HEGGIES

REPORT 10-7759R3

Revision 0

Sydney Adventist Hospital
Staged Alterations and Additions
Construction Noise Impact Statement

PREPARED FOR

Sydney Adventist Hospital Limited
Master Planning Committee
c/- Origin Properties
186-188 Willoughby Road
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14 JULY 2010

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Staged Alterations and Additions
Construction Noise Impact Statement

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1 INTRODUCTION

Heggies Pty Ltd (Heggies) has been engaged by Sydney Adventist Hospital Ltd (SAH) to assess the potential noise and vibration emission levels from the construction works associated with the staged alterations and additions to the Sydney Adventist Hospital.

Specific acoustic terminology is used within this report. An explanation of common terms is included as **Appendix A**.

2 DESCRIPTION OF THE PROPOSED WORKS

This CNIS provides a site specific assessment of the construction works associated the staged alterations and additions to the Sydney Adventist Hospital (the Project).

The Project involves the staged construction of buildings across the hospital site as outlined below.

Stage 1A

1. New CSB Expansion -– Surgical Precinct
2. Level 1 to Level 10
3. New Carpark
4. New Carpark
5. Refurbishment of Existing Hospital
6. Temporary Carpark
7. Site Services Upgrade
8. New Multi Level Carpark - and Adjoining Surface Carparks
9. Landscape Works

Stage 1B

1. New CSB Expansion – Cancer Precinct
2. Level 2 to Level 6
3. Road Works
4. Landscaped Area

Stage 2

5. Education Centre
   Three to four levels
6. New Access Roads
7. New Concourse
   Level 1 to Level 4
8. Refurbishment of Existing Hospital
   Introducing a Level 2 Arrival Podium

Stage 3

9. The New Shannon Wing
   Level 1 to Level 11
10. Refurbishment of Existing Hospital
11. Relocate Bethel House

This site specific assessment has focussed on the first stage of works (Stage 1A), however, it is anticipated that the findings and recommendations provided in this report will be applied during the detailed design phase and prior to release of Construction Certificates for future stages (Stage 1B, 2 and 3).

This CNIS has been prepared to satisfy Key Issue 18 of the Director-General's Requirements.

> *"**18. Noise and Vibration***
>
> *Provide a quantitative assessment of the potential demolition, construction, operation and traffic noise impacts of the project."*

Construction often requires the use of heavy machinery which can generate significant noise and vibration emissions at nearby buildings and receivers. For some equipment, there is limited opportunity to mitigate the noise and vibration levels in a cost-effective manner and hence the potential impacts should be minimised by using feasible and reasonable management techniques.

At any particular location, the potential noise and vibration impacts can vary greatly depending on factors such as the relative proximity of sensitive receivers, the overall duration of the construction works, the intensity of the noise and vibration emissions, the time at which the construction works are undertaken and the character of the noise or vibration emissions.

Offsite traffic access will remain unchanged during the proposed construction works and there would be negligible changes to traffic on the surrounding local road. Accordingly, traffic noise emissions are not considered any further in this CNIS.

3 NEAREST SENSITIVE RECEIVERS

The SAH is the nearest and most sensitive receiver to the proposed works and will ultimately limit the noise and vibration emissions from the project. However, the purpose of this CNIS is to determine the potential noise and vibration impacts on the nearest non-associated properties. Accordingly, the three nearest non-SAH associated sensitive receivers have been identified and shown in **Figure 1**, together with the location of the existing CSB.

Figure 1 Location of the Nearest Sensitive Receivers

4 CONSTRUCTION NOISE AND VIBRATION GOALS

4.1 Noise Goals

In accordance with the DECCW's Interim Construction Noise Guideline (ICNG), **Table 1** presents the specific criteria as "$L_{Aeq(15minute)}$ Noise Management Levels (NMLs)" that have been adopted for noise sensitive residential receivers.

Table 1 Specific LAeq(15minute) NMLs for Residential Receivers

Time of Day	Management Level, LAeq(15minute)[1]	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Note 1: Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

In addition, the ICNG presents the NMLs for noise at other sensitive land uses based on the principle that the characteristic activities for each of these land uses should not be unduly disturbed, as shown in **Table 2**.

Table 2 Noise at sensitive land uses (other than residences) using quantitative assessment

Land use	Noise Management level, LAeq (15 min) (applies when properties are being used)
Classrooms at schools and other educational institutions	Internal noise level 45 dB(A)
Hospital wards and operating theatres	Internal noise level 45 dB(A)
Places of worship	Internal noise level 45 dB(A)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dB(A)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dB(A)
Community centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS2107 for specific uses.

Unattended noise surveys at the nearest residential receivers were undertaken between 28 April and 5 May 2010. The L_{A90} background noise levels (RBLs) together with the corresponding construction noise management levels are presented in **Table 3**.

Table 3 Background Noise Levels and Construction Noise Management Levels

Receiver	L_{A90} Background Noise Levels (RBL) - Daytime	Construction NMLs[1] - LAeq (15 minute)	
		Noise Affected	Highly Noise Affected
173 Fox Valley Road	43 dBA	53[2] dBA	75[3] dBA
75 Mount Pleasant Avenue	42 dBA	52[2] dBA	75[3] dBA
205 The Comenarra Parkway	45 dBA	55[2] dBA	75[3] dBA
Existing CSB	46 dBA	65[4] dBA	

Note 1: The construction NMLs are based on DECCW's Interim Construction Noise Guideline (ICNG) July 2009.

Note 2: Based on RBL + 10 dBA for residential receivers.

Note 3: For the "highly noise affected" residential receivers

Note 4: External Noise Levels - Based on the NMLs for sensitive land use (ie hospitals) and assuming 20 dBA facade attenuation.

4.2 Vibration Damage Goals - Surface Structures

Most commonly specified "safe" structural vibration limits are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have potential to cause damage to the main structure.

4.2.1 British Standard 7385: Part 2 - 1993 Guidelines

In terms of the most recent relevant vibration damage goals, Australian Standard AS 2187: Part 2-2006 *'Explosives - Storage and Use - Part 2: Use of Explosives'* recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 *'Evaluation and measurement for vibration in buildings Part 2'* as they "are applicable to Australian conditions".

The Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration that are considered in the standard include demolition, blasting (carried out during mineral extraction or construction excavation), piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in **Table 4** and graphically in **Figure 2**.

Table 4 Transient Vibration Guide Values - Minimal Risk of Cosmetic Damage

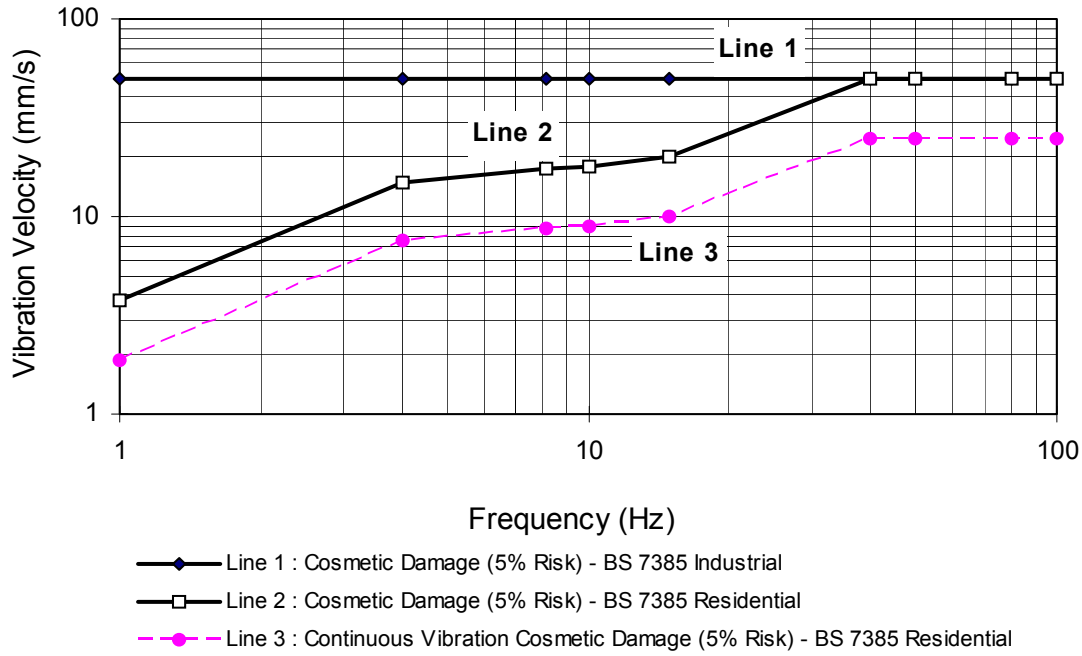
Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

The Standard states that the guide values in **Table 4** relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings.

Where the dynamic loading caused by continuous vibration may give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in **Table 4** may need to be reduced by up to 50%.

Note: rockbreaking/hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures (eg residences) and it may therefore be appropriate to reduce the transient values by 50%.

Figure 2 Graph of Transient Vibration Guide Values for Cosmetic Damage



In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for building types corresponding to 'Line 2' are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.

The Standard goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in **Table 4**, and major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in the Standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in **Table 4** should not be reduced for fatigue considerations.

In order to assess the likelihood of cosmetic damage due to vibration, AS2187 specifies that vibration measured should be undertaken at the base of the building and the highest of the orthogonal vibration components (transverse, longitudinal and vertical directions) should be compared with the guidance curves presented in **Figure 2**.

It is noteworthy that extra to the guide values nominated in **Table 4**, the standard states that:

> *"Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."*

Also that:

> *"A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive."*

For most construction activities involving intermittent vibration sources such as rockbreakers, piling rigs, vibratory rollers, excavators and the like, the predominant vibration energy occurs at frequencies greater than 4 Hz (and usually in the 10 Hz to 100 Hz range). On this basis, a conservative vibration damage screening level of 7.5 mm/s has been adopted for preliminary assessment purposes.

At locations where the predicted and/or measured vibration levels are greater than 7.5 mm/s, a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure would be required to determine the applicable safe vibration level.

4.2.2 Human Comfort Vibration Goals

Humans are far more sensitive to vibration than is commonly realised. They can detect vibration levels which are well below those causing any risk of damage to a building or its contents.

The actual perception of motion or vibration may not, in itself, be disturbing or annoying. An individual's response to that perception, and whether the vibration is 'normal' or 'abnormal', depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as "normal" in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

Human tactile perception of random motion, as distinct from human comfort considerations, was investigated by Diekmann and subsequently updated in German Standard DIN 4150 Part 2-1975. On this basis, the resulting degrees of perception for humans are suggested by the vibration level categories given in **Table 5**.

Table 5 Peak Vibration Levels and Human Perception of Motion

Approximate Vibration Level		Degree of Perception
Peak Vibration Level	**RMS Vibration Level**	
0.10 mm/s	0.07 mm/s	Not felt
0.15 mm/s	0.1 mm/s	Threshold of perception
0.35 mm/s	0.25 mm/s	Barely noticeable
1 mm/s	0.7 mm/s	Noticeable
2 mm/s	1.4 mm/s	Easily noticeable
6 mm/s	4.2 mm/s	Strongly noticeable
14 mm/s	10 mm/s	Very strongly noticeable

Note: These approximate vibration levels (in floors of building) are for vibration having a frequency content in the range of 8 Hz to 80 Hz. The RMS vibration levels assume a crest factor of 1.4 for sinusoidal vibration.

Table 5 suggests that people will just be able to feel floor vibration at levels of about 0.1 mm/s (RMS) and that the motion becomes 'noticeable' at a level of approximately 0.7 mm/s (RMS).

The DECCW's *"Assessing Vibration: a technical guideline"* notes that *"vibration in buildings can be caused by many different external sources, including industrial, construction and transportation activities. The vibration may be continuous (with magnitudes varying or remaining constant with time), impulsive (such as in shocks) or intermittent (with the magnitude of each event being either constant or varying with time)."*

Construction activities typically generate building vibrations that are intermittent or impulsive in nature, however vibration levels may sometimes be constant from sources such as generators or ventilation fans.

Examples of intermittent vibration events include the vibration generated by rockbreakers, vibratory rollers, drilling/piling and excavators. Examples of impulsive vibration events include the vibration generated by demolition activities, blasting or the dropping of heavy equipment.

Where vibration is intermittent or impulsive in character, the DECCW's vibration guideline (and other similar guidelines) recognise that higher vibration levels are tolerable to building occupants than for continuous vibration. As such, higher vibration goals are usually applicable for short term, intermittent and impulsive vibration activities than for continuous vibration sources.

The following sections describe the applicable continuous and intermittent vibration goals for the construction activities.

4.2.3 Human Comfort Goals for Continuous and Impulsive Vibration

The DECCW's *'Assessing Vibration: a technical guideline'* is applicable for the construction work and is based on the guidelines contained in British Standard BS 6472-1992 '*Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)'*. The DECCW guideline refers only to human comfort considerations and nominates preferred and maximum vibration goals for critical areas, residences and other sensitive receivers.

The criteria in the DECCW's guideline are non-mandatory, *"they are goals that should be sought to be achieved through the application of all feasible and reasonable mitigation measures. Where all feasible and reasonable measures have been applied and vibration values are still beyond the maximum value, the operator would need to negotiate directly with the affected community"*.

Construction vibration can be continuous, intermittent or impulsive and the DECCW's vibration guideline provides different goals for each category. The continuous vibration goals are most stringent and higher vibration levels are acceptable for intermittent and impulsive vibration on the basis of the shorter exposure times. Examples of typical vibration sources are provided in **Figure 3**.

Figure 3 Examples of Vibration (DECCW Vibration Guideline)

Examples of types of vibration

Continuous vibration	Impulsive vibration	Intermittent vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZECC (1990).	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer this would be assessed against impulsive vibration criteria.

The applicable human comfort vibration goals for continuous, intermittent and impulsive vibration sources are provided in **Table 6**, **Table 7** and **Table 8** respectively. In all cases, the vibration goals are expressed in terms of the RMS vibration velocity level in mm/s, measured in the most sensitive direction (z-axis).

The DECCW's vibration guideline notes the following in relation to the preferred and maximum vibration levels:

> *"There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Activities should be designed to meet the preferred values where an area is not already exposed to vibration. Where all feasible and reasonable measures have been applied, values up to the maximum value may be used if they can be justified. For values beyond the maximum value, the operator should negotiate directly with the affected community. Situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances and infrequent events of short term duration. An example is a construction or excavation project.*
>
> *In circumstances where work is short term, feasible and reasonable mitigation measures have been applied, and the project has a demonstrated high level of social worth and broad community benefits, then higher vibration values (above the maximum) may apply. In such cases, best management practices should be used to reduce values as far as practicable, and a comprehensive community consultation program should be instituted."*

Table 6 Preferred and Maximum Vibration Levels for Continuous Vibration

Building Type	Preferred Vibration Level RMS Velocity (mm/s)	Maximum Vibration Level RMS Velocity (mm/s)
Critical Woking Areas (eg hospital operating theatres, precision laboratories)	0.10	0.20
Residential Daytime	0.2	0,4
Residential Night-time	0.14	0.28
Offices, schools, educational institutions and places of worship	0.4	0.8
Workshops	0.8	1.6

Note: Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am.

Table 7 Preferred and Maximum Vibration Levels for Intermittent Vibration (Vibration Dose Values)

Building Type	Preferred Vibration Dose Value ($m/s^{1.75}$)	Maximum Vibration Dose Value ($m/s^{1.75}$)
Critical Woking Areas (eg hospital operating theatres, precision laboratories)	0.10	0.20
Residential Daytime	0.2	0,4
Residential Night-time	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8
Workshops	0.8	1.6

Note: For the definition of the Vibration Dose Value refer to the discussion in the following section. Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am.

Table 8 Preferred and Maximum Vibration Levels for Impulsive Vibration

Building Type	Preferred Vibration Level RMS Velocity (mm/s)	Maximum Vibration Level RMS Velocity (mm/s)
Critical Working Areas (eg hospital operating theatres, precision laboratories)	0.10	0.20
Residential Daytime	6.0	12.0
Residential Night-time	2.0	4.0
Offices, schools, educational institutions and places of worship	13.0	26.0
Workshops	13.0	26.0

Note: Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am.

Intermittent Vibration (Vibration Dose Values)

For most construction activities that generate perceptible vibration in nearby buildings, the character of the vibration emissions is intermittent. This includes equipment such as rockbreakers, excavators, piling rigs, rock drills, vibratory rollers and heavy vehicle movements.

Intermittent vibration is defined in the DECCW's vibration guideline as follows:

> *"**Intermittent vibration** can be defined as interrupted periods of continuous (e.g. a drill) or repeated periods of impulsive vibration (e.g. a pile driver), or continuous vibration that varies significantly in magnitude. It may originate from impulse sources (e.g. pile drivers and forging presses) or repetitive sources (e.g. pavement breakers), or sources which operate intermittently, but which would produce continuous vibration if operated continuously (for example, intermittent machinery, railway trains and traffic passing by). This type of vibration is assessed on the basis of vibration dose values".*

Where vibration comprises a number of events, a Vibration Dose (Dv) may be estimated for each event by the following formula using vibration measured in velocity:

$$Dv = 0.07\ V\ (rms) \times t^{0.25}\ m/s^{1.75}$$

Where, V (rms) = rms particle velocity (mm/s)
t = Total cumulative time (seconds) of the vibration event or period of vibration

The total vibration dose is then calculated using the following formula:

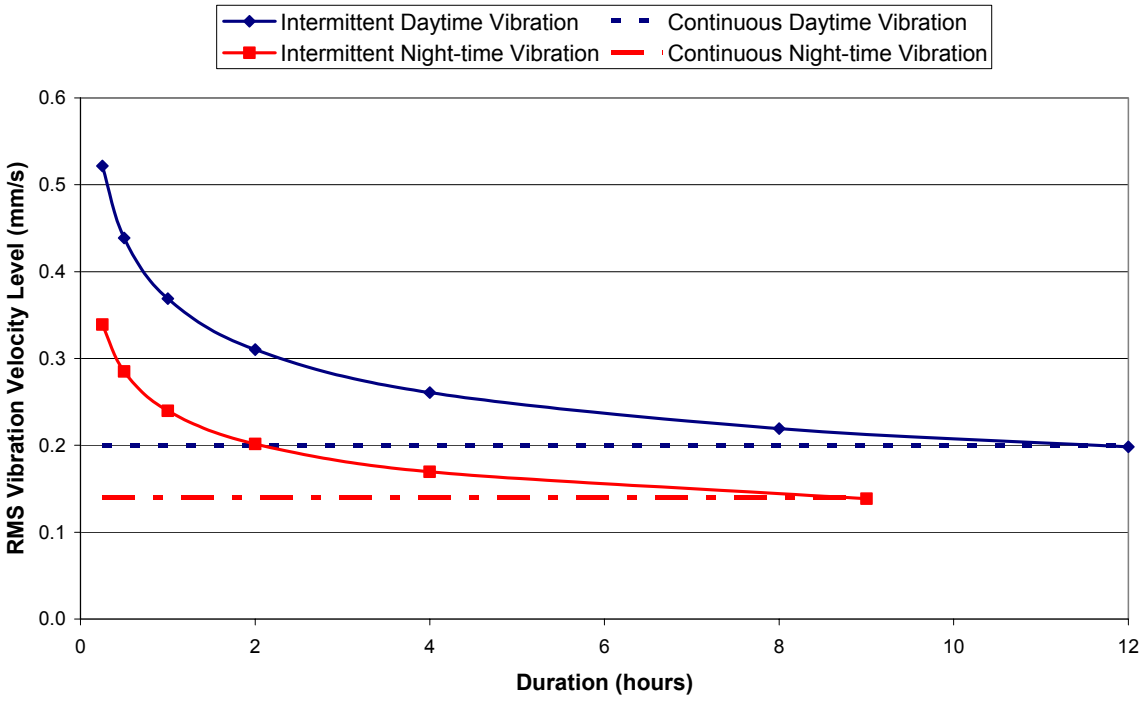
$$Dv = \left(\sum_{n=1}^{n=N} Dv_n^4 \right)^{0.25}$$

Where, Dv = Total vibration dose value for the day or night
Dvn = Vibration dose value for each vibration dose event
N = Total number of vibration dose events

The permissible vibration level corresponding to the vibration dose value varies according to the duration of exposure. For example, higher vibration levels are permitted if the total duration of the vibration event(s) is small and lower vibration levels are permitted with if the total duration of the vibration event(s) is large.

This concept is illustrated graphically in **Figure 4**, where the intermittent vibration curves for the daytime and night-time periods correspond to the preferred Vibration Dose Values in **Table 7**. As the total duration of the intermittent vibration sources during the daytime and night-time periods get larger, the intermittent vibration goals approach the preferred continuous vibration goals in **Table 6**.

Figure 4 Vibration Levels Corresponding to "Low Probability of Adverse Comment" for Residential Receivers - Continuous and Intermittent Vibration



5 CONSTRUCTION NOISE PREDICTIONS

5.1 Methodology and Assumptions

The noise levels at the nearest sensitive receiver have been calculated based on the maximum sound power levels from the equipment and the distance between the construction site and the nearest sensitive receivers. Furthermore, the calculated noise levels will inevitably depend on the number of plant items and equipment operating at any one time and their precise location relative to the receiver of interest.

In practice, the noise levels will vary due to the fact that plant and equipment will move about the work sites and will not all be operating concurrently. In some cases, reductions in noise levels will occur when plant are located in cuttings or behind embankments or buildings.

Maximum sound power levels for equipment assumed in the modelling are presented in **Table 9**.

Table 9 Summary of Sound Power Levels used for Construction Equipment

Plant Item	L_{Amax} Sound Power Level (dBA)
Rockbreaker	122
Dozer	121
Dump Truck	108
Excavator (approx 30T)	110
Front End Loader	111
Compactor	105
Scraper	110
Grader	110
Water Cart	108
Concrete Saw	118
Mobile Crane	110
Generator	104
Jack Hammer	113
Bored Piling Rig	110
Concrete Pump	109
Compressor	105
Vibratory Roller	114

The sound power levels given in **Table 9** are maximum noise emission levels for plant that will, or may, be used on this project in typical operation. To assess the impact of the likely noise emissions, it is necessary to convert these levels to equivalent $L_{Aeq(15minute)}$ noise emissions. From numerous field studies on large construction projects, the measured difference values between the L_{Amax} and $L_{Aeq(15minute)}$ noise levels have been found to be up to 10 dBA depending on the mixture of the plant, intensity of operation and location of the plant relative to the receiver.

The proposed equipment used at the station sites will be a subset of that presented in **Table 9**, with the noise model using sound power levels (SWLs) per activity and plant operating loads and cycles, based on the maximum noise levels presented in **Table 9**.

Based on these parameters, the $L_{Aeq(15minute)}$ SWL for each major noise generating activity is estimated as follows:

- Demolition and excavation using Rockbreakers and Dozers - 121 dBA
- Building Construction - 110 dBA

5.2 Construction Noise Predictions

A summary of the predicted $L_{Aeq(15minute)}$ noise levels at the nearest affected receivers adjacent to the construction works are provided in **Table 10**.

Table 10 Construction Noise Predictions

Receiver	Type of Building	Distance from the Site (m)	Predicted LAeq(15 minute) Noise Level (dBA)		Noise Criteria LAeq(15 minute) (dBA)[1]	
			Demolition and Earthworks	Building Construction	Noise Affected	Highly Noise Affected
173 Fox Valley Road	Residential	285	64	53	53	75
75 Mount Pleasant Avenue	Residential	265	65	54	52	75
205 The Comenarra Parkway	Residential	193	67	56	55	75
Existing CSB	Hospital	2	107	96	65	

5.3 DISCUSSION

With reference to **Section 5.2**, the noise predictions indicate that $L_{Aeq(15minute)}$ construction noise levels in the range of 64 dBA to 67 dBA are expected at the nearest noise affected residential receivers for typical demolition and earthworks (including rockbreaker and dozer). The NMLs are predicted to be exceeded by up to 13 dBA at the nearest noise affected residential receivers.

In addition, with reference to **Section 5.2**, the noise predictions indicate that $L_{Aeq(15minute)}$ construction noise levels in the range of 53 dBA to 56 dBA are expected at the nearest noise affected residential receivers and for typical building construction works. The NMLs are predicted to be exceeded by up to 2 dBA at the nearest noise affected residential receivers.

Further, significant exceedances are predicted to occur within the SAH grounds in the vicinity of the proposed works, particularly the Existing CSB. Accordingly, it is likely that the SAH will implement a construction Noise Management Plan in order to manage and mitigate the noise emissions from the works to SAH associated sensitive receivers which will consequently result in a benefit to the surrounding residential receivers.

6 VIBRATION ASSESSMENT

As a guide, indicative safe working distances for typical items of vibration intensive plant are listed in **Table 11**. The safe working distances are quoted for both “cosmetic” damage (refer BS 7385) and human comfort (refer BS 6472).

Table 11 Indicative Safe Working Distances for Vibration Intensive Plant

Plant Item	Rating/Description	Indicative Working Distance	
		Cosmetic Damage (BS 7385)	Human Response (BS 6472)
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	100 m
	> 300 kN (> 18 tonnes)	25 m	100 m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg - 12 to 18t excavator)	7 m	23 m
Large Hydraulic Hammer	(1600 kg - 18 to 34t excavator)	22 m	73 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	20 m
Pile Boring	≤ 800 mm	2 m (nominal)	N/A
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

Note: More stringent conditions may apply to sensitive structures.

The safe working distances presented in **Table 11** are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions. Vibration monitoring is recommended to confirm the safe working distances at specific sites and for specific plant items.

For highly sensitive receivers (eg, high technology facilities, operating theatres and MRIs), specific assessment is required to ensure satisfactory operation of the facility and any mitigation or management measures are required to minimise the potential impacts.

In relation to human comfort (response), the indicative safe working distances in **Table 11** relate to continuous vibration. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods may be allowed.

7 NOISE AND VIBRATION MONITORING

7.1 Noise Monitoring

Where it has been predicted that noise levels may be in excess of the nominated construction noise goals at a noise sensitive receiver, noise monitoring would be conducted at:

- the affected receiver; or
- if more than one affected receiver has been identified, at the nearest affected receiver; or
- where the nearest affected receiver refuses noise monitoring on their property, at the near point to that receiver within the site boundary.

If it can be demonstrated that direct measurement of noise from the construction site is impractical, alternative means of determining construction noise levels may be adopted in accordance with Chapter 11 of the NSW Industrial Noise Policy.

All noise monitoring results would be assessed against the nominated noise goals and compiled into a report to be forwarded to the construction contractor and project manager. Reporting would be submitted to the construction contractor and project manager within one week of being undertaken or at weekly intervals for continuous monitoring.

7.2 Vibration Monitoring

Where it is anticipated that an item of plant will operate within the safe working distance for cosmetic damage nominated in **Table 11**, vibration monitoring would be required on the potentially nearest affected receiver. Where it is anticipated that an item of plant will operate within the safe working distance for human response and concerns have been raised regarding vibration, vibration monitoring would also be required at the receiver(s) under question.

All vibration monitoring results would be assessed against the nominated vibration goals and compiled into a report to be forwarded to the construction contractor and project manager. Reporting would be submitted to the construction contractor and project manager within one week of being undertaken or at weekly intervals for continuous monitoring.

8 NOISE AND VIBRATION MANAGEMENT PLAN

Where noise and/or vibration issues have been identified after all feasible and reasonable mitigation measures have been implemented, the construction contractor would produce a noise and vibration management plan. The noise and vibration management plan is to be project specific and will cover all aspects of the works. A copy of the noise management plan would be kept on site in order to provide guidance to the construction contractor relating to the management of noise and vibration issues. The noise and vibration management plan would include:

- Identification of the specific activities that will be carried out and associated noise and vibration sources.
- Identification of all potentially affected sensitive receivers (both SAH associated and private), including residences, churches, commercial premises, schools and properties containing noise and/or vibration sensitive equipment.
- The construction noise objectives based on the existing background noise levels in accordance with the conditions of consent.
- The construction vibration criteria specified in the conditions of consent.
- Determination of appropriate noise and vibration objectives for each identified sensitive receiver in accordance with the conditions of consent.
- Noise and vibration monitoring, reporting and response procedures assessment of potential noise and vibration from the proposed demolition, excavation and construction activities, including noise from construction vehicles and any traffic diversions.
- Description of specific mitigation treatments, management methods and procedures that will be implemented to control noise and vibration during construction.
- Construction timetabling to minimise noise impacts including time and duration restrictions, respite periods and frequency.
- Construction timetabling to minimise noise impacts including time and duration restrictions, respite periods and frequency.
- Procedures for notifying residents of construction activities which are likely to affect their amenity through noise and vibration.
- Contingency plans to be implemented in the event of non-compliances and/or noise complaints.

9 CONCLUSION

The noise predictions indicate that both the proposed demolition and construction activities are likely to exceed the construction noise goals by clear margins, resulting in anticipated moderate noise impacts at the nearest noise affected residential receivers and high noise impact at the SAH.

Accordingly, a noise and vibration management plan will be produced indentifying reasonable and feasible noise mitigation measures to reduce the noise emissions from the Project to acceptable levels, and where this is not achievable, identify noise management practices to reduce the potential impacts.

Recommendation of noise and vibration monitoring for assessment against the noise levels and safe working distance predicted in this report at the nearest and most impacted noise and vibration sensitive receivers during construction works.

10 REFERENCED DOCUMENTS AND GUIDELINES

- Director-General's Requirements (Application Number: MP 10_0070)
- British Standard 6472:1992 - *Guide to evaluation of human exposure to vibration in buildings.*
- British Standard 7385-1:1990 *Evaluation and measurement for vibration in buildings. Guide for measurement of vibrations and evaluation of their effects on buildings*.
- DECCW's Assessing Vibration: *A Technical Guideline* (MCoA 2.6).
- DIN 4150 Part 3:1999 *Structural Vibration in Buildings - Effects on Structures* (MCoA 2.6).