Road and the railway lines to the east.

4.2.2 Time of Measurements

The long-term monitoring was conducted between the 1st and the 14th July, 2016.

Short-term attended measurements were taken between 3:30pm – 6:30pm on the 14th July, 2016.

4.2.3 Measurement Equipment

Equipment used consisted of an Acoustic Research Laboratories Pty Ltd noise logger. The logger was set to A-weighted fast response and was programmed to store 15-minute statistical noise levels throughout the monitoring period. The monitor was calibrated at the start and end of the monitoring period using a Rion NC-73 calibrator. No significant drift was noted. Noise logger data is provided in Appendix 1.

Attended measurements were taken using a Svantech 958 Sound Level Analyser. The analyser was calibrated before and after measurements and no significant drift was recorded.

4.2.4 Measurement Results

The traffic noise levels listed in Table 3 were determined based on the logging data and attended measurements.

Table 3 – Measured Traffic Noise

Location	Period	Noise Level
Future eastern façade	Day (7am – 10pm)	68 $L_{eq(15hr)}$dB(A)
	Night (10pm – 7am)	55 $L_{eq(9hr)}$dB(A)
Future western façade	Day (7am – 10pm)	66 $L_{eq(15hr)}$dB(A)
	Night (10pm – 7am)	54 $L_{eq(9hr)}$dB(A)

4.3 EVALUATION OF NOISE INTRUSION AND RECOMMENDATIONS

Internal noise levels will primarily be as a result of noise transfer through the windows and doors and roof, as these are relatively light building elements that offer less resistance to the transmission of sound.

The predicted noise levels through the windows, doors and roof are discussed below. The predicted noise levels have been based on the measured level and spectral characteristics of the external noise, the area of building elements exposed to traffic noise, the absorption characteristics of the rooms and the noise reduction performance of the building elements.

Calculations were performed taking into account the orientation of windows, barrier effects (where applicable), the total area of glazing, facade transmission loss and the likely room sound absorption characteristics. In this way the likely interior noise levels can be predicted.

4.3.1 Glazing Constructions

The recommended glazing assemblies are indicated in Table 4 below. The glazing thicknesses recommended are those needed to satisfy acoustic requirements and do not take into account other requirements such as structural, safety or other considerations. These additional considerations may require the glazing thickness to be increased beyond the acoustic requirement.

Table 4 – Glazing Requirements

Façade Location	Levels	Glazing Thickness	Acoustic Seals
Western	All levels	6.38mm laminated	Yes
Eastern	All levels	10.38mm laminated	Yes
Northern and southern	All levels	6.38mm laminated	Yes
All Orientations	Retail/Commercial	6.38mm laminated	Yes

In addition to complying with the minimum scheduled glazing thickness, the STC/R_w rating of the glazing fitted into operable frames and fixed into the building opening should not be lower than the values listed in the Table 8 below.

Where nominated, this will require the use of acoustic seals equal to Schlegel Q-lon series *(acoustic bulb seal)* around the full perimeter of operable frames. The frame will need to be sealed into the building opening using a flexible 100% polyurethane sealant. Note that mohair seals and/or mohair/plastic fin combination seals in windows and doors are not acceptable where acoustic seals are required.

It is recommended that only window systems have test results indicating compliance with the required ratings obtained in a certified laboratory be used where windows with acoustic seals have been recommended.

Table 5 – Minimum STC/R_w of Glazing Requirements

Glazing Assembly	Acoustic Seals	Minimum STC/R_w of Installed Window
6.38mm laminated	Yes	30
10.38mm laminated	Yes	35

4.3.2 External Walls

For external walls of masonry construction, no acoustic upgrade is required. There should be no vents on the internal skin of external walls. All penetrations in the internal skin of external walls should be acoustically sealed.

4.3.3 Roof/Ceiling Construction

The proposed external roof/ceiling construction does not require additional acoustic treatments.

5 RAILWAY VIBRATION ASSESSMENT

Trains induce ground borne vibration that is transmitted through the subsoil. These vibrations can be perceptible close to railways, as tactile vibrations and as structure borne noise.

5.1 PROJECT VIBRATION OBJECTIVES

5.1.1 Tactile Vibration

Human comfort is normally assessed with reference to the British Standard BS 7385 Part 2 1993 or Australian Standard AS 2670.2 1990.

The Interim Guideline references the EPA *Assessing Vibration- A technical guideline* which recommends that habitable rooms should comply with the criteria therein which is in line with the requirements of British Standard BS 6472:1992 "Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)".

British Standard BS 6472:1992 "Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)" is recommended by the RIC's and SRA's Interim Guidelines for Councils "Consideration of rail noise and vibration in the planning process" as this standard includes guidance for the assessment of human response to building vibration including intermittent vibrations such as that caused by trains.

Human response to vibration has been shown to be biased at particular frequencies, which are related to the orientation of the person. This standard provides curves of equal annoyance for various orientations. These curves are applied as correction filters such that an overall weighted acceleration level is obtained. As the orientation of the receiver is unknown or varying the weighting filter used is based on the combined base curve as given in ISO 2631 & Australian Standard 2670 "Evaluation of Human Exposure to Vibration and Shock in

Buildings (1 to 80Hz)" which represents the worst case of the X, Y and Z axes. Filtered measurements are made in all three co-ordinate axes and the highest value axis used.

This standard assesses the annoyance of intermittent vibration by using the Vibration Dose Value (VDV). Alternatively the VDV may be estimated by the eVDV which is derived by a simpler calculation using an empirical factor. The VDV or eVDV is calculated for the two periods of the day being the "Daytime" (6am-10pm) and "Night time" (10pm-6am). The overall value is then compared to the levels in Table 10. For this project the aim will be for a low probability of adverse comment.

Table 6 - Vibration Dose Values ($m/s^{1.75}$) above which various degrees of adverse comment may be expected in residential buildings.

Place	Low Probability of adverse comment	Adverse comment possible	Adverse comment probable
Residential buildings 16hr day (Daytime)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6

Note: in the absence of criteria for office/retail building the daytime vibration criteria for residential buildings has been used in this assessment.

5.2 RAIL VIBRATION MEASUREMENTS

Rail vibration measurements were conducted in line with the future proposed western façade, which is the location with the closest proximity to the train lines.

Attended train vibration measurements were conducted on 14th July, 2016. A Svan 912A Vibration Analyser was used for the vibration measurements. The analyser was fitted with a Dytran triaxial accelerometer.

The measured vibration levels, duration of train passby and the number of rail movements per hour were used to determine the overall vibration dose (VDV) at the proposed development for both daytime and night time periods. The results are presented the table below.

Table 7 - Vibration Dose Values

Time Period	Calculated VDV $m/s^{1.75}$	Criteria VDV $m/s^{1.75}$	Complies
Day (7am – 10pm)	0.12	0.2 to 0.4	Yes

In the event the future train use increases, say by 10%, predicted eVDV will not increase significantly (no more than approximately 0.02 more than the levels predicted in the table above) and will not impact recommended vibration isolation treatments.

The calculated levels comply with the tactile vibration requirements listed in table 7 above and used for the assessment of the proposed Health and Wellbeing project.

5.3 DISCUSSION

Based on the results of the vibration dose values presented in table above, no additional acoustic or vibration treatments are required to be conducted to the proposed development to ensure compliance with the relevant standards as presented within this report for train passbys.

6 NOISE EMISSION ASSESSMENT

The main noise emitted from the project site will be those from the mechanical plant servicing the site. Detailed mechanical equipment selection and layouts are not available at this stage, detailed acoustic assessment will be conducted at construction certificate stage. The external noise emission criteria are set up in this section of the report to ensure that the acoustic amenities of nearby receivers are not adversely affected.

As the site is surrounded commercial properties, the nearest potentially affected receivers are:

- Existing commercial receivers to the east of the site.
- Residential receivers to the south of the site on Holden Street and at 62-64 Showground Road.

6.1 BACKGROUND NOISE MEASUREMENTS

The same unattended noise monitor was used for background noise monitoring, the noise levels are incorporated with the attended background noise monitor conducted at the site as detailed in Section 4.2 of this report.

The representative background noise levels of the site are presented in Table 8 below.

Table 8 – Measured Background Noise Levels

Location	Period/Time	Assessment Background Noise Level dB(A) L_{90}
Gosford Hospital, Health and Wellbeing	Day (7am-6pm)	48
	Evening(6pm-10pm)	38
	Night(10pm-7am)	34

6.2 ACOUSTIC OBJECTIVES

In the absence of any specific control over noise emission from Wyong Shire DCP, the project criteria are based on the following documents:

- EPA NSW Industrial Noise Policy.
- Restaurant Noise – OLGR

6.2.1 EPA Industrial Noise Policy

The EPA Industrial Noise Policy, has two criteria which need to be satisfied namely Intrusiveness and Amenity. These are described below:

- *Intrusiveness Criteria* - This guideline is intended to limit the audibility of noise emissions at residential receivers and requires that noise emissions measured using the L_{eq} descriptor not exceed the background noise level by more than 5 dB(A). Where applicable, the intrusive noise level should be penalised (increased) to account for any annoying characteristics such as tonality.
- *Amenity Criteria* - This guideline is intended to limit the absolute noise level from all "industrial" noise sources such as mechanical plant to a level that is consistent with the general environment.

The EPA Industrial Noise Policy sets out acceptable noise levels for various localities. Table 2.1 on page 16 of the policy indicates 4 categories to distinguish different areas.

Due the project site is surrounded by commercial receivers, only the Amenity Criteria is applied.

Noise levels are to be assessed at the property boundary or nearby dwelling, or at the balcony or façade of a building.

The criteria for commercial receivers are:

Table 9 – EPA Amenity Noise Levels

Type of Receiver	Time of day	Recommended Noise Level dB(A)$L_{eq(period)}$	
		Recommended	Maximum
Commercial	When in use	65	70
Residential	Day	55	60
	Evening	45	50
	Night	40	45

7 CARPARK NOISE EMISSION ASSESSMENT

The external noise emission from the proposed carpark associated with the project have been predicted to the nearest residential receivers neighbouring the site, the predicted noise levels have been presented below.

The predicted carpark noise levels have been presented below by taking account of the recommended acoustic treatments in this report.

Calculations have included the following assumptions based on the operation of the proposed carpark:

1. During the peak day time periods up to it is estimated to generate up to 142 vehicle movements during the morning peak hour (entering the facility) period based on the concept design report, and:

2. The expected peak period of use including the following;

    a. 142 trips for the morning peak and;

    b. 106 trips during the evening peak

3. The source noise level of a car within the carpark has been based on noise level measurements of a similar facility conducted by this office of 85 dB(A) SWL for movement of level grade and 94 dB(A) SWL on an inclined ramp.

Table 10 –Predicted Carpark Operational Noise Levels

Noise Receiver	Time Period	Predicted Noise Level dB(A) $L_{eq\ (15\ min)}$	Criteria dB(A) $L_{eq\ (15\ min)}$	Compliance
Residential receiver neighbouring the site	Peak Daytime periods	Up to 51	53	Yes

7.1 RECOMMENDATION

The following development controls are recommended to ensure the 24-hour use of the public parking easement will not result in adverse noise impacts:

- Coatings on floors to minimise tyre squeal – Floor finishes should include a concrete finish which is not painted and should be broom finished with a ruff texture.
- Installation of speed humps to deter potential for anti-social driving behaviour – Speed humps and other speed reducing methods are not required for acoustic impact to surrounding receivers.
- There is no required mechanical ventilation as the carpark will be naturally ventilated, therefore an assessment of noise from mechanical equipment is not required to be investigated future.
- Sealing any gated drains – All drains and grills are to be securely fixed such that noise from moving of grills is not generated.
- Construct a solid (i.e. Colorbond, lapped and capped timber or similar) fence/retaining wall along the northern boundary of 64 Showground Road (for control of late night vehicle noise from the use of new drop off zone). The fence/retaining wall must be at least 500mm higher than the top of any windows/doors along the northern façade of the residential properties at 62-64 Showground Road.
- The following open areas along the façades of the carpark must be acoustically treated, to ensure noise emissions comply with the relevant noise goals;
    - Southern façade closest to the southern boundary of the site (shaded in gold below); and
    - Opening along the northern façade.

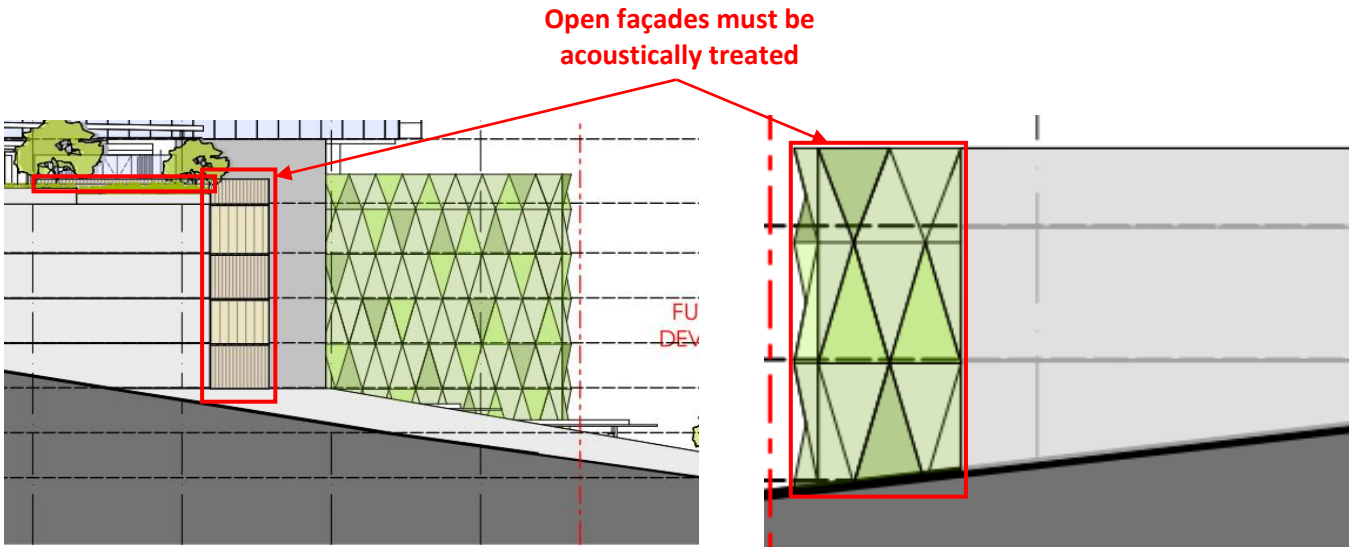

Figure 2 – Recommended Treatments

7.2 CARPARK SLEEP DISTURBANCE NOISE LEVELS

Sleep disturbance assessment based on the requirements of the EPA's Industrial Noise Policy (INP) should be conducted in conjunction with the following as directed by the EPA's Application Notes:

> ***Sleep disturbance***
>
> *Peak noise level events, such as reversing beepers, noise from heavy items being dropped or other high noise level events, have the potential to cause sleep disturbance. The potential for high noise level events at night and effects on sleep should be addressed in noise assessments for both the construction and operational phases of a development. The INP does not specifically address sleep disturbance from high noise level events.*
>
> *EPA reviewed research on sleep disturbance in the NSW Environmental Criteria for Road Traffic Noise (ECRTN) (EPA, 1999). This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.*
>
> *From the research, EPA recognised that current sleep disturbance criterion of an LA1, (1 minute) not exceeding the LA90, (15 minute) by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, EPA will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.*
>
> *The detailed analysis should cover the maximum noise level or LA1, (1 minute), that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the appendices to the ECRTN. Other factors that may be important in assessing the extent of impacts on sleep include:*
>
> - *How often high noise events will occur*
> - *Time of day (normally between 10pm and 7am)*
> - *Whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).*
>
> *The LA1, (1 minute) descriptor is meant to represent a maximum noise level measured under 'fast' time response. EPA will accept analysis based on either LA1, (1 minute) or LA, (Max).*

7.3 SLEEP DISTURCANCE CRITERIA

Sleep arousal is a function of both the noise level and the duration of the noise.

To assess potential sleep arousal impacts, a two stage test is carried out:

Step 1 - An "emergence" test is first carried out. That is, the L_1 noise level of any specific noise source should not exceed the background noise level (L_{90}) by more than 15 dB(A) outside a resident's bedroom window between the hours of 10pm and 7am. If the noise events are within

this, then sleep arousal impacts are unlikely and no further analysis is needed. This is consistent with the Noise Guide for Local Government. The guideline level is set out below.

Table 11 – Sleep Arousal Emergence Criteria

PERIOD/TIME	BACKGROUND NOISE LEVEL dB(A)L_{90}	EMERGENCE LEVEL (dB(A) L_1)
Night (10pm-7am)	34	49

Step 2 - If there are noise events that could exceed the emergence level, then an assessment of sleep arousal impact is required to be carried out taking into account the level and frequency of noise events during the night, existing noise sources, etc. This test takes into account the noise level and number occurrences of each event with the potential to create a noise disturbance. As is recommended in the explanatory notes of the EPA Industrial Noise Policy, this more detailed sleep arousal test is conducted using the guidelines in appendix B of the EPA Environmental Criteria for Road Traffic Noise.

Appendix B of the NSW Environmental Criteria for Road Traffic Noise (ECRTN) (EPA, 1999) includes criteria for the assessment of sleep disturbance. The criteria details noise levels which are likely to be a source of a sleep disturbance, this is represented within as a graph within the standard which is detailed below.

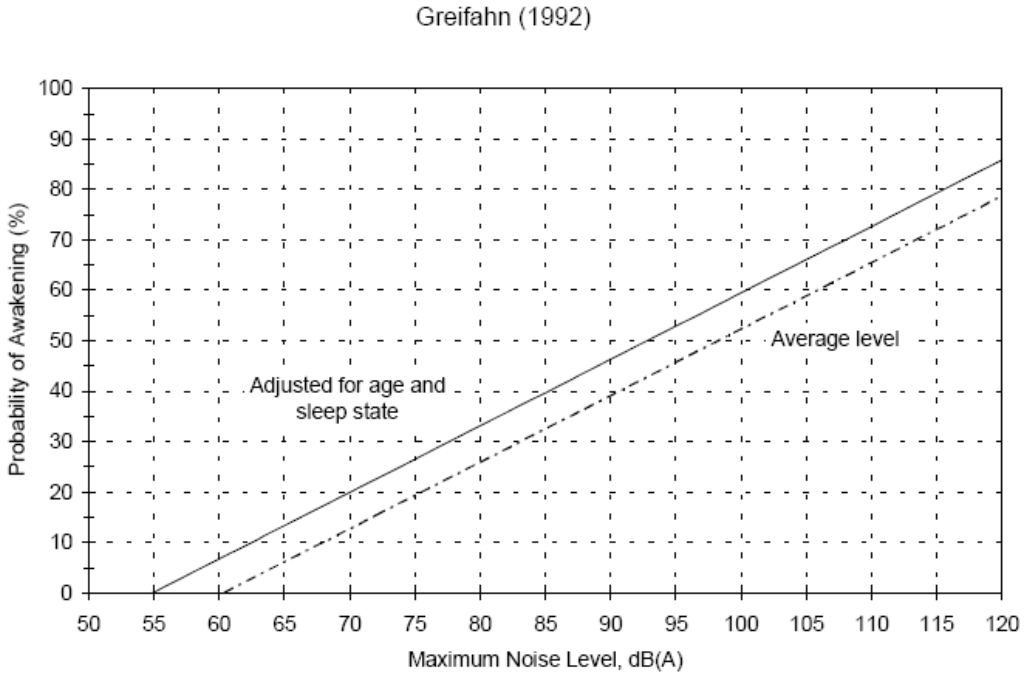

Figure B4 Probability of awakening related to age and sleep state (Griefahn 1992)

Based on the requirements of the NSW Environmental Criteria for Road Traffic Noise (ECRTN) (EPA, 1999) as represented on the table below an internal noise level of 55 dB(A) or less will result in a 0% probability of sleep arousal and is therefore considered to be acceptable.

7.3.1 Potential carpark Noise Sources

The potentially significant carpark noise sources which have been used as the basis of this report are listed in Table 12 below. The emission levels in Table 12 have been obtained from noise measurements of typical car doors and engines. Noise measurements were obtained using a Norsonics SA 140 sound level meter, set to fast response. The sound level meter was calibrated before and after the measurements using a Rion NC-73 calibrator. No significant drift was recorded.

Table 12 – Carpark Noise Source Emission Levels

Noise Source	Sound Emission Level dB(A)
Car Door Closing	69 dB(A) L_1 @ 5m
Car Starting	68 dB(A) L_1 @ 5m

7.4 PREDICTED NOISE LEVELS AT MOST AFFECTED RECEIVERS

Noise levels at the worst affected receivers neighbouring proposed carpark have been predicted based on the noise emission levels in Table 1211, which are typical for the proposed carpark. Noise levels have been predicted based on the potential worst case location of cars within the carpark (see figure 1 above) of 15m to the existing building façade (linearly to the worst affected residential neighbour).

Step 1: Assessment requires that noise emissions from cars starting or car doors closing not exceed 48 dB(A)L_1 (15dB(A) above the background noise level).

Our analysis indicates that vehicles located within carpark of the club will create L_1 noise levels exceeding 48 dB(A) when starting their engines and closing doors. Therefore more detailed assessment using EPA Road Traffic Noise sleep disturbance analysis is recommended (and is presented below).

Step 2: Applying the Road Traffic Noise Sleep Disturbance test, noise levels of less than 55dB(A) when measured *inside* a bedroom are considered to result in a 0% probability of sleep arousal (page 29 of the guidelines, extracted, appendix 15 as detailed in the graph above).

Assuming that the window of a residential receiver is left open, there will be a 10dB(A) noise reduction as noise travels from outside to inside the room.

Calculating the resulting noise levels from car doors closing and engine start ups and the distance correction for the location of cars at the potentially worst location within the carpark the following levels have been calculated:

- Calculated noise level from a car starting at the potentially worst affected parking spot to the nearest residential window will be 56 dB(A)L_1 when measured at the bedroom on the residential receiver externally resulting in an internal noise level of 46 dB(A). This nose level complies with the EPA Road Traffic Noise sleep disturbance criteria as there will be a 0% probability of sleep arousal.

- Calculated noise level from a car door closing at the potentially worst affected parking spot to the nearest residential window will be 55 dB(A)L_1 when measured inside the bedroom of the neighbouring residence externally resulting in an internal noise level of 55 dB(A). This nose level complies with the EPA Road Traffic Noise sleep disturbance criteria as there will be a 0% probability of sleep arousal.

- Noise levels generated by cars starting in all but the closest parking spot will be less than the calculated levels above and also comply with required criteria.

8 MECHANICAL PLANT TREATMENTS

A detailed mechanical noise assessment will be conducted once plant selections and services drawings have been finalised as part of the construction documentation to ensure noise levels comply with the criteria detailed in this report. Details will be provided as part of the CC submission of the project.

It is noted that the carpark is proposed to be naturally ventilated.

Based on experience with similar development acoustic treatments are both possible and practical using acoustic treatments such as lining of ductwork, acoustic silences, variable speed controllers, time switches, acoustic screens etc.

9 CONCLUSION

This report presents our acoustic assessment for the proposed Gosford Hospital Redevelopment - Health & Wellbeing Precinct.

Noise intrusion impact from environmental noise (including traffic and train noise) onto the future development has been assessed in accordance with Australian Standard 2107:2000. The acoustic treatments in principle necessary to achieve these guidelines have been set out in Section 4.5.

Noise emissions criteria for the site have been determined based on the on-site noise logging and NSW EPA Industrial Noise Policy. These have been presented in Section 7. Based on the proposed Gosford Health and Wellbeing project there will be minimal environmental impact on the surrounding environment including to the surrounding residential receivers including noise from operation of the services on the site and the use of the proposed carpark.

We trust this information is satisfactory. Please contact us should you have any further queries.

Yours faithfully,

Acoustic Logic Consultancy Pty Ltd
Ben White

APPENDIX 1: NOISE LOOGING DATA