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St George Hospital Stage 3

REF Acoustic Assessment

Refurbishment and Demolition Work

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1 EXECUTIVE SUMMARY

This REF Acoustic Assessment has been prepared by Acoustic Logic on behalf of the Health Infrastructure NSW (the **Applicant**) to assess the potential environmental impacts that could arise from the refurbishment works at St George Hospital at 16 Kensington Street, Kogarah (the **site**).

This report has been prepared to support of the proposed refurbishment and demolition work at St George Hospital Campus and addresses the potential construction noise and vibration impacts associated with the proposed work.

This report accompanies a Review of Environment Factors that seeks approval for the refurbishment of the existing St George Hospital, which involves the following works:

- Internal refurbishment works within existing hospital buildings.
    - Burt Nielson Wing Level 1 – Fluoroscopy
    - Burt Nielson Wing Level 2 – Paediatrics and CYF
    - Clinical Services Building & Services Block Ground Floor – Back of House
    - Ward Block Level 2 – Multi-faith, Patient Transit and AAU
    - Tower Ward Block Level 4 – Renal
    - Tower Ward Block Level 6 – Surgical
    - Prichard Wing Various Levels – Sexual Health, Antenatal and Gynaecology
    - Acute Services Building Level 7 – Palliative Care
- Minor extension for a new Clinical Waste building within the hospital campus and new covered walkways
- Services upgrade/ modification works & new services installations including but not limited to lighting, hydraulics, mechanical, fire and stormwater and drainage
- Demolition of existing buildings within the hospital campus and wider precinct
- Civil & Landscaping works adjacent to Belgrave Street for continuation of the Ambulatory Care main entry forecourt area

For a detailed project description, refer to the Review of Environmental Factors prepared by Ethos Urban.

2 SITE DESCRIPTION AND THE PROPOSAL

2.1 DESCRIPTION OF THE PROPOSAL

The St George Hospital is located on Kensington Street, Kogarah, within the Georges River Council Local Government Area (LGA) on Bidjigal Country. The hospital site is approximately 12 kilometres south of the Sydney CBD and has an area of approximately 5.16 hectares.

The hospital is located in a cluster of health and education uses within the Kogarah town centre. It comprises a number of buildings associated with the hospital campus situated around an internal road network.

St George Hospital is within proximity of transport services and key road links, including Kogarah Railway Station approximately 350 metres to the north of the site and Princes Highway to the east of the site. An aerial image of the site is shown at Figure 1.

Figure 1 – Site Aerial (*Source: Nearmap, edits by Ethos Urban*)

2.2 STATEMENT OF SIGNIFICANCE

Based on the identification of potential issues, and an assessment of the nature and extent of the impacts of the proposed development, it is determined that:

- The extent and nature of potential impacts are moderate and will not have significant adverse effects on the locality, community and the environment.
- Potential impacts can be appropriately mitigated or managed to ensure that there is minimal effect on the locality, community.

2.3 SENSITIVE RECEIVERS

The following table lists the nearest/potentially most impacted sensitive receivers surrounding the site. An aerial photo of the site indicating nearby noise sensitive receivers and measurement locations is presented in Figure 2.

Table 1 – Sensitive Receivers

Receiver (Refer Figure 2)	Receiver Type	Comment
R1	Residential	Residential apartment along northern boundary of the site at 19 Belgrave St, Kogarah NSW 2217
R2	Residential	Residential apartment along northern boundary of the site at 26-28 Belgrave St, Kogarah NSW 2217
R3	Residential	Residential house to the south at 1 Chapel St, Kogarah NSW 2217
R4	Residential	Residential apartments to the south at 52-54, 38 Chapel St and 143 Princes Hwy, Kogarah NSW 2217
R5	Residential	Residential apartments to the south at 2-12 Short Street, 42 Gray St, Kogarah NSW 2217
E1	Educational	St Patrick's Catholic Primary School at 36 Chapel St, Kogarah NSW 2217
H1	Healthcare	Existing St George Hospital Buildings

Figure 2 – Project locational diagram (*Source: Six Map*)

3 REFERENCED DOCUMENTS

3.1 BACKGROUND INFORAMTION USED

The assessment is based on the following drawings, reports and other information:

- *REF Residents notification site plans* prepared by Jacobs (Project number *IA256500*).
- *SSDA Acoustic Assessment report* (*Ref: 210074*) prepared by JHA.

3.2 GUIDELINES

The following planning instruments and guidelines have been used in the assessment:

- NSW EPA *Noise Policy for Industry* (**NPI**) October 2017.
- NSW EPA *Interim Construction Noise Guideline* (**IGNG**) July 2009.
- Australian Standard *AS2436:2010 Guide to Noise Control on Construction, Maintenance and Demolition Sites* (**AS2436:2010**).
- BS 6472:1992 *Guide to Evaluate Human Exposure to Vibration in Buildings (1Hz to 80Hz)*.
- German Standard DIN 4150-3 *Structural Vibration: Effects of Vibration on Structures*.

The REF acoustic requirement and relevant content of this report addressing each requirement are summarised in the table below.

Table 2 – Sections in This Report Addressing REF

Section	REF Requirement	Relevant Section of Report
Section 6.2.2 Nosie & Vibration	Note 5: The assessment of construction noise impacts must be carried out in accordance with the NSW Interim Construction Noise Guidelines (DECC 2009). If sensitive receivers will be impacted for greater than 3 weeks a quantitative assessment is required.	Section 6
	Note 6: The assessment of operational noise impacts must be in accordance with the Noise Policy for Industry (EPA, 2017).	Section 5
	Note 7: If proposing works outside of standard construction hours, a description of the proposed works is to be provided, duration of the proposed works and justification for why these works are required outside of the hours. An acoustic report is to be prepared to ensure noise impacts outside of hours are adequate.	NA
	Note 8: Potential impacts from vibration during construction and/or operation such as plant and machinery, must also be quantified. Refer to Assessing Vibration: a technical guideline (Dec. 2006).	Section 6.2

4 ABBREVIATIONS AND DEFINITIONS

The following Abbreviations and definitions are used in this noise impact assessment.

dB	Decibels - unit for the measurement of sound
dB(A)	A-weighted decibels. Unit of measurement for broadband sound with the A-frequency weighting applied to approximate human loudness perception to sounds of different pitch.
L_{eq}	Energy, time averaged sound level
L_{max}	Maximum sound pressure level, fast response
L_{90}	Sound level exceeded for 90% of the measurement period
R_w	Frequency weighted sound reduction index.
NRC	Average absorption co-efficient for the octave bands with centre frequencies of 250Hz to 2 kHz inclusive.
Day*	The period from 7 am to 6 pm (Monday to Saturday) and 8 am to 6 pm(Sundays and public holidays).
Evening*	Refers to the period from 6 pm to 10 pm.
Night*	The period from 10 pm to 7 am (Monday to Saturday), and 10 pm to 8 am(Sundays and public holidays).
Project Trigger Level	Target noise levels for a particular noise-generating facility.
Assessment Background Level (ABL)	Background noise level representative of a single period.
Rating Background Level (RBL)	The overall, single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period. (Calculated in accordance with NPfI unless noted otherwise)

* Unless nominated otherwise.

5 SITE OPERATIONAL NOISE EMISSIONS ASSESSMENT

5.1 OPERATIONAL NOISE ASSESSMENT CRITERIA

Criteria to assess noise emissions from the operation of the proposed development have been developed using the NPfI. This policy was primarily developed to assess noise impacts from industrial development but can also be adapted to assess other types of development such as commercial buildings and air conditioning plant.

For each receiver type:

- Receivers have been grouped into "catchments". These are receivers that have been assessed as having similar characteristics (receiver type and ambient noise level). These are shown in APPENDIX B and Table 1.

- For each catchment, representative noise assessment trigger levels have been determined based on NPfI guidelines. The trigger levels have been adopted in this assessment as criteria. These will be used to indicate whether additional mitigation is needed to manage noise emissions.

- For each catchment, noise emissions have been assessed to the most impacted receiver. This means that impacts at all other receivers within that catchment will be less. Compliance at the most impacted receiver will therefore also result in compliance at all other receivers within the catchment.

For residential receivers, three criteria are assessed:

- Intrusive assessment– that is, how audible is the emitted noise compared to ambient, background noise). Criteria are determined relative to the measured rating background noise level.

- Amenity assessment – that is, how loud is the absolute level of industrial noise, including cumulative noise from other industrial sources. The NPfI nominates appropriate amenity noise levels depending on the receiver type and prevailing noise environment/zoning.

- Maximum Noise assessment – will high-level, short-term noise events cause adversely impact sleep at night? Trigger levels are determined relative to the measured night rating background and assessed outside rooms where sleep is likely to occur.

For residential receivers, noise emissions are assessed against the trigger levels to determine the likely extent of impacts. The lower of the relevant intrusiveness and amenity trigger levels are adopted. Noise emissions lower than the trigger levels indicate there is no adverse impact. A maximum noise level assessment is separately undertaken if night time emissions occur.

For other receiver types, only an "amenity" assessment is required.

APPENDIX A summarises the results of ambient noise monitoring. APPENDIX B provides the derivation of NPfI trigger levels for each of the receivers. These are summarised in the following table.

Table 3 – Project Specific Trigger Levels

Location/Receiver Type	Time	RBL dB(A) L_{90}	Trigger Noise Level (dB(A) $L_{eq,15min}$)		
			Intrusiveness	Amenity	Max Event
Residential (Urban)	Day	58	63	**60**	N/A
	Evening	53	58	**50**	N/A
	Night	51	56	**45**	56 L_{eq} 66 L_{max}
E1 – Educational (internal)	Noisiest 1hr	N/A	N/A	35 (internal)	N/A
Hospital buildings within the site	Noisiest 1hr	N/A	N/A	35 (internal) 50 (external)	N/A

5.2 OPERATIONAL NOISE EMISSION ASSESSMENT

5.2.1 Mechanical Plant Noise

Detailed plant selection has not been undertaken at this stage, as plant selections have not been determined. Detailed acoustic review should be undertaken at DD stage to determine acoustic treatments to control noise emissions to satisfactory levels. Satisfactory levels will be achievable through appropriate plant selection and location and, if necessary, standard acoustic treatments such as duct lining, acoustic silencers and enclosures.

Noise emissions from all mechanical services plant to the closest residential receiver should comply with the noise emission criteria in Section 5.1.

6 CONSTRUCTION NOISE AND VIBRATION IMPACT ASSESSMENT

6.1 NOISE MANAGEMENT CRITERIA

Noise emissions associated with construction activities on the project site to external areas of receivers will be assessed in with reference to the following:

- NSW EPA *Interim Construction Noise Guideline* (**IGNG**) July 2009.
- Australian Standard *AS2436:2010 Guide to Noise Control on Construction, Maintenance and Demolition Sites* (**AS2436:2010**).
- American Society of Heating, Refrigerating and Air-conditioning Engineers (**ASHRAE**) Handbook.

6.1.1 NSW DECC Interim Construction Noise Guideline

Noise associated of construction activities on the site will be assessed in accordance with the NSW *DECC Interim Construction Noise Guideline* (ICNG, 2009).

The "quantitative" assessment procedure, as outlined in the Interim Construction Noise Guideline (ICNG) will be used. The quantitative assessment method requires: Determination of noise generation goals (based on ambient noise monitoring); Prediction of operational noise levels at nearby development; and if necessary, recommendation of noise controls strategies in the event that compliance with noise emission goals is not possible.

DECC guidelines adopt differing strategies for noise control depending on the predicted noise level at the nearest residences:

- *"Noise affected" level*. Where construction noise is predicted to exceed the "noise affected" level at a nearby residence, the proponent should take reasonable/feasible work practices to ensure compliance with the "noise affected level". For residential properties, the "noise affected" level occurs when construction noise exceeds ambient levels by more than 10dB(A)$L_{eq(15min)}$.
- "*Highly noise affected level*". Where noise emissions are such that nearby properties are "highly noise affected", noise controls such as respite periods should be considered. For residential properties, the "highly noise affected" level occurs when construction noise exceeds 75dB(A)$L_{eq(15min)}$ at nearby residences.

Long term unattended background noise measurements were undertaken by Wood and Grieves, dated 8 May 2018. Additional attended noise measurements were taken by this office in March and May 2022. Refer to APPENDIX A for the results of ambient noise monitoring.

Unattended noise monitoring was conducted by JHA during the SSDA stage of the hospital. Details are presented in APPENDIX A.

A summary of the recommended noise levels from the ICNG is presented below in Table 4.

Table 4 – Noise Management Levels – Residential Receivers

Receiver Type	Period / Time	Background Noise Level dB(A) L_{90}	"Noise Affected" Level - dB(A)$L_{eq(15min)}$	"Highly Noise Affected" Level - dB(A)$L_{eq(15min)}$
Residential Receivers	Day (7am to 6pm)	58	63	75

Table 5 – Noise Management Levels – Other Receivers

Location	Noise Management Level - dB(A)$L_{eq(15min)}$
Educational receiver	45 (internally)
Hospital wards and operating theatres	45 (internally)

If noise levels exceed the management levels identified in the tables above, reasonable and feasible noise management techniques will be reviewed.

6.1.2 Australian Standard AS2436:2010 Guide to Noise Control on Construction, Maintenance and Demolition Sites

Australian Standard AS2436 does not provide specific noise management targets. The guideline focuses on strategies for developing feasible and reasonable mitigation methodologies, management controls and community liaison to reach realistic compromises between the needs of construction activities and potentially affected receivers.

For the control and regulation of noise from construction sites AS2436:2010 *Guide to noise control on construction, maintenance and demolition sites* nominates the following:

- That reasonable suitable noise management objectives are established.
- That all practicable measures be taken on the building site to regulate noise emissions, including the siting of noisy static processes to locations of the site where they can be shielded, selecting less noisy processes, and if required regulating demolition hours, and

6.2 VIBRATION CRITERIA

Vibration associated with demolition and excavation activities on the site will be assessed in conjunction with the following guidelines:

For human exposure to vibration - Department of Environment and Conservation *NSW Assessing Vibration: A Technical Guideline* (Feb 2006) is based on the guidelines contained in BS 6472:1992 *Guide to Evaluate Human Exposure to Vibration in Buildings (1Hz to 80Hz)* for low probability of adverse comment.

For structural damage vibration - German Standard DIN 4150-3 *Structural Vibration: Effects of Vibration on Structures.*

6.2.1 Assessing Amenity (Human Comfort Guidelines)

Vibration goals for the amenity of nearby land users are those recommended by the EPA document *Assessing Vibration: A technical guideline.* These levels are presented below:

Table 6 – (Table 2.2 Assessing Vibration: A Technical Guideline) – Preferred and Maximum Weighted RMS Values for Continuous and Impulsive Vibration Acceleration (m/s^2) 1-80Hz

Location	Assessment Period [1]	Preferred values		Maximum Values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous Vibration					
Critical Working Areas (e.g. Hospital Operating Theatres)	Daytime	0.0050	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.02	0.014
Impulsive Vibration					
Critical Working Areas (e.g. Hospital Operating Theatres)	Daytime	0.0050	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42

Note 1: Continuous vibration relates to vibration that continues uninterrupted for a defined period (usually throughout the daytime or night-time), e.g. continuous construction or maintenance activity. (DECC, 2006).

Note 2: Impulsive vibration relates to vibration that builds up rapidly to a peak followed by a damped decay and that may or may not involve several cycles of vibration (depending on frequency and damping), with up to three occurrences in an assessment period, e.g. occasional loading and unloading, or dropping of heavy equipment. (DECC, 2006).

6.2.2 Structure Borne Vibration (Damage Criteria)

German Standard DIN 4150-3 (2016) provides vibration velocity guideline levels for use in evaluating the effects of vibration on structures. The criteria presented in DIN 4150-3 (2016) is shown in the below table.

It is noted that the peak velocity is the absolute value of the maximum of any of the three orthogonal component particle velocities as measured at the foundation, and the maximum levels measured in the x- and y-horizontal directions in the plane of the floor of the uppermost storey.

Table 7 – (Table 1 – DIN 4150-3 (2016)) – Guideline Values for Vibration Velocity, $v_{i,max}$, for Evaluating the Effects of Short-Term Vibration on Structures

	TYPE OF STRUCTURE	Guideline values for $v_{i,max}$ in mm/s				
		Foundation, all directions, i = x, y, z, at a frequency of			Topmost floor, horizontal direction, i = x, y	Floor slabs, vertical direction, i = z
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz [a]	All Frequencies	All Frequencies
L/C	1	2	3	4	5	6
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	40	20
2	Residential buildings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15	20
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 **and** are of great intrinsic value (e.g. listed buildings) buildings that are under a preservation order)	3	3 to 8	8 to 10	8	20[b]

NOTE Even if guideline values as in line 1, columns 2 to 5, are complied with, minor damage cannot be excluded.

a *At frequencies above 100 Hz, the guideline values for 100 Hz can be applied as minimum values.*

b *It may be necessary to lower the guideline value markedly to prevent minor damage*

All surrounding residential dwellings are to be assessed as 'Type 2'.

6.2.3 Sensitive Equipment within Hospital Buildings

Where sensitive equipment is located within nearby St George Hospital buildings, criteria are to be determined based on data provided by the manufacturer/supplier/operator. These are to be determined prior to the commencement of any works. When setting vibration limits for sensitive medical equipment for vibration generated by construction activities, the appropriate vibration curve from the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) Handbook based on the equipment type is typically applied.

The ASHRAE Handbook provides specific vibration levels associated with potential disruption to the use of sensitive equipment within the clinic. The maximum vibration velocities (mm,s^{-1}) recommended from 1-100Hz is given in Figure 37 of the Handbook, used in conjunction with the recommended equipment requirement curves given in Table 46. Figure 37 and Table 46 of the Handbook are reproduced below in Figure 3 and Table 8 respectively.

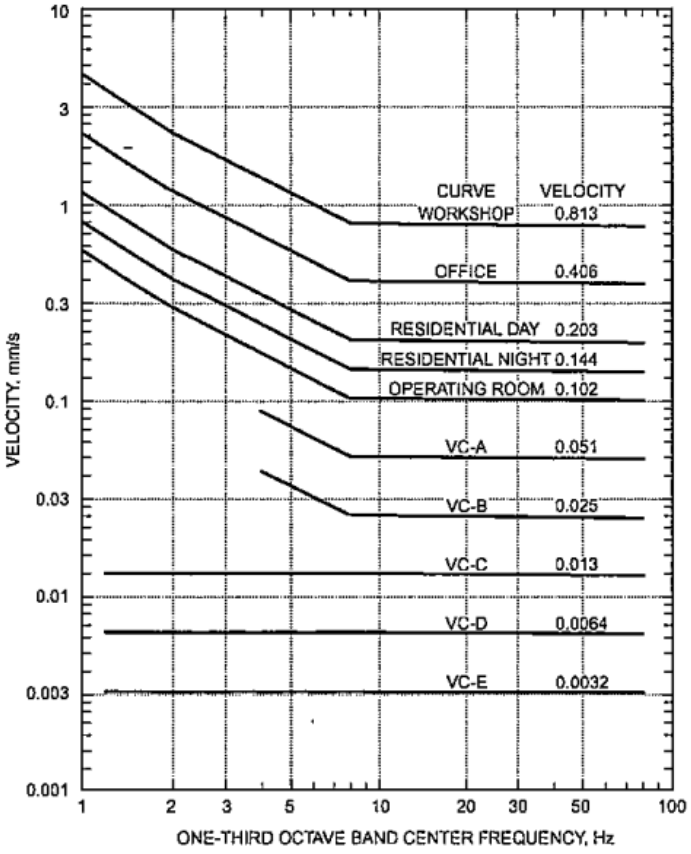


Fig. 37 Building Vibration Criteria for Vibration Measured on Building Structure

Figure 3 – Vibration Curves as per Figure 37 of ASHRAE Handbook (2007)

Table 8 – Equipment Vibration Criteria – ASHRAE Handbook (2007)

Equipment Requirements	Curve
Adequate for computer equipment, probe test equipment, and microscopes less than 40x magnification	0.203 (Residential – day)
Bench Microscopes up to 100x magnification; laboratory robots	0.102 (Operating Room)
Bench microscopes up to 400x magnification; optical and other precision balances; coordinate measuring machines; metrology laboratories; optical comparators; microelectronics manufacturing equipment; proximity and projection aligners, etc.	0.051 (VC – A)
Microsurgery, eye surgery, neurosurgery; bench microscopes at magnification greater than 400x magnification; optical equipment on isolation tables; microelectronic manufacturing equipment, such as inspection and lithography equipment (including steppers) to 3mm line widths	0.025 (VC – B)
Electron microscopes up to 30,000x magnification; microtomes; magnetic resonance imagers; microelectronics manufacturing equipment, such as lithography and inspection equipment to 1mm detail size	0.013 (VC – C)
Electron microscopes at magnification greater than 30,000x magnification; mass spectrometers; cell implant equipment; microelectronic manufacturing equipment such as, aligners, steppers and other critical equipment for photolithography with line widths of 1/2μm; includes electron beam systems	0.0064 (VC – D)
Un-isolated laser and optical research systems; microelectronics manufacturing equipment, such as aligners, steppers and other critical equipment for photolithography with line widths of 1/4μm; includes electron beam systems	0.0032 (VC – E)

Table Notes:

- *Refer to Figure 2 for corresponding vibration curve*

We note that the sensitive equipment vibration requirements may already be exceeded under ambient conditions. As such, AL recommends that careful coordination with the hospital be established to ensure disruptions are minimised. Ambient vibration monitoring may be undertaken prior to the commencement of construction works so that a baseline vibration level may be established for comparison to vibration generated by the works.

6.3 CONSTRUCTION NOISE EMISSION ASSESSMENT

AL note that internal refurbishment work will cause minimal vibration and noise impact to the surrounding receivers given the enclosed existing building envelope will provide significant barrier effect and also from distance attenuation. For noise and vibration impact to existing hospital buildings, any potential impact can be controlled by arranging the construction activities to suitable times based on ongoing coordination and feedback from the hospital.

In this section, the construction noise emission assessment will focus on external demolition works which are more likely to generate impact on external receivers.

6.3.1 Construction Source Noise Data

In this section, typical equipment/processes anticipated to be used during the construction of the project site are outlined in the table below with A-weighted sound power levels. The equipment list is prepared based on our experience with similar projects. Typically, the most significant sources of noise or vibration generated during a construction project will be demolition and excavation.

Table 9 – Sound Power Levels of Equipment

Equipment /Process	Typical Sound Power Level dB(A)	Duty
6T excavators	115	75%
Electric generators jack hammers	113	75%
10T excavators with hydraulic jacks	118	75%
Oxy-acetylene (gas cutting/welding)	110	50%
Concrete saw	118	75%
Grinders	105	50%
20T Truck	103	10%

The noise levels presented in the above table are derived from the following sources, namely:

- On-site measurements.
- Table A1 of Australian Standard 2436-2010.
- Data held by this office from other similar studies.

Noise levels take into account correction factors (for tonality, intermittency where necessary).

6.3.2 Construction Noise Prediction Methodology

Noise from the loudest typical construction activities for all stages of works have been predicted to the nearest most affected sensitive receivers.

Predictions take into account:

- The distance between the noise source and the receiver.
- The screening effect provided by any building structure or building shell, if applicable. In particular, noise from works proposed during the fit-out stages when the building shell will screen these activities from the surrounding sensitive receivers.

6.3.3 Proposed Hours of Work

The following hours of operation will be applied to all construction activities on site:

- Monday to Friday – 7:00am to 6:00pm.
- Saturdays – 8:00am to 1:00pm.
- Sundays and Public Holidays – No works.

6.3.4 Predicted Noise Levels

Maximum noise impacts from the construction equipment listed above have been predicted to the nearest noise receivers and presented below. Given the size of the site predicted noise levels will change significantly depending on where the noise source is located. As such, a noise level range has been presented, giving expected noise levels for activities 'farthest from' to 'nearest to' the receiver.

Table 10 – Predicted Construction Noise Levels – R1

Activity	Predicted Noise Level	Criteria	Comment
6T excavators	59-68	Noise Affected Level (NML)-**63** dB(A)$L_{eq(15min)}$ Highly Noise Affected Level (HNML)-**75**dB(A)$L_{eq(15min)}$	Exceed NML 63 dB(A) when work close to the northern boundary of the site but below HNML
Electric generators jack hammers	57-66		
10T excavators with hydraulic jacks	64-72		
Oxy-acetylene (gas cutting/welding)	52-61		Below NML 63dB(A)
Concrete saw	62-71		Exceed NML 63 dB(A) when work close to the northern boundary of the site but below HNML
Grinders	47-56		Below NML 63dB(A)
20T Truck	38-44		

Table 11 – Predicted Construction Noise Levels – R2

Activity	Predicted Noise Level	Criteria	Comment
6T excavators	62-68	Noise Affected Level (NML)-**63** dB(A)$L_{eq(15min)}$ Highly Noise Affected Level (HNML)-**75**dB(A)$L_{eq(15min)}$	Exceed NML 63 dB(A) when work close to the northeastern boundary of the site but below HNML
Electric generators jack hammers	60-66		
10T excavators with hydraulic jacks	66-72		
Oxy-acetylene (gas cutting/welding)	55-61		Below NML 63dB(A)
Concrete saw	65-71		Exceed NML 63 dB(A) when work close to the northeastern boundary of the site but below HNML
Grinders	50-56		Below NML 63dB(A)
20T Truck	41-47		

Table 12 – Predicted Construction Noise Levels – R3

Activity	Predicted Noise Level	Criteria	Comment
6T excavators	70-84	Noise Affected Level (NML)-**63** dB(A)$L_{eq(15min)}$ Highly Noise Affected Level (HNML)-**75**dB(A)$L_{eq(15min)}$	Exceed HNML 75 dB(A) when work close to the north boundary of the site
Electric generators jack hammers	68-82		
10T excavators with hydraulic jacks	75-89		
Oxy-acetylene (gas cutting/welding)	63-77		
Concrete saw	73-87		
Grinders	58-72		Exceed NML 63 dB(A) when work close to the north boundary of the site but below HNML
20T Truck	49-63		Below NML 63dB(A)

Table 13 – Predicted Construction Noise Levels – R4

Activity	Predicted Noise Level	Criteria	Comment
6T excavators	68-79	Noise Affected Level (NML)-**63** dB(A)$L_{eq(15min)}$ Highly Noise Affected Level (HNML)-**75**dB(A)$L_{eq(15min)}$	Exceed HNML 75 dB(A) when work close to the east boundary of the site
Electric generators jack hammers	66-77		
10T excavators with hydraulic jacks	73-84		
Oxy-acetylene (gas cutting/welding)	61-72		Exceed NML 63 dB(A) when work close to the east boundary of the site but below HNML
Concrete saw	71-82		Exceed HNML 75 dB(A) when work close to the east boundary of the site
Grinders	56-67		Exceed NML 63 dB(A) when work close to the east boundary of the site but below HNML
20T Truck	47-58		Below NML 63dB(A)

Table 14 – Predicted Construction Noise Levels – R5

Activity	Predicted Noise Level	Criteria	Comment
6T excavators	68-74	Noise Affected Level (NML)-**63** dB(A)$L_{eq(15min)}$ Highly Noise Affected Level (HNML)-**75**dB(A)$L_{eq(15min)}$	Exceed NML 63 dB(A) but below HNML
Electric generators jack hammers	66-72		
10T excavators with hydraulic jacks	73-79		Exceed HNML 75 dB(A) when work close to the east boundary of the site
Oxy-acetylene (gas cutting/welding)	61-67		Exceed NML 63 dB(A) when work close to the western boundary of the site but below HNML
Concrete saw	71-77		Exceed HNML 75 dB(A) when work close to the east boundary of the site
Grinders	56-62		Below NML 63dB(A)
20T Truck	47-53		

Table 15 – Predicted Construction Noise Levels – E1 (Internal)*

Activity	Predicted Noise Level	Criteria	Comment
6T excavators	37-45	Noise Management Level-**45** dB(A)$L_{eq(15min)}$ (Internally)	Below Noise Management level
Electric generators jack hammers	35-43		
10T excavators with hydraulic jacks	42-50		Exceeds Noise Management level when work close to eastern boundary
Oxy-acetylene (gas cutting/welding)	30-38		Below Noise Management level
Concrete saw	40-48		Exceeds Noise Management level when work close to eastern boundary
Grinders	25-33		Below Noise Management level
20T Truck	16-24		

*Assumes a 30dB(A) façade noise reduction. Lower performing façades will require additional mitigation measures or management controls.

6.4 GENERAL DISCUSSION

Noise

Given the proposed demolition activities are located at several different locations/buildings, as shown in Figure 2, the noise and vibration impact to receivers are assessed considering the worst affected scenarios where construction activities occurring close to the receiver.

Residential receivers **R1** and **R2** will have the worst impact when works are conducted to the north of the hospital campus close to 1 South St, Kogarah. Predictions show that noise levels will below the HNML for all equipment while exceed NML when 6T excavators, Electric generators jack hammers, 10T excavators with hydraulic jacks and concrete saw are used individually. It is unlikely for all works to be conducted right at the site boundary and any shielding from onsite elements will also reduce noise emissions.

Residential receivers **R3, R4** and **R5** will have the worst impact when works are conducted to the south of the hospital campus at 5 Chapel St, Kogarah. For receiver **R3**, predicted noise levels will exceed HNML when 6T excavators, Electric generators jack hammers, 10T excavators with hydraulic jacks, Oxy-acetylene (gas cutting/welding) and Concrete saw are used close to the site boundary individually. Similarly, for receivers **R4** and **R5**, exceedances are predicted when 10T excavators with hydraulic jacks and Concrete saw are used along the site boundary individually. It is unlikely for all works to be conducted right at the site boundary and any shielding from onsite elements will also reduce noise emissions.

Educational receiver **E1** is exposed to direct demolition noise in some external works areas and may be subject to noise levels above the NML if the façade is opened or is degraded. With a façade noise reduction of 30dB(A), internal noise predictions are within the NML, however lower performing façades will result in exceedances of the NML in internal areas. Careful consideration into demolition methodology to minimise external noise impact to **E1** is recommended subject to the Builder's input.

Despite the exceedances that are predicted, specific recommendations are detailed in Section 7 that, in our opinion, will be capable of managing noise and vibration impacts. The existing CNVMSP for the SSD works can also be used as a reference for management procedures, with both documents aiding to sufficiently manage noise and vibration impacts.

Vibration

The highest levels of vibration are likely to be produced when demolition activities are undertaken. This activity would only produce a moderate level of vibration close to the work site. Given the closest residential receivers **R1** and **R2** are located away from the site, the impact at these properties is moderate considering amenity and structure damage.

However, for receivers **R3**, **R4** and **R5**, the greatest risk of vibration to these buildings will occur from the use of excavator mounted hydraulic hammers. The prediction of actual vibration levels is difficult because receiver vibration levels are affected by a number of factors including the vibration force imparted, sub-soil propagation conditions, building footings and building structural design.

Vibration monitoring of these activities is recommended for the hospital receiver in the event of complaints or concern for structural damage to nearby buildings or vibration sensitive equipment is identified close the working area. The specific location and quantity of vibration monitors to monitor residential houses are to be determined in consultation with the builder and structural engineer

All other construction items are also not expected to generate vibration exceeding building damage or amenity acoustic criteria.

7 RECOMMENDATIONS

In light of the above, we recommend:

1. **Community Consultation/Notification:** Notification (leaflet or similar) of all residents within 100m of the development is recommended prior to commencement of works. Notification should advise of anticipate date and duration of excavation.

2. **Respite Periods:** To protect the amenity of nearby residential receivers, it is proposed to introduce respite periods where construction activities exceed the 'highly noise affected level (75 dB(A) $L_{eq(15min)}$). Based on the predicted noise levels presented in Section 6.3.4. In the event that respite periods are to be imposed, recommended times are to be agreed upon between the builder and the hospital, noting that the conditions of consent already provide the following restrictions as a respite period.

   Rock breaking, rock hammering, sheet piling, pile driving and similar activities may only be carried out between the following hours:

   (a) 9am to 12pm, Monday to Friday;

   (b) 2pm to 5pm Monday to Friday; and

   (c) 9am to 12pm, Saturday.

   a. It is noted that the construction plant which is predicted to exceed the 'highly noise affected level' would only be in use intermittently during the excavation stage.

   b. It is noted that respite periods will extend the length of demolition, excavation and construction works and may provide heavier loss of amenity compared to non-imposed excavation.

3. **SGH Management Controls:** To protect the amenity of the Hospital, it is proposed that construction activities must not exceed the vibration levels set out in Section 6.2.3 for sensitive spaces. Liaison with the Hospital shall be frequently conducted to manage impacts.

4. **Quiet Work Methods/Technologies:**

   a. The primary noise generating activity at the site will be the bulk excavation period. As much as practicable, use of quieter excavation methods is to be adopted.

   b. Excavation is conducted initially using excavator with bucket (quietest excavation method), then use of rock saws or rippers. Use of the loudest excavation equipment is used only when other options are not available.

   c. It is recommended to use rock saws near all boundaries to reduce vibration and noise levels.

   d. Materials handling/vehicles:

      i. Trucks and bobcats to use a non-tonal reversing beacon (subject to OH&S requirements) to minimise potential disturbance of neighbours.

      ii. Avoid careless dropping of construction materials into empty trucks.

      iii. Trucks, trailers and concrete trucks (if feasible) should turn off their engines during idling to reduce noise impacts (unless truck ignition needs to remain on during concrete pumping).

5. **Site Induction:**

   a. A copy of the Noise Management Plan is to be available to contractors. The location of the Noise Management Plan should be advised in any site induction.

   b. Site induction should also detail the site contact in the event of noise complaint.

6. **Construction Vibration Impacts:** Construction vibration impacts are to be minimised through consideration of the following:

   a. To prevent impacts on sensitive rooms within the neighbouring buildings, a detailed vibration monitoring methodology is required to be developed in conjunction with the builder. In this regard, it is noted that consultation has already begun to develop appropriate procedures.

   b. Sample vibration measurements for construction activities are to be undertaken prior to undertaking demolition/excavation works to determine the likely impact of these works, particularly on sensitive areas of surrounding buildings.

   c. Alternative construction processes are to be used to minimise vibration impacts, such as:

      i. Use of concrete cutting and excavator, rather than pneumatic hammer to remove existing concrete slabs.

      ii. Avoiding the use of vibratory rollers.

      iii. Where new construction processes are used on site, careful attention should be paid to any exceedances detected by vibration monitors within the site.

   d. Road surfaces used for trucks and deliveries shall be kept as smooth as practicable to minimise sudden impacts and vibration transfers from loaded vehicles.

   e. Where it is expected that vibration levels would impact operation of sensitive areas and alternative processes are not possible, works are to be scheduled to minimise impact, which is to be agreed upon through discussion with the hospital.

7. **Vibration Monitoring:** In the event of continuous complaint, we recommend vibration monitoring is to be implemented along the property boundary closest to the vibration receiver who issued the complaint, or where the proposed plant is used within 30m of the residential building.

8. **Site Specific Barrier Constructions:** In the event of complaint from SGH, additional barriers can be erected to protect staff from airborne noise intrusion through the worst affected façades, such as a barrier or temporary structures covering high noise generating equipment such as a Flexshield Sonic Acoustic Mobile Tents around jackhammering locations or other processes that can be covered. Liaison will be required with SGH and surrounding residential receivers to ascertain appropriate site-specific constructions on a case-by-case basis as the works area is too broad to provide specific recommendations at this stage.

8 ADDITIONAL CONSTRUCTION NOISE AND VIBRATION MANAGEMENT AND CONTROL

Notwithstanding that the assessment indicates noise and vibration emissions to residential receiver will generally comply with the noise and vibration management levels except for high noise generating equipment, emissions should be minimised as part of best practice endeavours, and contingency measures should be put into place to respond to complaints or if it is found the processes needed to complete the tasks vary from those envisaged in this assessment.

The recommended measures are provided below.

8.1 NOISE AND VIBRATION MONITORING, REPORTING AND RESPONSE PROCEDURES

Vibration monitoring is recommended for areas in the hospital where sensitive equipment is located or in the event of complaints or concern of operation of the sensitive equipment.

The monitors are proposed to be fitted with GSM modem and remotely signal up to five mobile phones indicating any exceedance of the prescribed vibration criteria to enable immediate notification to be sent to the contractor when vibration thresholds are approached.

Whilst it is impossible to predict the vibrations induced by the excavation/construction operations on site at potentially affected receivers, the total vibration emissions are to be limited with real-time alarm notification given to the plant operators. Based on feedback from the real-time monitoring system, the plant operators will be able to modify their operations to ensure the vibrations are kept within acceptable limits.

8.1.1 Vibration Monitoring Download

Downloading of the vibration logger will be conducted on a regular basis. In the event exceedance of vibration criteria or alarms occur, downloading of the logger will be conducted more frequently. Results obtained from the vibration monitor will be presented in a graph format and will be forwarded to the client for review. It is proposed that reports are provided fortnightly with any exceedance in the vibration criteria reported as detailed in this report.

8.1.2 Vibration Monitoring Reports

A fortnightly report will be submitted to the client via email summarising the vibration events. The vibration exceedance of limit is recorded the report shall be submitted within 24 hours. Complete results of the continuous vibration logging will be presented in fortnightly reports including graphs of collected data.

8.1.3 Reporting Requirements

The following is an example of reporting which may be kept on site:

1. A register of complaints received/communication with the local community shall be maintained and kept on site with information as detailed below.

2. Where noise/vibration complaints require noise/vibration monitoring, results from monitoring shall be retained on site at all times.

3. Any noise exceedances occurring including, the actions taken and results of follow up monitoring.

4. A report detailing complaints received and actions taken shall be presented.

5. All monitoring and reporting shall be conducted in conjunction with the conditions of consent.

8.1.4 Response Procedures

Complaints associated with noise and vibration generated by site activities shall be recorded on a Noise Complaint Form. The person(s) responsible for complaint handling and contact details for receiving of complaints shall be established on site prior to construction works commencing. A sign shall be displayed at the site indicating the site manager and the general public and their contact telephone number.

If a noise complaint is received the complaint should be recorded on a Noise Complaint Form. The complaint form may list:

- The name and address of the complainant (if provided).
- The time and date the complaint was received.
- The nature of the complaint and the time and date the noise was heard.
- The name of the employee who received the complaint.
- Actions taken to investigate the complaint, and a summary of the results of the investigation.
- Indicate what operations were occurring on site at the time of the complaint.
- Required remedial action, if required
- Validation of the remedial action.
- Summary of feedback to the complainant.

The flow chart that follows illustrate the process followed to assess construction activities prior to the start of work on site and well as the ongoing investigation into noise during the construction period.

8.2 GENERAL NOISE CONTROL METHODS

The determination of appropriate additional noise control measures will be dependent on the particular activities and the construction equipment and plant identified as requiring future acoustic treatments to those already identified in this report. This section provides an outline of available methods which have previously been used on similar construction sites and may be possible on this site.

8.2.1 Selection of Alternate Appliance or Process

Where a particular activity or plant and equipment is found to generate noise levels that exceed the management levels, it may be possible to select an alternative approach or plant and equipment. For example, the use of excavator mounted hydraulic hammers of the site may potentially generate high levels of noise. By carrying this activity by using concrete saws or smaller plant here practical, construction noise levels and/or length of exposure to construction noise levels may be reduced.

8.2.2 Acoustic Barriers

The placement of barriers at the source is generally only effective for static plant. Placing barriers at the source cannot effectively attenuate equipment which is on the move or working in rough or undulating terrain.

The degree of noise reduction provided by barriers is dependent on the amount by which the line of sight can be blocked by the barrier. If the receiver is totally shielded from the noise source reductions of up to 15 dB(A) can be affected. Where only partial obstruction of line of sight occurs, noise reductions of 5 to 8 dB(A) may be achieved. Where the barrier does not obstruct line of sight, generally no noise reduction will occur.

Barriers are used to provide shielding and do not act as an enclosure. The material they are constructed from should have a noise reduction performance which is approximately 10dB(A) greater than the maximum reduction provided by the barrier screening. In this case, the use of a material such as 15mm plywood (or equivalent material) would be acceptable for the barriers.

8.2.3 Silencing Devices

Where construction methodologies or plant and equipment permit, investigate the use of silencing devices. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts, for example.

8.2.4 Treatment of Specific Equipment

In certain cases, it may be possible to specially treat a piece of equipment to dramatically reduce the sound levels emitted.

8.2.5 Establishment of Site Practices

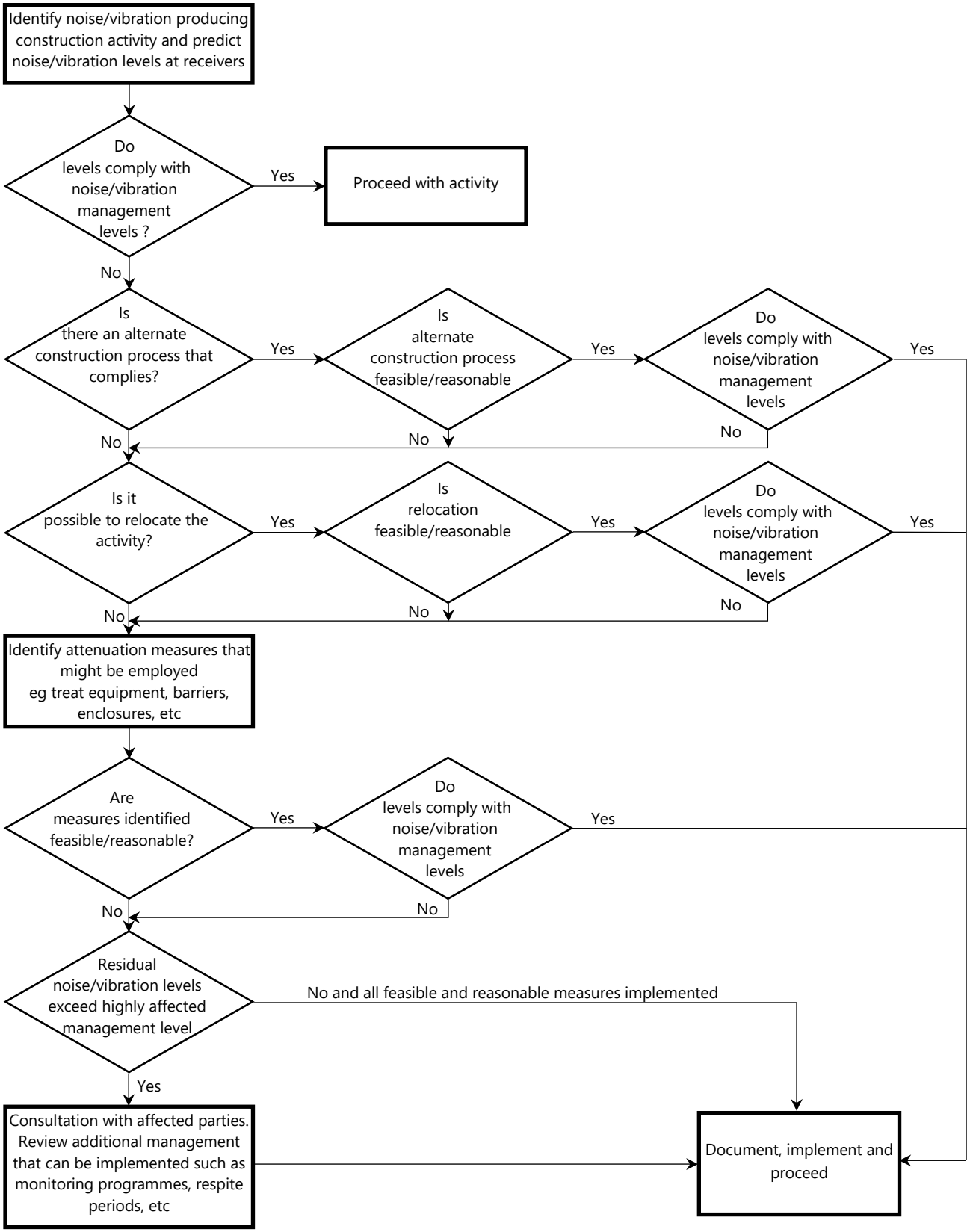
This involves the formulation of work practices to reduce noise generation. This includes investigating the possibility of locating fixed plant items as far as possible from residents as well as rotating plant and activities to provide respite to receivers.

8.2.6 Notification

Notification of affected receivers of the progress of works, particularly when short-term activities likely to create higher noise levels occur, can in many cases minimise community reaction.

9 CONTROL OF CONSTRUCTION NOISE AND VIBRATION – PROCEDURAL STEPS

The flow chart presented below illustrates the process that will be followed in assessing construction activities.



10 CONCLUSION

This report presents an acoustic assessment of the potential noise and vibration impacts associated with the refurbishment and demolition work within St George Hospital Campus.

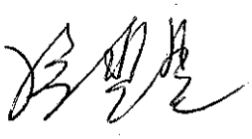
Noise and vibration impacts assessed within this document have been assessed with reference to the requirements of the following documents:

- NSW EPA *Noise Policy for Industry* (**NPI**) October 2017.
- NSW EPA *Interim Construction Noise Guideline* (**IGNG**) July 2009.
- Australian Standard *AS2436:2010 Guide to Noise Control on Construction, Maintenance and Demolition Sites* (**AS2436:2010**).
- BS 6472:1992 *Guide to Evaluate Human Exposure to Vibration in Buildings (1Hz to 80Hz).*
- German Standard DIN 4150-3 *Structural Vibration: Effects of Vibration on Structures.*
- American Society of Heating, Refrigerating and Air-conditioning Engineers (**ASHRAE**) Handbook.

Based on our assessment, the proposal is able to achieve all relevant acoustic (noise and vibration) requirements of the above documents.

Please contact us should you have any further queries.

Yours faithfully,



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APPENDIX AAMBIENT NOISE MONITORING SUMMARY

Unattended noise monitoring was conducted by JHA during the SSDA stage of the hospital. The Noise and Vibration Assessment Report (Ref: *210074*) presented the measured RBL (lowest 10th Percentile noise levels during operation time period) as per Table below. The monitoring was conducted from 28th Jun 2021 to 6th July 2021.

Table 16 – Adopted Background Noise Levels

Measurement Location	Measurement Time	Measured Background Noise Level
SGH Kensington Street Entrance (SSDA monitoring)	Day (7am-6pm)	58dB(A) L_{90}
	Evening (6pm-10pm)	53dB(A) L_{90}
	Night (10pm-7am)	51dB(A) L_{90}

APPENDIX B EPA NOISE POLICY FOR INDUSTRY TRIGGER LEVELS

Project specific assessment trigger levels have been determined for each noise source applying at the identified potentially most impacted receivers.

B.1 NPFI TRIGGER LEVELS

The NPfI requires noise impacts at residential receivers to be assessed in 3 ways:

- Whether the emitted noise is unreasonably loud relative to ambient background noise. (which the EPA calls the "intrusiveness" trigger level).
- Whether the noise emitted is unreasonably loud in an absolute sense, and consistent with surrounding land use and environment. ("amenity" trigger level)
- For night noise emissions, whether discrete noise events are likely to adversely impact sleep ("maximum noise level" trigger levels).

For other receiver types only the amenity trigger level is relevant.

B.1.1 INTRUSIVENESS

The $L_{eq,15min}$ descriptor is used for the intrusiveness trigger level, and is set at a level that is 5dB(A) above the rating background noise level.

B.1.2 AMENITY

Table 2.2 of the NPfI (repeated below) sets out acceptable noise levels for various receiver types.

There are 3 categories of residential receivers - rural, suburban, urban. The nearest residential receivers to the subject site are categorised as "urban" receivers. Categories for non-residential uses are also indicated in the table.

The NPI typically requires project amenity noise levels to be calculated in the following manner:

$$L_{Aeq,15min} = \textit{Recommended Amenity Noise Level} - 5\ dB(A) + 3\ dB(A)$$

Section 2.4 of the NPfI states:

Where cumulative industrial noise is not a necessary consideration because no other industries are present in the area, or likely to be introduced into the area in the future. In such cases the relevant amenity noise level is assigned as the project amenity noise level for the development.

Given there are no other nearby "industrial" noise sources, and nor are any likely in the future, the applicable amenity $L_{Aeq,15min}$ trigger level can be calculated without the 5 dB(A) adjustment.

The NfPI permits the project specific amenity level to be increased in areas where ambient noise levels already significantly exceed the levels in Table 2.2 of the NPfI.

NPfI Table 2.2: Amenity Noise Levels			
Receiver	***Noise Amenity Area***	***Time of Day***	***Recommended Amenity Noise Level L_{Aeq}***
Residential	*Rural*	*Day*	*50*
		Evening	*45*
		Night	*40*
	Suburban	*Day*	*55*
		Evening	*45*
		Night	*40*
	Urban	*Day*	*60*
		Evening	*50*
		Night	*45*
Hotels motels caretakers' quarters holiday accommodation permanent resident caravan parks	*See column 4*	*See column 4*	*5 dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day*
School classroom – internal	*All*	*Noisiest 1-hour period when in use*	*35 (see notes for table)*
Hospital ward internal external	*All* *All*	*Noisiest 1-hour* *Noisiest 1-hour*	*35* *50*
Place of worship – internal	*All*	*When in use*	*40*
Area specifically reserved for passive recreation (e.g. national park)	*All*	*When in use*	*50*
Active recreation area (e.g. school playground golf course)	*All*	*When in use*	*55*
Commercial premises	*All*	*When in use*	*65*
Industrial premises	*All*	*When in use*	*70*
Industrial interface (applicable only to residential noise amenity areas)	*All*	*All*	*Add 5 dB(A) to recommended noise amenity area*

Notes: The recommended amenity noise levels refer only to noise from industrial sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

Types of receivers are defined as follows:

• rural residential – see Table 2.3

• suburban residential – see Table 2.3

• urban residential – see Table 2.3

• industrial interface – an area that is in close proximity to existing industrial premises and that extends out to a point where the existing industrial noise from the source has fallen by 5 dB or an area defined in a planning instrument. Beyond this region the amenity noise level for the applicable category applies. This category may be used only for existing situations (further explanation on how this category applies is outlined in Section 2.7)

• commercial – commercial activities being undertaken in a planning zone that allows commercial land uses

• industrial – an area defined as an industrial zone on a local environment plan; for isolated residences within an industrial zone the industrial amenity level would usually apply.

Time of day is defined as follows:

• day – the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays

• evening – the period from 6 pm to 10 pm

• night – the remaining periods.

(These periods may be varied where appropriate, for example, see A3 in Fact Sheet A.)

In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable L_{Aeq} noise level may be increased to 40 dB $L_{Aeq(1hr)}$.

B.2MAXIMUM NOISE LEVEL ASSESSMENT

The purpose of this assessment is to identify whether discrete, night time noise events have the potential to produce adverse sleep impacts.

Section 2.5 of NPfI recommends the following procedure to assess the potential for adverse sleep disturbance.

Where the subject development/ premises night -time noise levels at a residential location exceed:

- *$L_{eq(15min)}$ 40 dB(A) or the prevailing RBL (L_{90}) plus 5 dB, whichever is the greater, and/or*
- *L_{max} 52 dB(A) or the prevailing RBL (L_{90}) plus 15 dB, whichever is the greater,*

a detailed maximum noise level event assessment should be undertaken.

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise 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 NSW Road Noise Policy.

Other factors that may be important in assessing the extent of impacts on sleep include:

- *how often high noise events will occur*
- *the distribution of likely events across the night-time period and the existing ambient maximum events in the absence of the subject development*
- *whether there are times of day when there is a clear change in the noise environment (such as during early-morning shoulder periods)*
- *current scientific literature available at the time of the assessment regarding the impact of maximum noise level events at night.*

Maximum noise level event assessments should be based on the LAFmax descriptor on an event basis under 'fast' time response. The detailed assessment should consider all feasible and reasonable noise mitigation measures with a goal of achieving the above trigger levels.

B.3PROJECT SPECIFIC TRIGGER LEVELS

The following table summarises the trigger levels applying at each of the identified "most impacted" receivers. These have been determined based on the NPfI methodology described above and the measured rating background noise levels.

The trigger levels in bold indicate the most stringent trigger level at each location.

Table 17 – Project Specific Trigger Levels

Location/Receiver Type	Time	RBL dB(A) L_{90}	Trigger Noise Level (dB(A) $L_{eq,15min}$)		
			Intrusiveness	Amenity	Max Event
Residential (Urban)	Day	58	63	**60**	N/A
	Evening	53	58	**50**	N/A
	Night	51	56	**45**	56 L_{eq} 66 L_{max}
E1 – Educational (internal)	Noisiest 1hr	N/A	N/A	35 (internal)	N/A
Hospital buildings within the site	Noisiest 1hr	N/A	N/A	35 (internal) 50 (external)	N/A