

St George Hospital Stage 3

Construction Noise and Vibration Management Sub Plan

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1 INTRODUCTION

Acoustic Logic has been engaged to prepare a Construction Noise and Vibration Management Sub Plan for the St George Hospital Stage 3 development.

The principal objective of this study is to undertake an evaluation of works/activities to be performed during the demolition, excavation and construction of the project and forecast the potential impacts of noise and vibration. This assessment will be used to formulate and streamline effective regulation and mitigation measures.

The principal issues which will be addressed in this report are as below:

- Identification of the noise and vibration standards which will be applicable to this project.
- Identification of potentially impacted nearby development.
- Identify likely sources of noise and vibration generation and predicted noise levels at nearby development.
- Formulation of a strategy to comply with the standards identified and mitigation treatments in the event that compliance is not achievable.

Provided all measures outlined in this report are fully implemented, noise and vibration impacts associated with the construction of the development site will be strictly controlled, and the impact on the surrounding environment minimised.

It is important to note that noise management levels from the EPA Interim Construction Noise Guideline (ICNG) will be used as an objective to assess construction noise levels to, but this level is not defined as a criterion. The vibration criteria adopted per the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and DIN 4150-3 standards are a set recommendation, however the ICNG noise management levels are not to be used as set criteria.

Further assessment through sample construction noise and vibration testing will supplement this plan to provide a real-world analysis of any adverse effects that can impact the surrounding developments.

Until sample construction activities can be individually tested, expectations must be managed due through ongoing iteration to this Construction Noise and Vibration Management Sub Plan.

2 SITE DESCRIPTION

Demolition, excavation and construction works anticipated are as follows:

- Demolition: Minimal demolition of awning and step back of roof.
- Remediation works.
- Bulk excavation: Phase 1 excavation through bedrock and bored piling close to sensitive receivers.
- Construction: Erection of building structure (powered hand tools for formwork, shotcrete, anchoring, concrete pump, vibrators).
- Use of electric crane.

Investigation has been carried out by this office in regards to the existing properties and noise impacts surrounding the proposed development, which is detailed below:

- Existing residential blocks to the far east and west of the site
- Existing commercial receivers to the west
- Existing educational facilities to the north-west, and
- Existing healthcare receivers to the north and south.

The nearest noise receivers around the site include:

- **R1:** Residential Receiver 1 – Residential receivers to the south-west along Gray Street
- **R2:** Residential Receiver 2 – Residential receivers to the west along Gray Street
- **R3:** Residential Receiver 3 – Residential receivers to the north-east at 11 Kensington Street
- **R4:** Residential Receiver 4 – Residential receivers to the east at 26 Belgrave Road.
- **C1:** Commercial Receiver 1 – Kogarah Fire Station to the west.
- **E1:** Educational Receiver 1 – United Early Learning Childcare Centre
- **H1:** Healthcare Receiver 1 – Healthcare receivers to the north at 19 Kensington Street.
- **H2:** Healthcare Receiver 2 – Healthcare receivers to the north at 11 Kensington Street
- **H3:** Healthcare Receiver 3 – Other buildings within the St George Hospital development envelope.

The risk of adverse noise and vibration impacts primarily occurs in relation to noise sensitive developments on the St George Hospital site itself.

A site map with surrounding receivers is presented in Figure 1.



- Project Site
- Residential Receivers
- Commercial Receivers

Figure 1 - Project Site
Source: NSW Six Maps

- Educational Receivers
- Healthcare Receivers
- Development Envelope

3 CONDITIONS OF CONSENT

The Minister for Planning has provided the following relevant conditions of consent (Ref: SSD-39170713, dated 13th February 2023).

B17. *The Construction Noise and Vibration Management Sub-Plan must address, but not be limited to, the following:*

- (a) be prepared by a suitably qualified and experienced noise expert;*
- (b) describe procedures for achieving the noise management levels in EPA's Interim Construction Noise Guideline (DECC, 2009), including in relation to sensitive receivers within existing hospital buildings;*
- (c) describe the measures to be implemented to manage high noise generating works such as piling, in close proximity to sensitive receivers, including existing patient care buildings within the hospital campus;*
- (d) include strategies that have been developed with the community for managing high noise generating works;*
- (e) describe the community consultation undertaken to develop the strategies in condition B17(d);*
- (f) include a complaints management system that would be implemented for the duration of the construction; and*
- (g) include a program to monitor and report on the impacts and environmental performance of the development and the effectiveness of the implemented management measures in accordance with the requirements of condition B14.*

B17A. *Prior to the commencement of construction of Phase 2 works (being demolition of the Prince William Wing and construction of the forecourt), the Construction Noise and Vibration Sub-Plan must be revised to include strategies to ameliorate noise and vibration impacts to occupants of adjoining occupied hospital buildings, including buildings approved as part of this consent.*

Construction Hours

C4. *Construction, including the delivery of materials to and from the site, may only be carried out between the following hours:*

- (a) between 7am and 6pm, Mondays to Fridays inclusive; and*
- (b) between 8am and 1pm, Saturdays.*

No work may be carried out on Sundays or public holidays.

C5. *Notwithstanding condition C4, provided noise levels do not exceed the existing background noise level plus 5dB, works may also be undertaken during the following hours:*

- (a) between 6pm and 7pm, Mondays to Fridays inclusive; and*
- (b) between 1pm and 5pm, Saturdays.*

C6. *Construction activities may be undertaken outside of the hours in condition C4 and C5 if required:*

- (a) by the Police or a public authority for the delivery of vehicles, plant or materials; or*
- (b) in an emergency to avoid the loss of life, damage to property or to prevent environmental harm; or*
- (c) where the works are inaudible at the nearest sensitive receivers; or*

- (d) *for the delivery, set-up and removal of construction cranes, where notice of the crane-related works is provided to the Planning Secretary and affected residents at least seven days prior to the works; or*
 - (e) *where a variation is approved in advance in writing by the Planning Secretary or her nominee if appropriate justification is provided for the works.*
- C7. *Notification of such construction activities as referenced in condition C6 must be given to affected residents before undertaking the activities or as soon as is practical afterwards.*
- C8. *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.*

Construction Noise Limits

- C13. *The development must be constructed to achieve the construction noise management levels detailed in the Interim Construction Noise Guideline (DECC, 2009). All feasible and reasonable noise mitigation measures must be implemented and any activities that could exceed the construction noise management levels must be identified and managed in accordance with the management and mitigation measures identified in the approved Construction Noise and Vibration Management Plan.*
- C14. *The Applicant must ensure construction vehicles (including concrete agitator trucks) do not arrive at the site or surrounding residential precincts outside of the construction hours of work outlined under condition C4.*
- C15. *The Applicant must implement, where practicable and without compromising the safety of construction staff or members of the public, the use of 'quackers' to ensure noise impacts on surrounding noise sensitive receivers (including occupants of existing hospital buildings) are minimised.*

Vibration Criteria

- C16. *Vibration caused by construction at any residence or structure outside the site must be limited to:*
- (a) *for structural damage, the latest version of DIN 4150-3 (1992-02) Structural vibration - Effects of vibration on structures (German Institute for Standardisation, 1999); and*
 - (b) *for human exposure, the acceptable vibration values set out in the Environmental Noise Management Assessing Vibration: a technical guideline (DECC, 2006) (as may be updated or replaced from time to time).*
- C17. *Vibratory compactors must not be used closer than 30 metres from residential buildings unless vibration monitoring confirms compliance with the vibration criteria specified in condition C16.*
- C18. *The limits in conditions C16 and C17 apply unless otherwise outlined in a Construction Noise and Vibration Management Plan, approved as part of the CEMP required by condition B17 of this consent.*

4 AMBIENT NOISE SURVEY

Unattended noise monitoring was conducted by JHA during the SSDA Stage. The conditioned *Noise and Vibration Assessment Report* (Ref: 210074) presented the measured RBL (lowest 10th percentile noise levels during operation time period) as per Table 4-1 below. The monitoring was conducted from 28th June 2021 to 6th July 2021.

Table 4-1 – Measured Noise Levels

Monitor	Time of day	Rating Background Noise Level dB(A)_{L90(Period)}
St George Hospital Kensington Street Entrance (SSDA monitoring)	Day (7am – 6pm)	58
	Evening (6pm – 10pm)	53
	Night (10pm – 7am)	51

5 CONSTRUCTION HOURS

The conditions of consent allow for the following standard hours:

- Monday to Friday: 7:00am-6:00pm; and
- Saturday: 8:00am-1:00pm.
- No work is to be carried out on Sundays or public holidays.

6 CONSTRUCTION NOISE AND VIBRATION OBJECTIVES

6.1 NOISE OBJECTIVES

Noise associated with construction activities on the site will be assessed in conjunction with the following guidelines:

- NSW EPA Interim Construction Noise Guideline; and
- Australian Standard 2436-2010 "Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites".

6.1.1 NSW EPA Interim Construction Noise Guideline

The EPA Interim Construction Noise Guideline (ICNG) assessment requires:

- Determination of noise management levels (based on ambient noise monitoring);
- Review of operational noise levels at nearby development; and
- If necessary, recommendation of noise controls strategies in the event that compliance with noise emission management levels is not possible.

EPA 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.

In addition to the above management levels for residential receivers, the ICNG nominates a Management Level of 70dB(A) $L_{eq}(15min)$ at commercial receiver facades (typical office, retail). And a Management Level of RBL + 5 dB(A) for any work done outside of standard hours.

As the proposed non-standard hours fall between daytime and evening time periods, the Noise Management Level for each period will differ due to their different rating background levels (RBL).

A summary of the above recommended noise levels from the ICNG is presented below.

Table 6-1 – Noise Emission Goal at Residential Property Boundaries

Location	"Noise Affected" Level - dB(A) $L_{eq}(15min)$ Standard Hours	"Highly Noise Affected" Level - dB(A) $L_{eq}(15min)$
R1, R2, R3 & R4	68 externally at façade	75

Where noise from the construction works is above the "noise affected" level, the proponent should apply any feasible and reasonable work practices to minimise noise. The "noise affected level is representative of a level where there may be some community reaction to noise.

If noise emissions are likely to exceed 75 dB(A) $L_{eq(15min)}$ "highly noise affected" at the boundary of surrounding affected residential receivers, the receiver is deemed to be "highly noise affected". The "highly noise affected" level is representative of a level where strong community reaction to noise is expected. Introduction of management controls such as scheduling of noisy periods, or respite periods is then recommended. Refer to Section 8 for specific recommendations.

Section 4.1.2 and 4.1.3 of the EPA Interim Construction Noise Guideline also nominates management levels for other sensitive land uses (other than residences). Criteria relevant to this assessment is detailed below.

Table 6-2 – Noise Emission Goal at Commercial/Sensitive Property Boundaries

Location	"Noise Affected" Level - dB(A)$L_{eq(15min)}$ Standard Hours
E1 Classrooms (Childcare)	45 internally when in use
H1, H2 & H3 Hospital wards and operating theatres	45 internally when in use
C1 Surrounding commercial receivers	70 externally at façade

It is noted that sensitive spaces can be individually measured for more justified internal noise goals depending on the sensitive space in question.

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

The Australian Standard AS2436 states that where all reasonable and available measures have been taken to reduce construction noise, mitigation strategies may be put in place to reduce levels noise levels to within a reasonable and acceptable level.

For the control and regulation of noise from construction sites, AS2436:1981 nominates the following:

- a. *That reasonable suitable noise criterion is established,*
- b. *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 construction hours, and*
- c. *The undertaking of noise monitoring where non-compliance occurs to assist in the management and control of noise emission from the construction site.*

The guideline reflects on feasible and reasonable mitigation strategies, management controls and public liaising in the effort to reach realistic compromises between construction sites and potential noise affected receivers.

Based on these criteria the following procedure will be used to assess noise emissions:

- Predict noise levels produced by typical construction activities at the sensitive receivers.
- Adopt management conditions as per AS2436 in the event of a non-compliance.

6.2 VIBRATION OBJECTIVES

Vibration caused by construction at any residence or structure outside the subject site will be assessed with reference to:

- For structural damage vibration, German Standard DIN 4150-3 *Structural Vibration: Effects of Vibration on Structures*.
- For vibration to sensitive equipment/spaces, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) recommendations for building vibration criteria.
- 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.
- Ausgrid requirements for the existing substation.

The criteria and the application of this standard are discussed in separate sections below.

6.2.1 Structure Borne Vibrations

German Standard DIN 4150-3 (2016) provides a guideline for acceptable levels of vibration velocity in building foundations, to assess the effects of vibration on structures. The table gives guidance on the maximum accepted values of velocity at the foundation and in the plane of the highest floor of various types of buildings, to prevent any structural damage.

The table below lists the peak particle velocity, which is the maximum absolute value of the velocity signals for the three orthogonal components. This is measured as a maximum value of any of the three orthogonal component particle velocities when 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.

It is noted that if measured vibration levels are below the guidelines listed below, damage that will reduce the serviceability of the building will not occur and if damage to the building does occur, it is assumed that the damage is related to other activities or sources. Furthermore, the DIN4150-3 guideline states the following regarding the limits presented in Table 1 of the standard:

“Exceeding the guideline values does not necessarily lead to damage. Should they be exceeded, however, further investigations may be necessary, such as determining and evaluating the stresses as detailed in 4.3 and 4.4.”

Table 6-3 – DIN 4150-3 (2016) – Safe Limits for Building Vibration

Type of Structure		Guideline values for Peak Particle Velocity ($v_{i,max}$) in mm/s				
		At Foundation at a Frequency of (all directions)			Topmost floor, horizontal direction	Floor slabs, vertical direction
		1Hz-10Hz	10Hz-50Hz	50Hz-100Hz*	All Frequencies	All frequencies
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

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

It is noted that even if the specific guideline values are complied with, minor damage cannot be excluded.

6.2.2 Vibration to the Ausgrid Substation

Ausgrid has provided the following advice with relation to the existing substation chamber (substation S10798) and associated vibration limits:

Vibration management and mitigation

Vibration limit for demolition, excavation and construction activities in the vicinity of the substation is a peak particle velocity (PPV) of 9mm/s at measured at the external surfaces of the substation.

Automatic alert shall be set at 80% of the vibrations limit i.e., at a PPV of 7.2mm /s. Protocols for the when alarms are triggered for Alert or Stop work shall be as per Ausgrid's Network Standard NS 192 "Blasting Near Substations and Power Lines".

Also refer to Ausgrid's Network Standard NS193 "Ground Movement and Vibration Limits Near Buried Cable" for vibration limits for cables.

Please note that there still is a risk of vibration events with a lower vibration level that can cause disruption of power supply from the substation. The specified limit is based upon a vibration response at a zone substation within Ausgrid's franchise area.

Ground movement and vibration management plan needs to be incorporated (or referenced) in BOTH the Construction Management Plan and the Demolition Management Plan.

The installation of new piles in close proximity of the substation are likely to exceed the vibration limits required by Ausgrid if an auger comes into contact with subsurface structures.

Any work, where excavation plant or equipment (rock breaker or similar) that comes into contact with the substation enclosure is likely to exceed the vibration limit and force a STOP WORK event.

It is prudent to correctly plan and control the works in the vicinity of the substation.

6.2.3 Vibration Objective for Sensitive Equipment Within St Georges Hospital

The establishment of relevant and appropriate construction vibration criteria has been developed based on previous project experience and criteria typically adopted for this type of space/equipment. It is noted that generic vibration criteria for operational requirements of specific equipment have not been provided by St Georges Hospital, however baseline ambient vibration testing is currently underway within St Georges Hospital with special focus on Mammography and MRI areas that are close to the façade fronting the construction works. Currently, only one week's worth of data has been accumulated with more ambient vibration monitoring to come.

Using the currently obtained baseline measurement results and assumed vibration criteria of sensitive instruments by our office based on similar projects, the following maximum PPV on the three orthogonal directions is presented below. It is of the opinion of this office that vibration criteria be nominated as the maximum PPV measured ambient levels for the respective sensitive spaces within the surrounding buildings from everyday activity.

Due to the sensitivity of the equipment surrounding the subject site, consideration must be given to vibration impacts around the development, although it is not possible to predict the levels of vibration impacts generated by construction at this stage. Though the construction methodology has been developed with this in mind, it is recommended that there is ongoing consultation with affected receivers. The timeframe for consultation is to be confirmed between the builder and St Georges Hospital. Vibration criteria is to be based on the operational vibration criteria of equipment, hours of operation and level of vibration that may cause damage to the machine and research experiments.

Mammography Area:

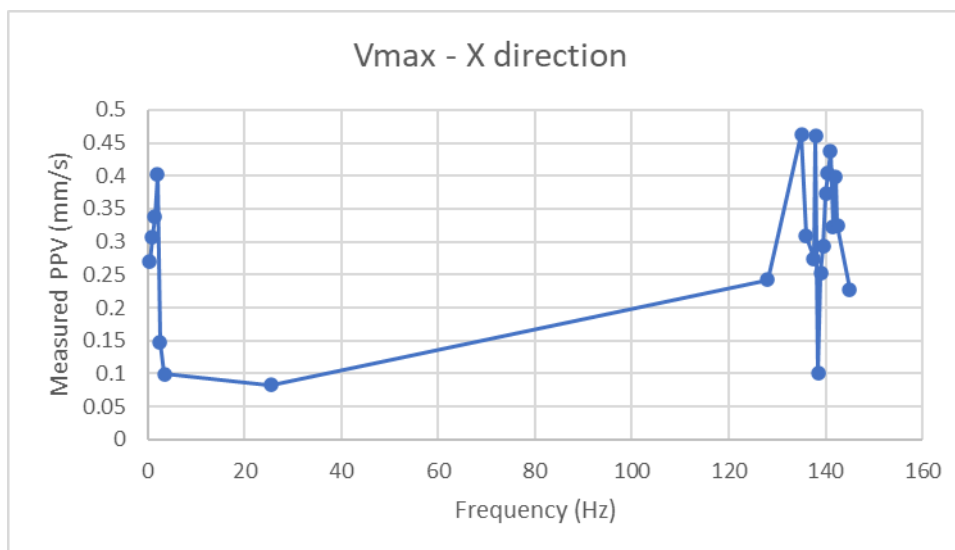


Figure 2 – Maximum Measured PPV in the X axis

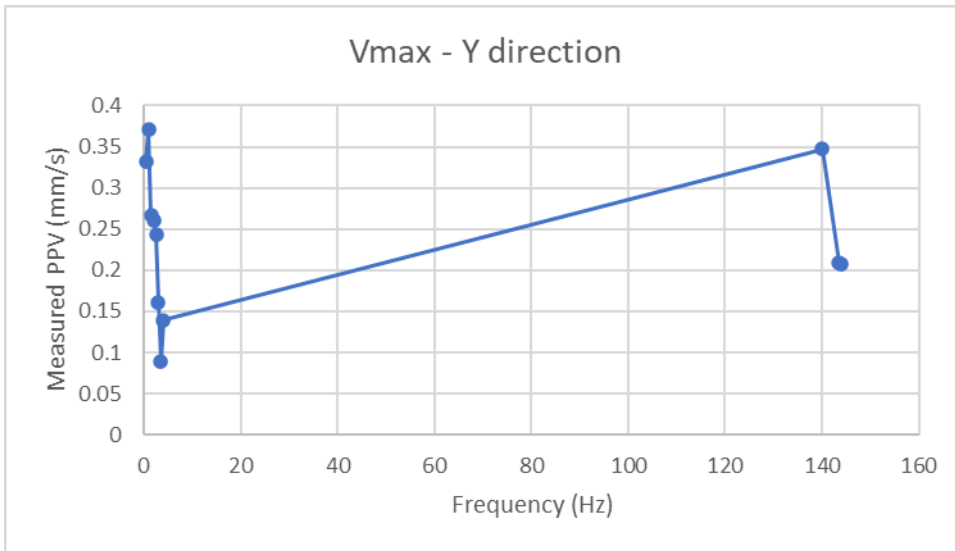


Figure 3 – Maximum Measured PPV in the Y axis

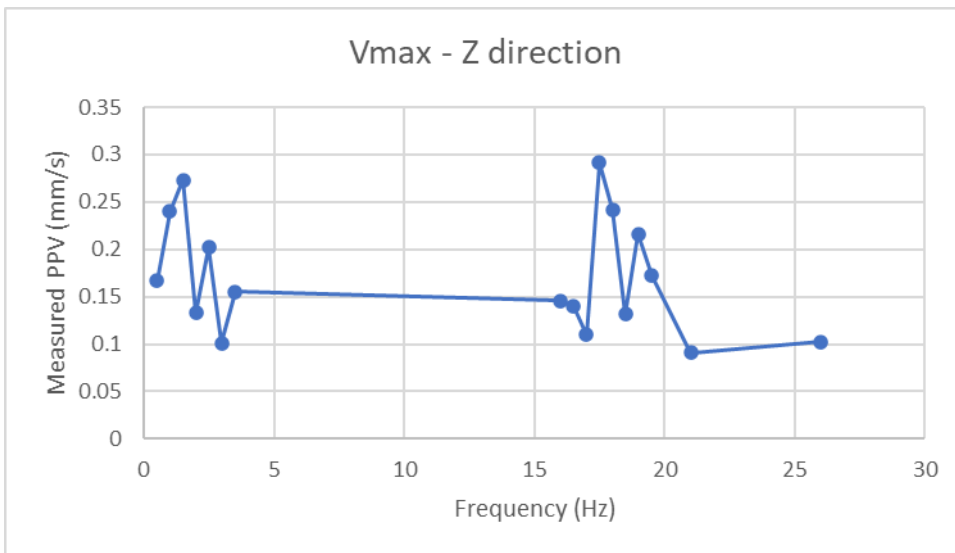


Figure 4 – Maximum Measured PPV in the Z axis

AL notes that extended baseline ambient noise monitoring is required to provide a more thorough dataset of typical maximum PPV's throughout the frequency spectrum and that the current data is incomplete. Further investigations are still ongoing and will supplement this CNVMSP to further develop suitable criteria.

MRI Area:

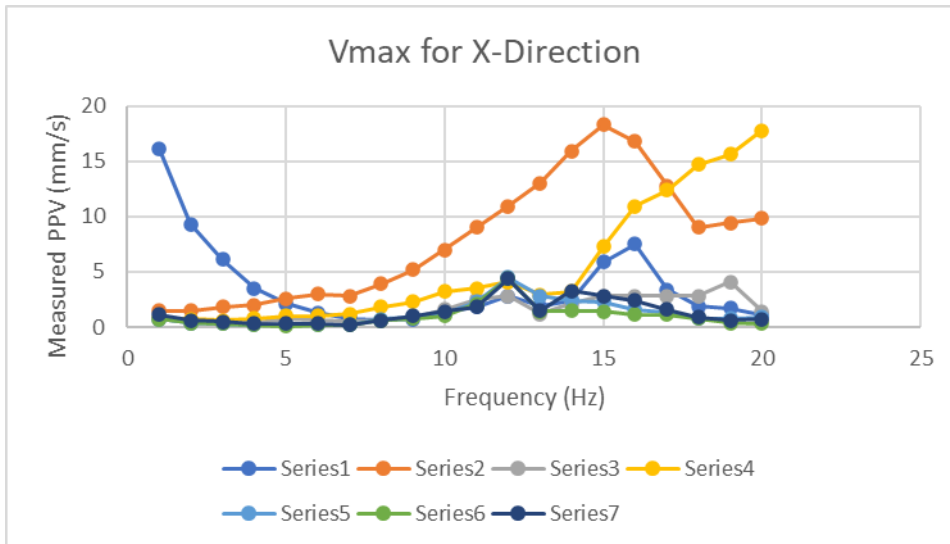


Figure 5 – Maximum Measured PPV in the X axis

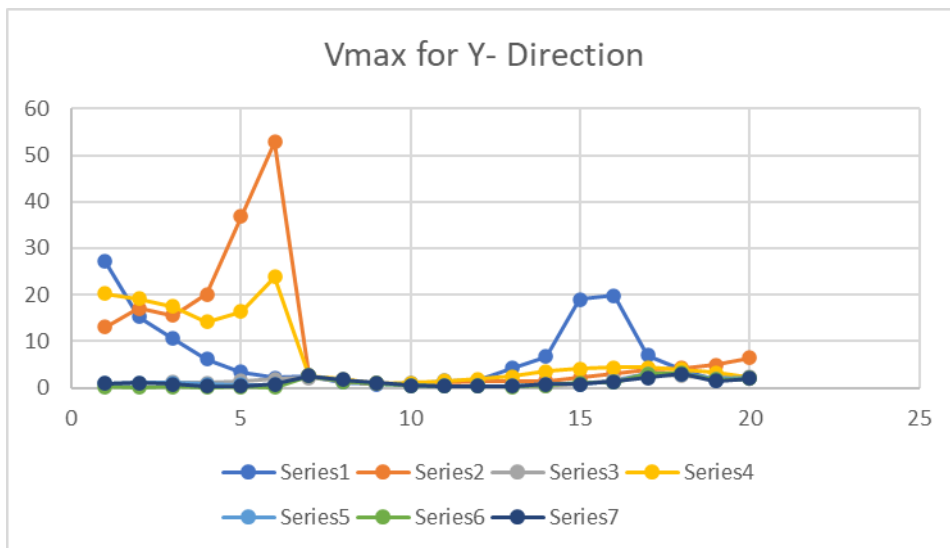


Figure 6 – Maximum Measured PPV in the Y axis

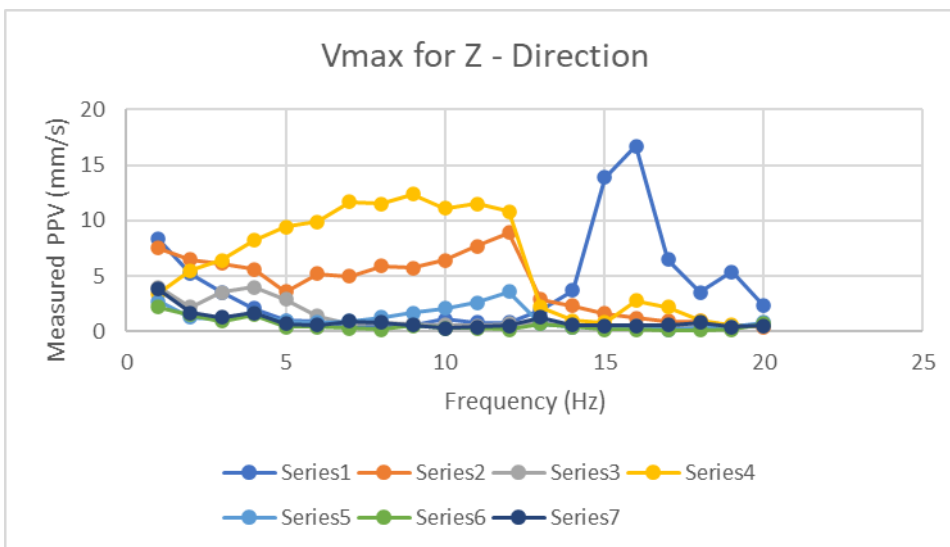


Figure 7 – Maximum Measured PPV in the Z axis

Further details are expected to supplement and justify any adopted criteria in future analysis. If any vibration exceedances are expected above the nominated ambient criteria, open communication between the builder and St Georges Hospital should be established to minimise any adverse effects.

It is noted that the above criteria are generally below the level of human perception, and compliance with the above would provide a satisfactory amenity for the staff and students utilising respective sensitive spaces.

It is also noted that it is possible for vibration to impact equipment even if it is below the level of human perception. Recommendations in Section 8 detail management conditions to minimise the likelihood of vibration impact during specific hours for sensitive experimentation to occur.

Sample vibration measurements of typical construction activities are to be undertaken at the same locations to provide further analysis. Open communication between the builder and St Georges Hospital is to be established for managing noise and vibration impacts. If any vibration exceedances are expected above the nominated criteria, agreed measures will be implemented to minimise and adverse effects.

6.2.4 Assessing Amenity

The NSW EPA's *Assessing Vibration – a technical guideline* is based on the guidelines contained in British Standard BS 6472-1992 'Guide to Evaluate Human Exposure to Vibration Buildings (1Hz to 80Hz)'. This guideline provides procedures for assessing tactile vibration and regenerated noise within potentially affected buildings.

The recommendations of this guideline should be adopted to assess and manage vibration from the site. Where vibration exceeds, or is likely to exceed, the recommended levels then an assessment of reasonable and feasible methods for the management of vibration should be undertaken.

Table 6-4 – BS 6472 Vibration Criteria

		RMS acceleration (m/s ²)		RMS velocity (mm/s)		Peak velocity (mm/s)	
Place	Time	Preferred	Maximum	Preferred	Maximum	Preferred	Maximum
Continuous Vibration							
Residences	Daytime	0.01	0.02	0.2	0.4	0.28	0.56
Offices	Day or night-time	0.02	0.04	0.4	0.8	0.56	1.1
Workshops		0.04	0.08	0.8	1.6	1.1	2.2
Impulsive Vibration							
Residences	Daytime	0.3	0.6	6.0	12.0	8.6	17.0
Offices	Day or night-time	0.64	1.28	13	26	18	36
Workshops		0.64	1.23	13	26	18	36

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 relate 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).

7 PROPOSED CONSTRUCTION ACTIVITIES

We have been advised of the typical equipment/processes anticipated to be used for the construction of the subject development. Noise impacts from these activities on the amenity of the surrounding identified sensitive receivers, will be predicted in this section. Typically, the most significant sources of noise or vibration generated during a construction project will be demolition, excavation, civil works (compaction, asphaltting) and piling.

The A-weighted sound power levels for the expected loudest equipment/processes for each stage of development are outlined in the table below.

Table 7-1 – Proposed Construction Activities and Associated Typical Sound Power Levels

Construction Stage	Equipment /Process	Typical Sound Power Level dB(A)
Demolition	Truck (> 20t)	107
	Powered Hand Tools (Electric)	102
Excavation	Concrete Saw	117
	Compactor & Machine Mounted Hydraulic Drill	113
	Trucks (> 20t) & Excavators	107
	Electric Crane	105
	Powered Hand Tools (Electric)	102
Construction	Compactor	113
	Concrete Agitator & Pump Truck	108
	Trucks (> 20t) & Excavators	107
	Electric Crane	105
	Powered Hand Tools (Electric)	102

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

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

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

8 NOISE AND VIBRATION ASSESSMENT

8.1 NOISE IMPACT ASSESMENT

The predicted noise levels during excavation and construction will depend on:

- The activity undertaken.
- The distance between the work site and the receiver. For many of the work areas, the distance between the noise source and the receiver will vary depending on which end of the site the work is undertaken. For this reason, the predicted noise levels will be presented as a range.

Predicted noise levels are presented below. Predictions take into account the following:

- Noise reduction as a result of distance.
- Barrier effects resulting from shielding of the surrounding buildings (where applicable).
- Depending on the management level adopted, noise emissions are predicted to either external areas (property boundaries/building facades) or internal areas. Where noise levels are predicted to internal areas, the NSW EPA Interim Construction Noise Guideline suggests that a reduction from external noise levels to internal spaces of 10 dB(A) is a conservative estimate. For new buildings, a reduction of over 20 dB(A) to internal spaces is considered appropriate.

Table 8-1 – Predicted Noise Generation to R1 Residential Receiver

Activity	Predicted Level – dB(A) L_{eq}(15min) (External Areas)	Comment
Concrete Saw	53-58	Under 68 dB(A) Noise Management Level
Compactor & Machine Mounted Hydraulic Drill	49-54	
Concrete Agitator & Pump Truck	44-49	
Trucks (> 20t) & Excavators	43-48	
Tower Crane	52	
Powered Hand Tools (Externally)	38-43	

Table 8-2 – Predicted Noise Generation to R2 Residential Receiver

Activity	Predicted Level – dB(A) L_{eq}(15min) (External Areas)	Comment
Concrete Saw	63-67	Under 68 dB(A) Noise Management Level
Compactor & Machine Mounted Hydraulic Drill	59-63	
Concrete Agitator & Pump Truck	54-58	
Trucks (> 20t) & Excavators	53-57	
Tower Crane	52	
Powered Hand Tools (Externally)	48-52	

Table 8-3 – Predicted Noise Generation to R3 Residential Receiver

Activity	Predicted Level – dB(A) L_{eq}(15min) (External Areas)	Comment
Concrete Saw	68-81	Over 68 dB(A) Noise Management Level and 75dB(A) Highly Noise Affected Management Level when working close to the north-eastern boundary (Refer to Recommendations Section 9)
Compactor & Machine Mounted Hydraulic Drill	64-77	
Concrete Agitator & Pump Truck	59-72	Over 68 dB(A) Noise Management Level but under 75dB(A) Highly Noise Affected Management Level (Refer to Recommendations Section 9)
Trucks (> 20t) & Excavators	58-71	
Tower Crane	64	Under 68 dB(A) Noise Management Level
Powered Hand Tools (Externally)	53-66	

Table 8-4 – Predicted Noise Generation to R4 Residential Receiver

Activity	Predicted Level – dB(A) L_{eq}(15min) (External Areas)	Comment
Concrete Saw	66-75	Over 68 dB(A) Noise Management Level but under 75dB(A) Highly Noise Affected Management Level (Refer to Recommendations Section 9)
Compactor & Machine Mounted Hydraulic Drill	62-71	
Concrete Agitator & Pump Truck	57-66	Under 68 dB(A) Noise Management Level
Trucks (> 20t) & Excavators	56-65	
Tower Crane	58	
Powered Hand Tools (Externally)	51-60	

Table 8-5 – Predicted Noise Generation to C1 Residential Receiver

Activity	Predicted Level – dB(A) L_{eq}(15min) (External Areas)	Comment
Concrete Saw	55-63	Under 70 dB(A) Noise Management Level
Compactor & Machine Mounted Hydraulic Drill	51-59	
Concrete Agitator & Pump Truck	46-54	
Trucks (> 20t) & Excavators	45-53	
Tower Crane	45	
Powered Hand Tools (Externally)	40-48	

Table 8-6 – Predicted Noise Generation to E1 Educational Receiver

Activity	Predicted Level – dB(A) L_{eq}(15min) (Internal Areas)*	Comment
Concrete Saw	56-65	Over 45 dB(A) Noise Management Level (Refer to Recommendations Section 9)
Compactor & Machine Mounted Hydraulic Drill	52-61	
Concrete Agitator & Pump Truck	47-56	
Trucks (> 20t) & Excavators	46-55	
Tower Crane	47	
Powered Hand Tools (Externally)	41-50	Over 45 dB(A) Noise Management Level when working near the north-western corner (Refer to Recommendations Section 9)

*A conservative 10dB(A) reduction through a window open for natural ventilation has been applied. Internal noise levels may be up to 10-20dB(A) lower than predicted levels above.

Table 8-7 – Predicted Noise Generation to H1 Healthcare Receiver

Activity	Predicted Level – dB(A) L_{eq}(15min) (Internal Areas)*	Comment
Concrete Saw	58-71	Over 45 dB(A) Noise Management Level (Refer to Recommendations Section 9)
Compactor & Machine Mounted Hydraulic Drill	54-67	
Concrete Agitator & Pump Truck	49-62	
Trucks (> 20t) & Excavators	48-61	
Tower Crane	54	
Powered Hand Tools (Externally)	43-56	Over 45 dB(A) Noise Management Level when working near the north-western corner (Refer to Recommendations Section 9)

*A conservative 10dB(A) reduction through a window open for natural ventilation has been applied. Internal noise levels may be up to 10-20dB(A) lower than predicted levels above.

Table 8-8 – Predicted Noise Generation to H2 Healthcare Receiver

Activity	Predicted Level – dB(A) L_{eq}(15min) (Internal Areas)*	Comment
Concrete Saw	65-71	Over 45 dB(A) Noise Management Level (Refer to Recommendations Section 9)
Compactor & Machine Mounted Hydraulic Drill	61-67	
Concrete Agitator & Pump Truck	56-62	
Trucks (> 20t) & Excavators	55-61	
Tower Crane	58	
Powered Hand Tools (Externally)	50-56	

*A conservative 10dB(A) reduction through a window open for natural ventilation has been applied. Internal noise levels may be up to 10-20dB(A) lower than predicted levels above.

Table 8-9 – Predicted Noise Generation to H3 Healthcare Receiver

Activity	Predicted Level – dB(A) L_{eq}(15min) (Internal Areas)*	Comment
Concrete Saw	69-85	Over 45 dB(A) Noise Management Level (Refer to Recommendations Section 9)
Compactor & Machine Mounted Hydraulic Drill	65-81	
Concrete Agitator & Pump Truck	60-76	
Trucks (> 20t) & Excavators	59-75	
Tower Crane	57	
Powered Hand Tools (Externally)	54-70	

*A conservative 10dB(A) reduction through a window open for natural ventilation has been applied. Internal noise levels may be up to 10-20dB(A) lower than predicted levels above.

8.2 GENERAL DISCUSSION

Noise

Primarily, the use of saws, machine mounted hydraulic drills and bored piling are predicted to be the highest noise generating equipment. All noise predictions have been presented as external noise levels for all receivers except for Educational Receivers and Healthcare Receivers which are presented as internal noise levels. Internal noise levels at all locations are expected to be 10-20 dB(A) lower than the predicted values dependant on the façade of each receiver, however a conservative 10 dB(A) reduction was used for calculation. It is also noted that all high noise generation equipment are only expected to be used during specific portions of the excavation stage and will not be continuous throughout the entire excavation stage.

It is also noted that the internal noise level criteria is taken for hospital wards from the ICNG. Other areas of the hospital can be considered less sensitive unless otherwise noted by the hospital.

Treatment processes are recommended as per Section 9 for concerns with noise levels that are predicted to be over the respective noise management level. Further recommendations in Sections 10, 11 & 12. With the implementation of the aforementioned sections, the Client demonstrates that all reasonable and feasible vibration and noise mitigation measures have been taken.

Ground floor receivers will be exposed to lower noise levels due to the barrier effect from on-site hoarding.

Noise emissions will be further lowered as excavation deepens due to the natural barrier effect of the lower elevation.

Vibration

Typically, excavation, piling and hydraulic drills are the activities with the greatest potential for generation of vibration. Excavation of building footings has the potential to produce vibration levels approaching the criteria set out in Section 6.2.

The primary potential vibration source will be from use of bored piling and hydraulic drills, especially when operating close to adjacent receivers. The vibration impact on all receivers is expected to be compliant with the criteria in Section 6.2 except for areas with vibration sensitive equipment.

Of particular concern to the development is the monitoring of internal vibration levels within the MRI and Mammography areas due to vibration sensitive equipment being in constant use. Vibration monitoring at these locations is recommended (see Section 9). All contractors and sub-contractors shall exercise caution when utilising vibration generating equipment around the local hospital wings.

Trigger levels for vibration monitoring in these areas shall be set to a level lower than the DIN4150-3 recommendations to provide a buffer before exceedance. Contractors and sub-contractors are to be mindful of and strictly adhere to this requirement or risk damage to the building and/or internal vibration sensitive equipment. As such, trigger levels set on the vibration monitors shall be lower than the actual peak particle velocity requirement of the DIN4150-3. A hard stop work order shall be implemented if the PPV is measured to be above criteria.

Baseline vibration measurements are recommended prior to construction works to ascertain the ambient vibration level at the monitoring location. This can be done through attended measurements or by setting up unattended vibration monitors a week prior to construction activities.

9 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 anticipated 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 8.1. 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. **St George Hospital 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.
4. **Ausgrid Management Controls:** To protect the substation, it is proposed that construction activities must not exceed the vibration levels set out in Section 6.2.2 as defined by Ausgrid.
5. **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).

6. **Complaints Handling:** In the event of complaint, the procedures outlined in Section 9 should be adopted.
7. **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.
8. **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. 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.
9. **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.

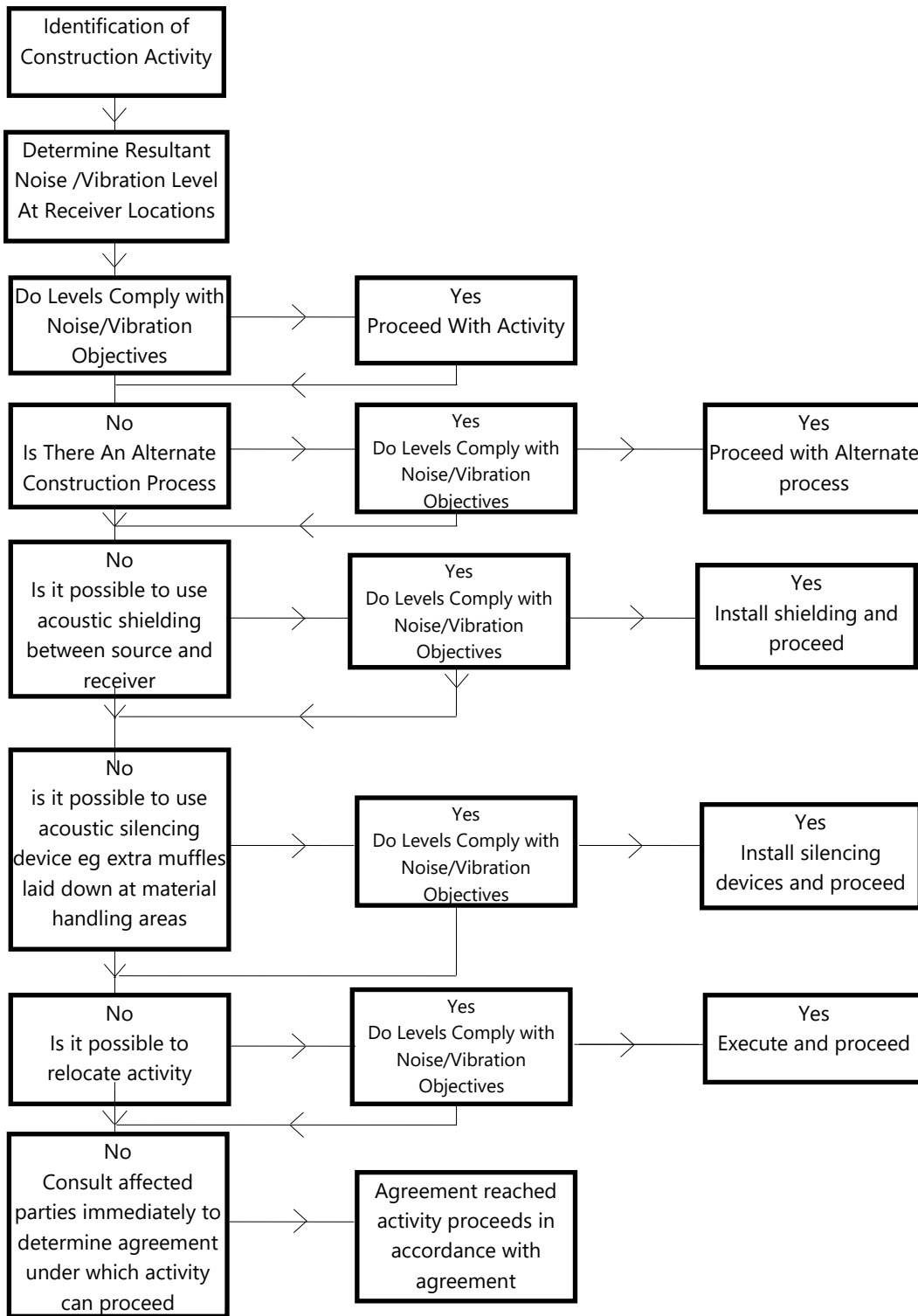
9.1.1 Vibration Sensitive Recommendations

To ensure ongoing compliance with the construction vibration requirements, the following is recommended:

1. Vibration intensive construction works such as usage of compactors are not to be undertaken close to vibration sensitive receivers to ensure that the vibration criteria is not exceeded in those areas.
2. An open line of communication is to be maintained with St George Hospital to provide feedback on the levels of vibration being experienced (if any). The contractor is to issue monthly records, with St George Hospital to arrange precinct management meetings with stakeholders and the builder.
3. Notification is to be provided to the hospital when there is expected to be periods of extensive vibration intensive works. The notification period is to be agreed upon with the hospital to minimise any disturbance to vibration sensitive equipment usage.
4. We recommend that use of sensitive equipment is scheduled outside of intensive construction vibration activities. This is to be agreed upon with St George Hospital.
5. One vibration monitor is to be installed within the MRI area for the duration of the excavation works required. Refer to Section 6.2 for vibration monitoring requirements.
6. Another vibration monitor is to be installed within the Mammography area for the duration of the excavation works required. Refer to Section 6.2 for vibration monitoring requirements.
7. Where a new construction process is introduced to site which has the potential to exceed the nominated vibration criteria, operators are to be made aware of the site requirements and practices to minimise vibration emissions.

10 CONTROL OF CONSTRUCTION NOISE AND VIBRATION – PROCEDURAL STEPS

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



11 ADDITIONAL NOISE AND VIBRATION CONTROL METHODS

In the event of complaints, there are a number of noise mitigation strategies available which can be considered.

The determination of appropriate noise control measures will be dependent on the particular activities and construction appliances. This section provides an outline of available methods.

11.1 SELECTION OF ALTERNATE APPLIANCE OR PROCESS

Where a particular activity or construction appliance is found to generate excessive noise levels, it may be possible to select an alternative approach or appliance. For example; the use of a hydraulic hammer on certain areas of the site may potentially generate high levels of noise. Undertaking this activity using bulldozers, ripping and/or milling machines will result in lower noise levels.

11.2 ACOUSTIC BARRIER

Given the position of adjacent development, it is unlikely that noise screens will provide significant acoustic benefit for commercial or residential receivers, but will provide noticeable improvement for those on ground level.

The placement of barriers at the source is generally only effective for static plant. Equipment which is on the move or working in rough or undulating terrain cannot be effectively attenuated by placing barriers at the source.

Barriers can also be placed between the source and the receiver.

The degree of noise reduction provided by barriers is dependent on the amount by which line of sight can be blocked by the barrier. If the receiver is totally shielded from the noise source reductions of up to 15dB(A) can be effected. Where only partial obstruction of line of sight occurs, noise reductions of 5 to 8dB(A) may be achieved. Where no line of sight is obstructed by the barrier, generally no noise reduction will occur.

As 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 that is approximately 10dB(A) greater than the maximum reduction provided by the barrier. In this case the use of a material such as 10mm or 15mm thick plywood (radiata plywood) would be acceptable for the barriers.

11.3 MATERIAL HANDLING

The installation of rubber matting over material handling areas can reduce the sound of impacts due to material being dropped by up to 20dB(A).

11.4 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.

11.5 ESTABLISHMENT OF SITE PRACTICES

This involves the formulation of work practices to reduce noise generation. A more detailed management plan will be developed for this project in accordance to the construction methodology outlining work procedures and methods for minimising noise.

11.6 COMBINATION OF METHODS

In some cases, it may be necessary that two or more control measures be implemented to minimise noise.

12 COMMUNITY INTERACTION AND COMPLAINTS HANDLING

12.1 ESTABLISHMENT OF DIRECT COMMUNICATION WITH AFFECTED PARTIES

In order for any construction noise management programme to work effectively, continuous communication is required between all parties, which may be potentially impacted upon, the builder and the regulatory authority. This establishes a dynamic response process which allows for the adjustment of control methods and criteria for the benefit of all parties.

The objective in undertaking a consultation process is to:

- Inform and educate the groups about the project and the noise controls being implemented;
- Increase understanding of all acoustic issues related to the project and options available;
- Identify group concerns generated by the project, so that they can be addressed; and
- Ensure that concerned individuals or groups are aware of and have access to a Constructions Complaints Register which will be used to address any construction noise related problems should they arise.

Community consultation is recommended prior to any works commencing on site, with letterbox notifications to all identified surrounding sensitive receivers (refer section 2). This will include a construction management plan detailing the proposed works on site and duration of each stage.

12.2 DEALING WITH COMPLAINTS

Should ongoing complaints of excessive noise or vibration criteria occur immediate measures shall be undertaken to investigate the complaint, the cause of the exceedances and identify the required changes to work practices. In the case of exceedances of the vibration limits all work potentially producing vibration shall cease until the exceedance is investigated.

The effectiveness of any changes shall be verified before continuing. Documentation and training of site staff shall occur to ensure the practices that produced the exceedances are not repeated.

If a noise complaint is received the complaint should be recorded on a Noise Complaint Form. The complaint form should 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;
- Required remedial action, if required;
- Validation of the remedial action; and
- Summary of feedback to the complainant.

A permanent register of complaints should be held. All complaints received should be fully investigated and reported to management. The complainant should also be notified of the results and actions arising from the investigation.

The investigation of a complaint shall involve where applicable:

- Noise measurements at the affected receiver.
- An investigation of the activities occurring at the time of the incident.
- Inspection of the activity to determine whether any undue noise is being emitted by equipment.
- Whether work practices were being carried out either within established guidelines or outside these guidelines.

Where an item of plant is found to be emitting excessive noise, the cause is to be rectified as soon as possible. Where work practices within established guidelines are found to result in excessive noise being generated then the guidelines should be modified so as to reduce noise emissions to acceptable levels. Where guidelines are not being followed, the additional training and counselling of employees should be carried out.

Measurement or other methods shall validate the results of any corrective actions arising from a complaint where applicable.

12.3 REPORTING REQUIREMENTS

The following shall 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 in this report.
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 to the construction liaison committee.

12.4 CONTINGENCY PLANS

Where non-compliances or noise complaints are raised the following methodology will be implemented.

1. Determine the offending plant/equipment/process.
2. Locate the plant/equipment/process further away from the affected receiver(s) if possible.
3. Implement additional acoustic treatment in the form of localised barriers, silencers etc where practical.
4. Selecting alternative equipment/processes where practical.

13 CONCLUSION

A construction noise and vibration assessment has been undertaken of the proposed construction works to be undertaken for St George Hospital Stage 3. Potential noise and vibration impacts on nearby developments have been assessed.

Provided that the mitigation techniques and vibration monitoring recommended in Sections 0, 10, 11 & 12 of this report are adopted, noise and vibration impacts on the adjacent buildings are expected to be acceptable.

It is important to note that noise management levels from the EPA Interim Construction Noise Guideline (ICNG) have been used as an objective to assess construction noise levels to, but this level is not defined as a criterion. The vibration criteria adopted per the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and DIN 4150-3 standards are a set recommendation, however the ICNG noise management levels are not to be used as set criteria.

It is also important to note that this is an iterative Construction Noise and Vibration Management Sub Plan that is to be further iterated during excavation and construction as site conditions change. Further assessment through sample construction noise and vibration testing will supplement the simulated and predicted noise levels from SoundPlan simulation modelling to provide a real-world analysis of any adverse effects that can impact the surrounding developments.

Until sample construction activities can be tested, expectations must be managed and further reviewed.

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

Yours faithfully,



Acoustic Logic Pty Ltd
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