Susan Wakil Health Building

Construction Noise and Vibration Management Plan

M17183RP4 Revision C

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Resonate

Document Information

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Distribution List

Recipient	Issue current revision to
Laing O'Rourke	✓
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Glossary

A-weighting	A spectrum adaption that is applied to measured noise levels to represent human hearing. A-weighted levels are used as human hearing does not respond equally at all frequencies.
Daytime	Between 7 am and 6 pm as defined in the INP.
dB	Decibel—a unit of measurement used to express sound level. It is based on a logarithmic scale which means a sound that is 3 dB higher has twice as much energy. We typically perceive a 10 dB increase in sound as a doubling of that sound level.
dB(A)	'A' Weighted sound level in dB.
Evening	Between 6 pm and 10 pm as defined in the INP.
Frequency (Hz)	The number of times a vibrating object oscillates (moves back and forth) in one second. Fast movements produce high frequency sound (high pitch/tone), but slow movements mean the frequency (pitch/tone) is low. 1 Hz is equal to 1 cycle per second. The human ear responds to sound in the frequency range of 20 to 20,000 Hz.
ICNG	New South Wales *Interim Construction Noise Guideline*
INP	New South Wales *Industrial Noise Policy*, 2000.
Intrusive Noise	Noise emission that when assessed at a noise-sensitive receiver (principally a residential premises boundary) is greater than 5 dB(A) above the background noise level.
L_{10}	Noise level exceeded for 10% of the measurement time. The L_{10} level is commonly referred to as the average maximum noise level.
L_{90}	Noise level exceeded for 90% of the measurement time. The L90 level is commonly referred to as the background noise level.
L_{eq}	Equivalent Noise Level—Energy averaged noise level over the measurement time.
L_{max}	Maximum measured sound pressure level in the time period.
mm/s	Millimetres per second—units of vibration velocity.
µm/s	Micrometres per second—units of vibration velocity.
Night-time	Between 10 pm on one day and 7 am on the following day as defined in the INP.
Rating Background Level (RBL)	Overall single-figure A-weighted background level representing an assessment period (Day/Evening/Night). For the short-term method, the RBL is simply the measured $L_{90,15min}$ noise level. For the long-term method, it is the median value of all measured background levels during the relevant assessment period.

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1 Introduction

The University of Sydney are proposing to develop a Health Precinct on the Camperdown campus, to support the business needs of the health disciplines and to co-locate the Faculty of Nursing and Midwifery, Central Clinical School and Faculty of Health Sciences with components of Medicine, Pharmacy, and Dentistry.

Stage 1 of the Health Precinct involves the construction of an eight-level building (Susan Wakil Health Building) that will provide a range of teaching and support spaces for the co-location of the Faculty of Nursing and Midwifery, the Faculty of Health Sciences and the Central Clinical School. The Stage 1 building will be constructed adjacent to the Royal Prince Alfred Hospital (RPAH).

This Construction Noise and Vibration Management Plan (CNVMP) forms part of Laing O'Rourke's Construction Environmental Management Plan (CEMP) for the construction of the Susan Wakil Health Building (the Project).

1.1 Objectives

The CNVMP has been prepared to fulfil the Conditions of Consent issued by the Department of Planning & Environment (DPE) for the Project, specifically Condition B22 which states:

a) Prior to the commencement of works, a Construction Noise and Vibration Management Plan (CNVMP) must be submitted for the approval of the Certifying Authority. The CNVMP must address, but not be limited to, the following matters where relevant:

   i) be prepared by a suitably qualified expert;

   ii) be prepared in consultation with Royal Prince Alfred Hospital, adjoining residential colleges and all noise sensitive receivers where noise levels exceed the construction noise management level, in accordance with EPA guidelines;

   iii) describe the measures that would be implemented to ensure:

      i. best management practice is being employed;

      ii. compliance with the relevant conditions of this consent;

   iv) describe the proposed noise and vibration management measures in detail;

   v) include strategies that have been developed to address impacts to noise sensitive receivers where noise levels exceed the construction noise management level, for managing high noise generating works;

   vi) describe the consultation undertaken to develop the strategies in v) above;

   vii) evaluates and reports on the effectiveness of the noise and vibration management measures; and

   viii) include a complaints management system that would be implemented for the duration of the construction works.

b) The Applicant must submit a copy of the CNVMP to the Department and Council prior to commencement of work.

The key objective of the NVMP is to ensure that project impacts on noise and vibration sensitive receivers are minimised and within the scope permitted by the planning approval. This includes a target to minimise complaints from the community and stakeholders relating to noise and vibration.

To achieve this objective, Laing O'Rourke will undertake the following:

- Ensure appropriate controls and procedures are implemented during construction activities to avoid or minimise noise and vibration impacts and potential adverse impacts to neighbouring sensitive receivers.
- Ensure appropriate measures are implemented to address Condition B22 and other guidance for construction noise and vibration management relevant to building works in NSW.

1.2 Consultation for preparation of this CNVMP

This CNVMP has been developed in consultation with the Royal Prince Alfred Hospital and Wesley College as required by the CoA, as well as additional neighbouring uses.

Consultation has been carried out with the following stakeholders:

- Elegancy Catering in the Grandstand – 9 July 2018
- RPAH including Gloucester House – 10 July 2018
- The Glasshouse, Cadigal Lane – 10 July 2018
- Laboratory Animal Services in ground level of Bosch 1B Building – 10 July 2018
- Library Study Area on Level 3 of Bosch 1B Building – 10 July 2018
- Wesley, St Andrew's and Women's Colleges – 17 July 2018
- Centenary Institute – 30 July 2018

A summary of the consultation is included in Appendix A of this document.

2 Approval requirements

2.1 Condition B13

Condition B13 of the Conditions of Consent states that:

> Prior to commencement of works, the Applicant must incorporate the noise mitigation recommendations in the Susan Wakil AO Health Building SEARS Noise and Vibration Assessment prepared by Resonate, dated 31 January 2018, in the detailed design drawings and submit to the Department documentation demonstrating that the noise impacts have been adequately mitigated to not exceed the project specific criteria identified in the report.

As this Condition refers to design drawings, it refers to operational noise management, and not to construction noise and vibration management that is addressed by this CNVMP. The noise mitigation recommendations from the SEARs Noise and Vibration Assessment will be included in the design documents for the project as required by Condition B13.

It is noted that the SEARs Noise and Vibration Assessment also made recommendations regarding management of construction noise and vibration impacts that have been included within this CNVMP.

2.2 Condition B22

The following table summarises the requirements of Condition B22 and where these have been addressed within this CNVMP.

Table 1 Condition B22 requirements

Reference		Where addressed
22 a)	Prior to the commencement of works, a Construction Noise and Vibration Management Plan (CNVMP) must be submitted for the approval of the Certifying Authority. The CNVMP must address, but not be limited to, the following matters where relevant:	This CNVMP
22 a) i)	be prepared by a suitably qualified expert;	The author and the reviewer both have significant experience in the assessment of construction noise and vibration, and are both Members of the Australian Acoustical Society.
22 a) ii)	be prepared in consultation with Royal Prince Alfred Hospital, adjoining residential colleges and all noise sensitive receivers where noise levels exceed the construction noise management level, in accordance with EPA guidelines;	Section 1.2 and Appendix A.
22 a) iii)	describe the measures that would be implemented to ensure:	Section 6.1.
22 a) iii) i.	best management practice is being employed;	Section 6.
22 a) iii) ii.	compliance with the relevant conditions of this consent;	Section 6.
22 a) iv)	describe the proposed noise and vibration management measures in detail;	Section 6.1.

Reference		Where addressed
22 a) v)	include strategies that have been developed to address impacts to noise sensitive receivers where noise levels exceed the construction noise management level, for managing high noise generating works;	Section 6.1.
22 a) vi)	describe the consultation undertaken to develop the strategies in v) above;	Section 1.2 and Appendix A.
22 a) vii)	evaluates and reports on the effectiveness of the noise and vibration management measures; and	Section 7.
22 a) viii)	include a complaints management system that would be implemented for the duration of the construction works.	Section 0.
22 b)	The Applicant must submit a copy of the CNVMP to the Department and Council prior to commencement of work.	Refer Distribution List.

3 Project and site description

3.1 Location

Stage 1 of the Health Precinct will be constructed on the Camperdown campus, located on Lambie Dew Drive and immediately east of the RPAH. Figure 1 shows the proposed site location.

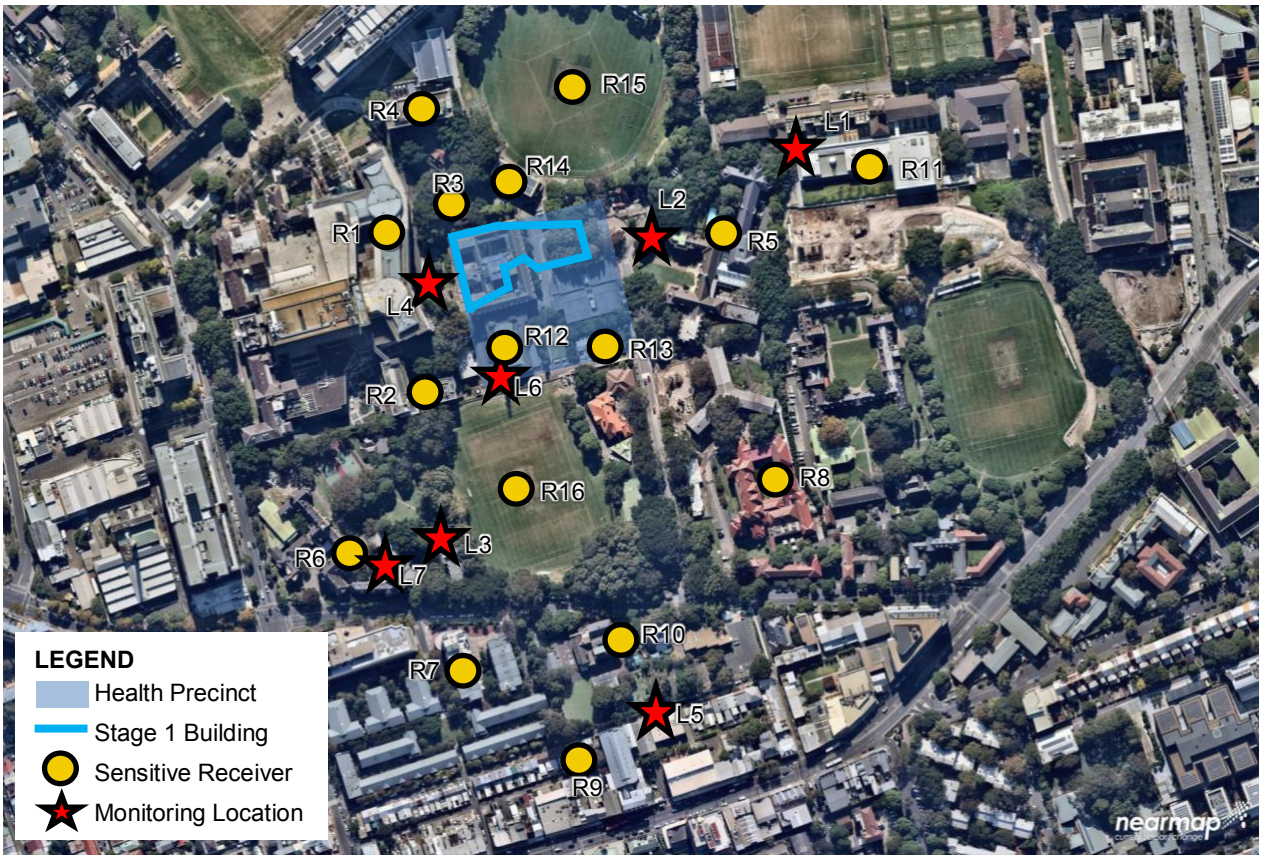

Figure 1 Stage 1 site location

A number of noise and vibration-sensitive land uses are located in the immediate vicinity of the Stage 1 site as shown on Figure 1, with the most significant being the Hospital to the west and Wesley College to the east. The nearest non-University residences are located a significant distance away from the site.

The sensitive land uses are summarised in Table 2 alongside a description of the land use.

Table 2 Noise and vibration sensitive land uses

Reference (see Figure 1) and name	Description
Health buildings	
R1 – Royal Prince Alfred Hospital	Main hospital building. Approximately 30 m west of site. RPAH has advised no specific sensitive equipment to be considered.
R2 – Gloucester House	Royal Prince Alfred Hospital building housing Sydney Cancer Centre. Approximately 50 m southwest of site.
R3 – Hospital Chapel	Chapel for Royal Prince Alfred Hospital. Approximately 20 m north of site.
R4 – Centenary Institute	Medical research institute. Approximately 80 m north of site. Building includes: • 2-photon microscopes and confocal microscopes • bio-resources for research.
Residential buildings and colleges	
R5 – Wesley College	Colleges and/or residential villages located on or around University of Sydney Camperdown campus. Wesley College is the closest, approximately 60 m east of the site.
R6 – St Andrew's College	
R7 – Sydney University Village	
R8 – Women's College	
R9 – Campbell Street	Nearest non-University residential uses to the south of the site. Over 300 m south of site.
Educational buildings including research	
R10 – Newtown North Public School	Public school, also includes Carillon Avenue Childcare Centre. Approximately 230 m south of site.
R11 – Sydney Nanoscience Hub	Educational and research building housing highly vibration-sensitive equipment. Approximately 150 m east of site.
R12 – Bosch 1B	Building in close proximity to construction site (~10 to 15 m). Laboratory Animal Services located at ground level of the Bosch 1B building, housing bio-resources. Library study area located on Level 3.
R13 – Glasshouse on Cadigal Lane	Glasshouse housing plants, with air-conditioning and temperature monitoring systems. Approximately 45 m from site.
Commercial uses	
R14 – Grandstand Elegancy Catering	Catering and function centre in University Oval Grandstand. Approximately 50 m north of site.
Recreational land uses	
R15 – University Oval No. 1	Active recreation land uses. University Oval No. 1 is approximately 50 m north of the site.
R16 – St Andrew's College Oval	

3.2 Stage 1 development

Stage 1 of the Health Precinct will involve the construction of an eight-level building (Level 1 up to Level 8) on the footprint shown in Figure 1. Landscaping will also occur around the Health Precinct area.

The demolition of the existing buildings at the site is to be undertaken as part of a separate project, which has been subject to a separate Review of Environmental Factors and approval.

3.3 Existing environment

The existing environment in the area immediately around the site is typical of an urban University campus, with a relatively low level of steady background noise from distant traffic and mechanical plant, with short-term noise from pedestrians and occasional vehicles on and around the campus.

Unattended noise monitoring conducted in accordance with the NSW INP has been used to establish existing conditions at sites representative of the following key receptor locations:

- Wesley College, which represents the nearest residential-type land use to the east of the site. This is based on monitoring previously conducted by AECOM at Wesley College in 2012 prior to the development of the Sydney Nanoscience Hub.
- Royal Prince Alfred Hospital during January 2018
- St Andrew's College, which represents the nearest residential-type land not within the University campus, during January 2018.

The unattended measured noise levels are presented in Table 3. Details on the monitoring at each site are included within the State Significant Development Assessment Report Noise and Vibration Assessment prepared for the Stage 1 development.[1]

Table 3 Unattended monitoring results

Location[1]	Rating Background Level, dB(A) L_{90}[2]			Ambient noise level, dB(A) L_{eq}		
	Day 7 am–6 pm	Evening 6 pm–10 pm	Night 10 pm–7 am	Day 7 am–6 pm	Evening 6 pm–10 pm	Night 10 pm–7 am
Wesley College L1[3]	46	46	46	55	56	51
Royal Prince Alfred Hospital L6	48	47	45	57	51	51
St Andrew's College L7	50	50	47	58	54	52

(1) Refer to Figure 1 for the location of the monitoring.

(2) The Rating Background Level is a measure of the typical minimum steady background noise level for each time of day.

(3) Monitoring conducted AECOM across the period from 9 to 16 March 2012 in accordance with the NSW INP. Monitoring was conducted at two locations with the measurement requirements for the quietest location shown here.

The adoption of the 2012 results for this assessment at Wesley College is considered conservative as noise levels typically increase over time and it does not include any mechanical plant noise from the Sydney Nanoscience Hub. It is noted that current construction works underway near the Sydney Nanoscience Hub mean that any additional unattended noise logging conducted at present near Wesley College may have been influenced by construction noise.

[1] Resonate, 31 January 2018, *Susan Wakil AO Health Building – SEARs Noise and Vibration Assessment*, M17183RP2 Revision C

4 Construction noise and vibration criteria

4.1 Construction noise

Construction noise in New South Wales is assessed using the Department of Environment & Climate Change (now Environment Protection Authority) *Interim Construction Noise Guideline* (ICNG). The ICNG is also defined as the relevant guideline for construction noise by the SEARs issued by DPE.

The ICNG aims to manage noise from construction works regulated by the EPA. It is also intended to provide guidance to other interested parties in the management of construction noise, and has therefore been adopted for this construction noise assessment. The ICNG prescribes $L_{eq,15min}$ Noise Management Levels (NML) for sensitive receivers as part of a quantitative construction noise assessment. Where the predicted or measured construction noise level exceeds these management levels, then all feasible and reasonable work practices should be implemented to reduce construction noise, and community consultation regarding construction noise is required to be undertaken.

4.1.1 Residential land uses

The NMLs prescribed for residential land uses by the ICNG are presented in Table 4. The levels apply at the most exposed property boundary of the noise sensitive receiver at a height of 1.5 metres above ground level. The NMLs have also been adopted for the University colleges on and around the Camperdown campus including:

- Wesley College
- St Andrew's College
- Sydney University Village
- Women's College.

Table 4 Noise management levels for residential land uses

Time of day	NML, $L_{eq,15min}$	Application notes
Recommended Standard Working Hours	Noise affected: RBL + 10 dB(A)	May be some community reaction to noise. • Where the predicted or measured construction noise level exceeds the noise affected level, all feasible and reasonable work practices should be applied to meet the noise affected level. • All residents potentially impacted by the works should be informed of the nature of the works, the expected noise levels and duration, and provided with site contact details.
	Highly noise affected: 75 dB(A)	May be strong community reaction to noise. • Where construction noise is predicted or measured to be above this level, the relevant authority may require respite periods that restrict the hours that the very noisy activities can occur. • Respite activities would be determined taking into account times identified by the community when they are less sensitive to noise, and if the community is prepared to accept a longer period of construction to accommodate respite periods.
Outside recommended Standard Working Hours	Noise affected: RBL + 5 dB(A)	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the affected noise level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the affected noise level, the proponent should negotiate with the affected community.

4.1.2 Bio-resources

Bio-resources are housed in both the Bosch 1B building (Laboratory Animal Services) and the Centenary Institute. Bio-resources are not addressed by the ICNG and therefore criteria have been developed from other guidance.

Noise Management Levels for bio-resources have been based on the *Code of Practice for the Housing and Care of Laboratory, Mice and Rats – Department of Primary Industries, Victoria, 2004*. The Code of Practice recommends noise limits of:

- 50 dB L_{eq} for steady continuous noise, that is to be free of distinct tones
- 85 dB L_{max} for short-term events.

The targets applied to a particular facility should be considerate of the frequency range associated with the bio-resources. For example, mice are typically considered sensitive across the range of 1000 Hz and above, while for rats it is typically 200 Hz and above. For the purposes of this report, we have assessed the measured noise levels on the basis of the frequency range of 200 Hz and above.

4.1.3 Other sensitive land uses

The ICNG also prescribes NMLs for other sensitive land uses, including educational buildings and hospitals. The NMLs for relevant land uses are summarised in Table 5 and apply only when those land uses are in use.

Table 5 ICNG noise management levels for other sensitive land uses

Land use	NML $L_{eq,15min}$ (applies when property in use)
Classrooms at schools and other educational institutions	Internal noise level of 45 dB(A)
Hospital wards and operating theatres	Internal noise level of 45 dB(A)
Places of worship	Internal noise level of 45 dB(A)
Commercial uses including offices and retail outlets	External noise level of 70 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 of 65 dB(A)

For those receivers where an internal NML applies, it is common to assume an outdoor-to-indoor noise reduction of 25 dB(A). This is based on a standard commercial building facade with windows kept closed, such as that at the Royal Prince Alfred Hospital. Therefore, for this assessment, an external NML of 70 dB(A) $L_{eq,15min}$ will be used for the health and educational sensitive land uses surrounding the development site.

4.1.4 Noise Management Levels

Table 6 summarises the NMLs applicable to sensitive land uses around the Health Precinct Stage 1 site during the construction phase. The NMLs are based on the background levels measured at St Andrew's College in 2018 and Wesley College in 2012, with those levels applied to other sensitive land uses, where relevant. Works are only proposed during Standard Working Hours and during extended periods on Saturdays, but NMLs are also presented for other time periods for information.

Table 6 Noise Management Levels applicable to Health Precinct Stage 1

Land use	External NML for time period in dB(A) unless otherwise indicated		
	Standard Working Hours	Extended periods on Saturdays 7:30 – 8 am, 1 – 3:30 pm	Other times (if required)
Wesley College	56 (NML) 75 (Highly noise affected)	51	51
St Andrew's College, Women's College, Sydney University Village and southern residential land uses	60 (NML) 75 (Highly noise affected)	55	52
Royal Prince Alfred Hospital and associated buildings including Chapel	70	70	70
Newtown North Public School and Childcare Centre	60[1]	60[1]	60[1]
Other educational buildings	70	70	70
Bio-resources at Bosch 1B and Centenary Institute[2,3]	50 dB $L_{eq,15min}$ 85 dB L_{max}	50 dB $L_{eq,15min}$ 85 dB L_{max}	50 dB $L_{eq,15min}$ 85 dB L_{max}
Sporting ovals	65	65	65

(1) A lower NML has been established for the Newtown North Public School and Childcare Centre on the basis that windows may be left open for ventilation in which case a 15 dB(A) outdoor-to-indoor difference would be expected. The NML is also consistent with that established for St Andrew's College which is exposed to a similar level of noise from Carillon Avenue.

(2) Bio-resources noise criteria apply across frequency range of relevant species. For the purposes of this assessment, this has been based on 200 Hz and above for rats.

(3) Internal, not external, noise management level.

4.2 Construction vibration

Ground vibration generated by construction can have a range of effects on buildings and building occupants. The main effects are generally classified as:

- impacts on vibration-sensitive equipment: vibration which means it is difficult to use highly sensitive research equipment (e.g. electron microscopes) and/or medical equipment (e.g. MRIs)
- impacts on bio-resources: vibration which may disturb bio-resources
- human disturbance – disturbance to building occupants: vibration which inconveniences or interferes with the activities of the occupants or users of the building
- effects on building structures – vibration which may compromise the condition of the building structure itself.

In general, vibration criteria for bio-resources, sensitive equipment and human disturbance are more stringent than vibration criteria for effects on buildings. Building occupants will normally feel vibration readily at levels well below those which may cause a risk of cosmetic or structural damage to a structure. However, it may not always be practical to achieve the human comfort criteria. Furthermore, unnecessary restriction of construction activities can prolong construction works longer than necessary, potentially resulting in other undesirable effects for the local community.

Construction vibration criteria have been adopted from the following sources:

- Cosmetic and structural damage to buildings: German Standard DIN 4150-3[2]
- Human comfort: *Assessing Vibration – A Technical Guideline* (the Vibration Guideline)
- Sensitive equipment: the VC criteria developed by Colin Gordon and Associates
- Bio-resources: the outcomes of previous experience with such spaces.

4.2.1 Cosmetic and structural damage

DIN 4150-3 summarises structural and cosmetic damage assessment criteria for different types of buildings, which are presented in Table 3, which are widely used for the assessment of construction vibration effects on buildings in Australia. The criteria are specified as Peak Particle Velocity (PPV) levels measured in any direction at or adjacent to the building foundation.

Table 3 DIN 4150-3 vibration cosmetic and structural damage criteria

Structure type	Peak Particle Velocity (PPV), mm/s			
	Foundation of structure			Vibration at horizontal plane of highest floor at all frequencies
	<10 Hz	10-50 Hz	50-100 Hz	
Buildings used for commercial, industrial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwelling and buildings of similar design and/or use	5	5 to 15	15 to 20	15
Structures that, because of their particular sensitivity to vibration, do not correspond to those listed in rows 1 and 2, and are of great intrinsic value (e.g. heritage-listed buildings)	3	3 to 8	8 to 10	8

[2] German Standard DIN 4150-3, 1999, *Structural Vibration – Part 3: Effects of vibration on structures*.

With respect to the project site, the only neighbouring State heritage sites on the NSW Office & Environment Heritage Register are:

- Royal Prince Alfred Hospital Admissions Block and Victoria & Albert Pavilions which are both located on the western side of the Hospital away from the works.
- The University Women's College which is over 100 m from the site.

However, it is understood that much of the University will eventually be added onto the State Heritage List. Therefore, as a conservative approach, it is recommended that vibration levels achieve compliance with the more conservative DIN 4150-3 heritage-listed limits, which start from 3 mm/s at low frequency.

DIN 4150-3 states that exposing buildings to vibration levels higher than that recommended would not necessarily result in damage. Rather, it recommends these values as maximum levels of short-term construction vibration at which experience has shown damage reducing the serviceability of structures will not occur due to vibration effects.

DIN 4150-3 is considered to be suitable for the assessment of both structural and cosmetic damage as it considers a reduction in serviceability of the structure is deemed to have occurred if:

- cracks form in plastered surfaces of walls
- existing cracks in the building are enlarged
- partitions become detached from loadbearing walls or floors.

4.2.2 Human comfort

The ICNG recommends that vibration from construction works be assessed under *Assessing Vibration – a technical guideline* (the Vibration Guideline), consistent with the SEARs issued by DPE.

The vibration assessment criteria defined in the Vibration Guideline are for human comfort and represent goals that, where predicted or measured to be exceeded, require the application of all feasible and reasonable mitigation measures. Where the maximum value cannot be feasibly and reasonably achieved, the operator would need to negotiate directly with the affected community.

The Vibration Guideline defines vibration assessment criteria for continuous, impulsive and intermittent vibration. Vibration can be classified according to the following definitions:

- Continuous vibration: continues uninterrupted for a defined period. Applies to continuous construction activity such as tunnel boring machinery.
- Impulsive vibration: rapid build-up to a vibration peak followed by a damped decay or the sudden application of several cycles of vibration at approximately the same magnitude providing that the duration is short. Applies to very occasional construction activities that create distinct events such as the occasional dropping of heavy equipment.
- Intermittent vibration: interrupted periods of continuous vibration (such as a drill) or repeated periods of impulsive vibration (such as a pile driver).

The majority of construction activities as part of the proposed works would be expected to be intermittent in nature.

Table 7 presents the management levels for continuous and impulsive vibration at different land uses. The management levels specified are as overall unweighted RMS vibration velocity levels. The Vibration Guideline specifies the management levels as suitable for vibration sources predominantly in the frequency range 8-80 Hz as would be expected for construction vibration.

For intermittent vibration, the Vibration Dose Value (VDV) is used as the metric for assessment as it accounts for the duration of the source, which will occur intermittently over the assessment period. The VDV management levels at different land uses for intermittent vibration sources are presented in Table 8.

Table 7 RMS velocity management levels for continuous and impulsive vibration

Land use	Continuous vibration – RMS vibration velocity, mm/s		Impulsive vibration – RMS vibration velocity, mm/s	
	Preferred	Maximum	Preferred	Maximum
Critical areas[1] and bio-resources	0.1	0.2	0.1	0.2
Residences and hospital wards – daytime[2]	0.2	0.4	6.0	12.0
Residences and hospital wards – night time[3]	0.14	0.28	2.0	4.0
Offices, schools	0.4	0.8	13.0	26.0
Workshops	0.8	1.6	13.0	26.0

(1) Critical operating areas include hospital operating theatres and precision laboratories where sensitive operations are occurring.

(2) Daytime is defined by the Vibration Guideline to be 7 am to 10 pm.

(3) Night time is defined by the Vibration Guideline to be 10 pm to 7 am.

Table 8 VDV management levels for intermittent vibration

Land use	VDV – intermittent vibration, $m/s^{1.75}$	
	Preferred	Maximum
Critical areas[1] and bio-resources	0.1	0.2
Residences and hospital wards – daytime[2]	0.2	0.4
Residences and hospital wards – night time[3]	0.13	0.26
Offices, schools	0.4	0.8
Workshops	0.8	1.6

(1) Critical operating areas include hospital operating theatres and precision laboratories where sensitive operations are occurring.

(2) Daytime is defined by the Vibration Guideline to be 7 am to 10 pm.

(3) Night time is defined by the Vibration Guideline to be 10 pm to 7 am.

4.2.3 Bio-resources

The *Code of Practice for the Housing and Care of Laboratory, Mice and Rats – Department of Primary Industries, Victoria, 2004* advises that noise and vibration should be controlled in a bio-resources facility but does not provide specific criteria for vibration levels.

From previous experience, vibration levels should ideally be limited at 100 to 200 µm/s (0.1 to 0.2 mm/s). This level of vibration has been found to be acceptable for other construction impacts at other Universities. As short-term vibration could potentially disturb bio-resources, this should be assessed over a relatively short period rather than using the VDV metric from the Vibration Guideline.

Therefore, an initial vibration target of 100 µm/s (0.1 mm/s), measured as a 1-minute rms vibration level is recommended for the Animal House during demolition. This is comparable to the criteria for operating theatres applied for continuous vibration.

4.2.4 Sensitive equipment

Certain land uses around the site have vibration-sensitive equipment that could be affected by vibration levels well below the level at which discomfort may arise for occupants of buildings. This would include the Sydney Nanoscience Hub and sensitive research equipment at the Centenary Institute.

Specific vibration criteria for sensitive equipment will depend on equipment specifications. However, a number of 'generic' vibration criteria have been developed over the years for sensitive electron microscope equipment. The VC criteria developed by Colin Gordon and Associates is internationally accepted and is one of the most commonly used vibration criteria for sensitive equipment. The VC criteria are reproduced in Table 9, with the value for operating theatres corresponding to the lowest 'Preferred' level from the Guideline for continuous vibration shown in Table 7.

Table 9 Generic VC criteria for sensitive equipment (from Colin Gordon and Associates)

Criterion curve	Amplitude, mm/s[1]	Detail size, μm[2]	Description of use
Operating theatre	0.1	25	Vibration not perceptible. Suitable in most instances for surgical suites, microscopes to 100x and for other equipment of low sensitivity.
VC-A	0.05	8	Adequate in most instances for optical microscopes to 400x, microbalances, optical balances, proximity and projection aligners etc.
VC-B	0.025	3	Appropriate for inspection and lithography equipment (including steppers) to 3 μm line widths.
VC-C	0.0125	1 – 3	Appropriate standard for optical microscopes to 1000x, lithography and inspection equipment (including moderately sensitive electron microscopes) to 1 μm detail size, TFT-LCD stepper/scanner processes.
VC-D	0.00625	0.1 – 0.3	Suitable in most instances for demanding equipment, including many electron microscopes (SEMs and TEMs) and E-Beam systems.
VC-E	0.00312	< 0.1	A challenging criterion to achieve. Assumed to be adequate for the most demanding of sensitive systems including long path, laser-based, small target systems. E-Beam lithography systems working at nanometer scales, and other systems requiring extraordinary dynamic stability.
VC-F	0.00156	n/a	Appropriate for extremely quiet research spaces; generally difficult to achieve in most instances, especially cleanrooms. Not recommended for use as a design criterion, only for evaluation.
VC-G	0.00078	n/a	Appropriate for extremely quiet research spaces; generally difficult to achieve in most instances, especially cleanrooms. Not recommended for use as a design criterion, only for evaluation.

(1) As measured in one-third octave bands over the frequency range 8 to 80 Hz (for operating theatres, VC-A and VC-B) or 1 to 80 Hz (for VC-C through VC-G).

(2) The detail size refers to line width in the case of microelectronics fabrication, the particle (cell) size in the case of medical and pharmaceutical research, etc. It is not relevant to imaging associated with probe technologies, AFMs, and nanotechnology.

From consultation undertaken with the Centenary Institute, it is understood that 2-photon microscopes and confocal microscopes are housed there. From previous experience, confocal microscopes typically require compliance with a vibration limit of VC-C in order to ensure no impacts from vibration on their operation.

5 Construction noise and vibration assessment

5.1 Construction works

5.1.1 Activities and schedule

Construction of the Stage 1 development has been broadly summarised in Table 10. Typical sound power levels for each item of plant and each overall stage are included in Appendix B.

Table 10 Anticipated construction schedule

Stage	Description
Site establishment Anticipated August 2018 at conclusion of demolition works (subject to separate approval process).	Bulk excavation and services diversions. Typical plant would involve: • Large excavator • Vibratory roller • Concrete truck • Concrete pump • Large truck
Substructure Anticipated August 2018 – October 2018	Piling works, followed by creation of Level 1 substructure. Typical plant would involve: • Bored piling rig • Crane • Large excavator • Pneumatic jackhammer • Concrete truck • Concrete pump • Large truck
Superstructure and façade Anticipated October 2018 – October 2019	Creation of building superstructure up to Level 8 roof and installation of building facade progressively. Typical plant would involve: • Mobile crane • Concrete truck • Concrete pump • Crane • General hand tools • Large truck
Internal works and fitout Anticipated March 2019 – January 2020	Internal works and fitout of all levels. Will commence progressively as Level superstructures completed. Typical plant would involve: • General hand tools • Compressor • Portable generator
External landscaping Anticipated July 2019 – November 2019	Landscaping works around the Stage 1 building and Health Precinct. Typical plant would involve: • Large excavator • Road laying and resurfacing equipment • Grader • Large truck

5.1.2 Working hours

It is planned that works would be undertaken during the hours of:

- Monday to Friday 7 am to 6 pm
- Saturday 7:30 am to 3:30 pm
- No work on Sundays or public holidays.

Generally, these hours align with the standard working hours documented within the ICNG, with the exception of:

- work is proposed from 7:30 am to 8 am on Saturday mornings
- work is proposed from 1 pm to 3:30 pm on Saturday afternoons

These extended hours are proposed for the works for the Stage 1 development as:

- the hours are not considered significantly more noise-sensitive than the standard working hours on Saturday given that works are not proposed prior to 7 am and the noise sensitivity of the Royal Prince Alfred Hospital would not be expected to change between a weekday and a Saturday
- it would assist in expediting completion of the project, reducing the overall disruption to users of the Hospital
- the hours are consistent with recent approvals for projects at the University of Sydney such as the F23 Administration Building and F07 LEES 1 Building.

5.2 Construction noise assessment

5.2.1 Occupied areas

Typical worst-case construction noise levels have been predicted using a three-dimensional environmental noise model of the site and surrounds, developed in SoundPlan version 7.4 environmental noise modelling software, including topography, building structures, ground absorption (ground assumed to be 50% absorptive and 50% reflective), air absorption and attenuation with distance.

Predictions have been carried out based on the environmental noise prediction algorithms documented in ISO 9613-2:1996 *Acoustics - Attenuation of sound during propagation outdoors -- Part 2: General method of calculation*. This provides predictions typical of conditions where the receiver is downwind of the source or where there is a moderate ground-based temperature inversion.

It is important to note that these predictions are typical worst-case predictions as they assume that:

- The construction works are occurring at the nearest point to each receiver and that the receiver is located at the most exposed position (e.g. the nearest windows of Wesley College and the Hospital).
- The noisiest construction sources are operating continuously for the entire 15-minute period. This will not occur at all times as equipment will regularly be stood down or idled while other activities are undertaken.

Typical worst-case predicted noise levels are shown in Table 11 for each sensitive-receiver location and each phase of works during standard working hours. Predicted noise levels that exceed the relevant Standard Work Hours NML are highlighted in **bold** type.

Typical worst-case predicted noise levels for extended Saturday hours are shown in Table 12 for each sensitive-receiver location and each phase of works. These predicted noise levels are compared to the relevant NMLs for the extended Saturday hours (from 7:30 – 8 am and 1 – 3:30 pm) with any exceedances highlighted in **bold** type.

Based on the predictions, it can be seen that construction noise from the site is predicted to exceed the relevant NMLs at:

- Bosch 1B building for the Level 3 Library Study Area for all phases other than internal fitout works.
- The Royal Prince Alfred Hospital, including the Chapel and associated Gloucester House for all phases other than the internal fitout works. The predicted exceedance is a maximum of 5 – 7 dB when works are occurring on the western side of the site.
- Wesley College for all phases other than the internal fitout works. The predicted noise levels at Wesley College exceed the standard working hours NML by 8 – 11 dB for the various external works, and to exceed the extended Saturday hours NML by up to 16 dB.
- Elegancy Catering at the University Oval Grandstand by up to 3 dB during noisy external works.
- University Oval No. 1 during major external works by up to 7 dB.

Given that works are anticipated to exceed the relevant NMLs at the above three sensitive land uses, reasonable and feasible noise mitigation measures will be implemented as detailed in Section 6.

At other locations, including residences and residential colleges (other than Wesley College), noise from construction works are expected to comply with the relevant requirements of the ICNG and no specific action is proposed beyond the implementation of the mitigation measures detailed in Section 6.

Table 11 Typical worst-case external construction noise levels for each phase during standard working hours

Receiver	Typical worst-case external construction noise level for phase, dB(A) L_{eq}				
	Site establishment	Substructure	Superstructure and facade	Internal fitout	External landscaping
R1 – Royal Prince Alfred Hospital	**74**	**76**	**73**	46	**75**
R2 – Gloucester House	70	**72**	69	42	**71**
R3 – Hospital Chapel	**76**	**77**	**74**	46	**76**
R4 – Centenary Institute	63	65	62	35	64
R5 – Wesley College	**65**	**67**	**64**	37	**66**
R6 – St Andrew's College	52	54	51	24	53
R7 – Sydney University Village	49	51	48	21	50
R8 – Women's College	48	50	47	20	49
R9 – Campbell Street	44	46	43	16	45
R10 – Newtown Nth Public School	49	51	48	21	50
R11 – Sydney Nanoscience Hub	50	52	49	22	51
R12 – Bosch 1B	**81**	**83**	**79**	52	**82**
R13 – Glasshouse on Cadigal Lane	66	68	66	40	67
R14 – Elegancy Catering	**71**	**73**	70	42	**73**
R15 – University Oval No. 1	**70**	**72**	**69**	42	**71**
R16 – St Andrew's College Oval	57	59	56	29	58

Table 12 Typical worst-case external construction noise levels for each phase during extended Saturday hours

Receiver	Typical worst-case external construction noise level for phase, dB(A) L_{eq}				
	Site establishment	Substructure	Superstructure and facade	Internal fitout	External landscaping
R1 – Royal Prince Alfred Hospital	**74**	**76**	**73**	46	**75**
R2 – Gloucester House	70	**72**	69	42	**71**
R3 – Hospital Chapel	**76**	**77**	**74**	46	**76**
R4 – Centenary Institute	63	65	62	35	64
R5 – Wesley College	**65**	**67**	**64**	37	**66**
R6 – St Andrew's College	52	54	51	24	53
R7 – Sydney University Village	49	51	48	21	50
R8 – Women's College	48	50	47	20	49
R9 – Campbell Street	44	46	43	16	45
R10 – Newtown Nth Public School	49	51	48	21	50
R11 – Sydney Nanoscience Hub	50	52	49	22	51

Receiver	Typical worst-case external construction noise level for phase, dB(A) L_{eq}				
	Site establishment	Substructure	Superstructure and facade	Internal fitout	External landscaping
R12 – Bosch 1B	**81**	**83**	**79**	52	**82**
R13 – Glasshouse on Cadigal Lane	66	68	66	40	67
R14 – Elegancy Catering	**71**	**73**	70	42	**73**
R15 – University Oval No. 1	**70**	**72**	**69**	42	**71**
R16 – St Andrew's College Oval	57	59	56	29	58

5.2.2 Bio-resources

The Bosch 1B Laboratory Animal Services facility is located in the basement on the northern facade of the building. It is understood that there are no windows to the Animal House, and it has been assumed that the external walls are brick veneer.

Based on an external construction noise level of 83 dB(A) L_{eq}, with typical construction frequency content based on previous measurements conducted by Resonate Acoustics, the expected internal noise levels within the bio-resources area are:

- 46 dB L_{eq} and 55 dB L_{max} over the frequency range relevant to rats (200 Hz and above)
- 38 dB L_{eq} and 47 dB L_{max} over the frequency range relevant to mice (1000 Hz and above).

Given the above, it is not expected that the noise management levels for mice or rats within the Animal House will be exceeded. Recommendations for noise and vibration management at the Animal House are provided in Section 6.

5.3 Construction vibration assessment

5.3.1 Occupied areas and building damage

Table 13 summarises recommended safe working distances for key vibration-generating activities that would be expected during the construction phase, based on prior measurements conducted by Resonate.

Table 13 Recommended safe working distances for key vibration generating activities

Plant	Rating	Typical safe working distance for occupant comfort, m		Typical safe working distance for building damage, m	
		Preferred vibration target	Maximum vibration target	Heritage structure	Commercial building
Vibratory roller	< 7t	≥ 35	≥ 20	≥ 10	≥ 2
	7t – 12t	≥ 50	≥ 30	≥ 15	≥ 5
	≥ 13t	≥ 75	≥ 40	≥ 20	≥ 10
Excavator	Large excavator digging	≥ 25	≥ 15	≥ 5	≥ 1
Bored or CFA piling	≤ 800mm	≥ 20	≥ 10	≥ 2	≥ 1
Jackhammer	Handheld	–(1)	–(1)	≥ 3	≥ 1

(1) Avoid contact with structure.

Based on the safe working distances above, vibration impacts on buildings are not expected.

Impacts on occupant comfort are likely to be limited to any vibratory compaction works occurring near to the Royal Prince Alfred Hospital including the Chapel and Gloucester House. All reasonable and feasible vibration mitigation measures will be implemented for vibratory compaction works near the Hospital and associated uses as detailed in Section 6.

It is noted that the safe working distances in Table 13 do not address highly vibration-sensitive equipment, such as that at the Sydney Nanoscience Hub and Centenary Institute. The Centenary Institute is located approximately 80 m from the site and may experience vibration levels above VC-C during vibratory compaction works. However, vibration levels at other times would not be expected to impact on sensitive equipment at this location.

Given the significant distance to the Sydney Nanoscience Hub and the relatively low vibration intensity of the proposed works, impacts on equipment at this location are not expected.

5.3.2 Bio-resources

The distances shown in Table 13 may also not be relevant to bio-resources at Centenary Institute and Bosch 1B, which are subject to a more stringent vibration target. As a general guide, the distances to the preferred vibration target provide an indication of the expected distances from works at which the bio-resources criterion of 0.1 mm/s would be expected to be achieved.

The vibration targets for bio-resources are likely to be exceeded at Bosch 1B during vibratory compaction works, excavation works and, potentially, piling works. Vibration management measures for the Bosch 1B bio-resources are included in Section 6.

Given that the Centenary Institute is located 80 m from the site, vibration impacts on bio-resources at this location are not expected.

6 Noise and vibration management measures

This section outlines noise management measures that will be implemented as part of the construction works, including consultation and complaint handling procedures.

It may not be feasible to adopt all management measures at all times during construction, and identification of all reasonable and feasible mitigation methods will be conducted by the site supervisor and/or environmental representative on a regular basis during noisy works near sensitive land uses.

In relation to the implementation of mitigation measures, feasibility addresses engineering consideration regarding what is practical to build. Reasonableness relates to the application of judgment in arriving at a decision, taking into account the following factors:

- noise reduction achieved
- number of people or other uses benefited
- cost of the measure
- delay to schedule and whether the measure will prolong exposure to noise
- community views
- pre-construction noise levels at receivers.

While the management measures presented will not necessarily result in mitigating all noise impacts at all times, they are expected to reduce impacts to levels most stakeholders should find acceptable considering the anticipated benefits of the completed project as a whole.

6.1 Noise and vibration management measures

The following noise management measures will be implemented throughout works where reasonable and feasible:

Table 14 Noise and vibration management measures

Reference	Details of management measures	Implementation		Responsibility
Implemented throughout external works		**PC[1]**	**C[2]**	
NVMM01	Works to be undertaken during Standard Working Hours where possible.	✓	✓	Construction Manager
NVMM02	Where works occur outside of Standard Working Hours, these will occur during the approved extended Saturday working hours.	✓	✓	Construction Manager
NVMM03	Where vibration-intensive works are occurring near bio-resources, notify bio-resources laboratory manager and commence works at furthest possible distance from facility to enable works to be stopped if excessive vibration levels are observed or if adverse reaction observed from bio-resources by laboratory manager. This would include: • Vibratory compaction within 70 m. • Excavation within 15 m. • Piling within 20 m.	✓	✓	Construction Manager Community Relations Manager
NVMM04	The induction of site staff will include a reference to potential noise impacts and the identification of noise-sensitive land uses.	✓		Construction Manager

Reference	Details of management measures	Implementation		Responsibility
Implemented throughout external works		**PC[1]**	**C[2]**	
NVMM05	'Toolbox talks' will include a reference to any noise management measures being implemented on site at the time.		✓	Site Supervisor
NVMM06	Where possible, schedule work breaks at same time as sensitive times for receivers. For example, break for lunch between 12 and 2 pm when catering usage is busy.		✓	Site Supervisor
NVMM07	Implement stakeholder notification and complaint response procedures as detailed in Section 6.2 and Section 0.	✓	✓	Community Relations Manager
NVMM08	Vehicle warning devices, such as horns, are not to be used as signalling devices.		✓	Site Supervisor Operators
NVMM09	No swearing or unnecessary shouting or loud stereos/radios on site.		✓	Site Supervisor
NVMM10	No unnecessary dropping of materials from height, throwing of metal items and slamming of doors.		✓	Site Supervisor
NVMM11	Site access and delivery points will be located as far away from the Hospital as possible.	✓	✓	Construction Manager
NVMM12	Truck movements will use arterial roads and be diverted away from residential streets and the Hospital where feasible.	✓	✓	Construction Manager
NVMM13	Loading and unloading operations will be undertaken away from the western boundary of the site to reduce impacts on the Hospital.		✓	Site Supervisor Operators
NVMM14	Traffic flow, parking and loading/unloading areas will be planned to avoid the need for reversing near sensitive uses such as the Hospital.	✓	✓	Construction Manager Site Supervisor
NVMM15	Two way radios will be used at the minimum effective volume.		✓	Site Supervisor Operators
NVMM16	Quieter construction methods, such as bored piling rather than driven piling, will be used where feasible and reasonable.	✓	✓	Construction Manager
NVMM17	Noise levels of plant and equipment will be considered in rental decisions and all plant and equipment will be selected and operated to be compliant with the sound power levels in Appendix B.	✓	✓	Construction Manager
NVMM18	Simultaneous operation of noisy plant close together and near the Hospital will be avoided.		✓	Site Supervisor
NVMM19	The offset distance between plant and sensitive uses will be maximised.		✓	Site Supervisor

Reference	Details of management measures	Implementation		Responsibility
Implemented throughout external works		**PC[1]**	**C[2]**	
NVMM20	Plant used intermittently will be shut down or throttled down to a minimum in between use.		✓	Site Supervisor
NVMM21	Plant emitting noise in a particular direction will be directed away from residences.		✓	Site Supervisor
NVMM22	Delivery vehicles will be fitted with straps rather than chains for unloading near sensitive areas, wherever possible.		✓	Site Supervisor Operators
NVMM23	Ensure that truck tailgates are cleared and locked at the point of unloading.		✓	Site Supervisor Operators
NVMM24	Locate plant and equipment to take advantage of barriers provided by existing site features and structures.		✓	Site Supervisor Operators
NVMM25	Implement mufflers/silencers on plant and equipment. Undertake regular maintenance of plant and equipment, including silencers, to ensure that noise emissions do not increase over time. Servicing, refuelling and warm-up to be undertaken during standard construction hours.		✓	Site Supervisor Operators
NVMM26	Noise associated with packing up plant and equipment at the end of works will be minimised.		✓	Site Supervisor Operators

(1) Pre-construction – note that this may refer to prior to commencement of specific activities rather than prior to the commencement of all construction works.

(2) Construction

6.2 Consultation

This CNVMP has been developed in consultation with various stakeholders. A summary of the consultation is included in Appendix A of this document.

The outcomes of this consultation are incorporated into the measures in Section 6.1 and in Section 7, including consideration of specific times at which various uses are more noise- and vibration-sensitive.

If significant changes to works are proposed that would alter the noise impact on sensitive land uses, then additional consultation will be undertaken with respect to the proposed change at least one week prior to it occurring. This would include:

- The use of noisier plant or equipment than currently envisaged within this CNVMP, e.g. rock-breaking.
- Carrying out works outside of approved hours where there is no alternative.

6.3 Complaint handling

A project information line will be established and made available 24 hours to receive complaints. The project information line phone number will be posted on signs on the site boundary and on the project website.

The person receiving complaints will have the ability to implement reasonable and feasible measures to action the complaint. These measures may include modification of the work site or work practices, or a review of night activities. The following complaint management procedure will be implemented during all works:

1) Assess whether the issue can be resolved easily and take immediate action if possible.
2) If not, assess the construction site and activities and determine whether there is any reason to believe noise levels are higher than anticipated.
3) Undertake monitoring of noise (where this is an appropriate response).
4) Ensure all planned management measures have been appropriately implemented.
5) If steps 3 and 4 are correct, no further site actions are required (proceed to step 8).
6) If steps 3 and 4 are incorrect, implement all reasonable and practicable mitigation measures where possible and implement correct engagement procedures.
7) Ensure person receiving complaints is well briefed on the existing mitigation measures in place during the activity and the justification for the activity, and understands the details of any night works approvals (if applicable).
8) Advise complainant of actions undertaken.

Records of any noise and vibration complaint received during the works, and the action taken in response to the complaint, will be maintained throughout the works.

7 Compliance management

7.1 Roles and responsibilities

The Laing O'Rourke Project Team's organisational structure and overall roles and responsibilities are outlined in the CEMP. Specific responsibilities for the implementation of noise and vibration management measures are detailed in Section 6.

7.2 Training

All employees, sub-contractors and utility staff working on site will undergo site induction training relating to noise and vibration management issues, including:

- Existence and requirements of this CNVMP.
- Standard and extended working hours.
- Location of noise sensitive areas and receivers.
- Specific requirements of sensitive receivers including:
  - After-hours contact details for RPAH.
  - RPAH Chapel being impacted by noise and any specific requirements around usage times there.
  - University Colleges and other uses being most sensitive during exam times, Fresher week and University Open Day on 25 August, and during other specific events.
  - Elegance Catering at the University Grandstand being most sensitive between midday and 2 pm on Monday to Friday during lunchtime.
- General noise and vibration management measures, including monitoring procedures at Bosch 1B.
- Complaints reporting.

7.3 Monitoring and inspections

Weekly inspections by the Site Manager or a suitably qualified representative will occur throughout construction.

Noise and vibration monitoring will also occur routinely during the works as detailed in Table 15.

Table 15 Noise and vibration monitoring plan

Situation	Monitoring requirements	Frequency, reporting and responsibility
Noise monitoring		
Attended monitoring to assess typical construction noise levels at the Hospital and Wesley College. Where complaint is received and monitoring is considered an appropriate response to determine if noise levels exceed predicted construction noise levels documented in this CNVMP.	If monitoring cannot be undertaken at the nearest relevant sensitive receiver, a suitable representative location will be selected. The testing method includes: • Sound level meter configured for "Fast" time weighting and "A" frequency weighting. • Test environment free from reflecting objects where possible. Where noise monitoring is conducted within 3.5 metres of large walls or a building facade, then a reflection correction of up to -2.5 dB(A) will be applied to remove of increased noise due to sound reflections. • Tests will not be carried out during rain or when wind speed exceeds 5m/s. • Conditions such as wind velocity and direction, temperature, relative humidity and cloud cover will be recorded from the nearest Bureau of Meteorology station or on-site weather station/observations. • The monitoring period should be sufficient such that measured noise levels are representative of noise over a 15-minute period. • At a minimum L_{eq}, L_{max}, L_{10} and L_{90} levels will be measured and reported. The observations of the person undertaking the measurements will be reported including audibility of construction noise, other noise in the environment and any discernible construction activities contributing to the noise at the receiver.	Frequency On a minimum monthly basis for attended monitoring As required for complaints. Reporting Written reports of all noise monitoring will be maintained by LOR and submitted to key stakeholders on request. Responsibility Monitoring to be undertaken by LOR staff suitably experienced in carrying out noise monitoring. If deemed necessary, a suitably qualified acoustic consultant will undertake monitoring to resolve complaints.
Spot checks of noisy plant to determine noise emission levels for: • assessing compliance against manufacturer specifications • assisting to assess accuracy of predictions • assessing quieter construction techniques where required.	Stationary test procedures according to AS 2012.1 Acoustics – Measurement of airborne noise emitted by earth-moving machinery and agricultural tractors – Stationary test condition. The testing method includes: • Sound level meter configured for "Fast" time weighting and "A" frequency weighting. • The test environment will be free from reflecting objects. • Tests will not be carried out during rain or when wind speed exceeds 5 m/s. • In accordance with *AS 2012.1*, a minimum of three measurement points will be defined at locations on the hemispherical surface around the plant with the radius determined by the basic length of the machine. • The A-weighted L_{eq} background noise at the measurement locations will be at least 6 dB and preferably 10 dB below the level with plant operating. • L_{eq} and L_{10} levels will be measured and reported.	Frequency On an as required basis during main works. Reporting Records of spot checks of noisy plant will be maintained by LOR. Responsibility Monitoring to be undertaken by LOR staff suitably experienced in carrying out noise monitoring.

Situation	Monitoring requirements	Frequency, reporting and responsibility
Vibration monitoring		
Site establishment and substructure works.	Continuous vibration monitoring conducted at Hospital throughout works as follows: • Geophone installed at ground adjacent to eastern side of Hospital subject to access being granted by Hospital. • Monitor to continuously record PPV vibration level in 15-minute (or shorter) intervals. • If PPV level exceeds 0.6 mm/s at any time, alert will be sent to site staff as this may indicate exceedance of human comfort levels for Hospital. • Upon receipt of an alert, work will STOP. • Necessary modifications will be made to work practices to reduce the vibration level and the works will continue as long as further alerts are not received. • If works can not be modified to reduce vibration levels sufficiently, consultation will be carried out with Hospital to determine appropriate times for carrying out works.	Frequency Continuous during site establishment and substructure works. Reporting Records of logged vibration levels will be maintained by LOR. Responsibility Monitoring to be undertaken by a suitably qualified acoustic consultant.
	Continuous vibration monitoring conducted at Bosch 1B Laboratory Animal Services throughout works as follows: • Sensor installed within nearest holding area to work sites. • Measure 1-minute rms vibration levels continuously throughout the works. At a minimum, vibration levels should be measured in the vertical direction. • Send sms and/or email alerts to relevant site staff when the noise management levels are exceeded. • Upon receipt of an alert, work will STOP. • Necessary modifications will be made to work practices to reduce the vibration level and the works will continue as long as further alerts are not received. • If works can not be modified to reduce vibration levels sufficiently, consultation will be carried out with laboratory manager to determine appropriate times for carrying out works. • Be capable of providing historical data when requested via a web server or similar.	Frequency Continuous during site establishment and substructure works. Reporting Records of logged vibration levels will be maintained by LOR. Responsibility Monitoring to be undertaken by a suitably qualified acoustic consultant.

Situation	Monitoring requirements	Frequency, reporting and responsibility
If any works occur within safe working distances for damage to buildings, detailed in Section 0.	Continuous vibration monitoring conducted throughout works as follows: • Geophone installed at ground adjacent to building foundations or equivalent (or nearer) location if access not provided to the outside of the building. • Monitor to continuously record PPV vibration level in 15-minute (or shorter) intervals. • If PPV level exceeds 75% of the minimum DIN 4150-3 building damage limit, an alert will be sent to nominated site staff via email/SMS. This will include a Site Supervisor with suitable authority to stop work. • Upon receipt of an alert, work will STOP. • Necessary modifications will be made to work practices to reduce the vibration level and the works will continue as long as further alerts are not received. • Note that if the frequency of the vibration event is such that 75% of the DIN 4150-3 limit was not exceeded, then works will proceed with caution, and the alert level adjusted as appropriate.	Frequency If required if works change such that works may occur in safe working distances for buildings. Reporting Records of logged vibration levels will be maintained by LOR. Responsibility Monitoring to be undertaken by a suitably qualified acoustic consultant.
Vibration monitoring in response to a complaint, where this is considered an appropriate response.	Attended vibration monitoring will be conducted of the relevant activities as follows: • Geophone installed at ground adjacent to building foundations or equivalent (or nearer) location if access not provided to the outside of the building. • Monitor to continuously record PPV and/or VDV vibration levels generated by the activity. • Measured levels to be compared to human disturbance vibration goals and/or building damage limits as appropriate. If necessary following the vibration measurements: • Appropriate vibration management measures will be implemented. Continuous vibration monitoring will be considered if this is considered of benefit to address the complaint.	Frequency As required for complaints. Reporting Report detailing measurement results and any corrective actions to be provided to the complainant and relevant stakeholders. Responsibility A suitably qualified acoustic consultant will undertake monitoring to resolve complaints.

Appendix A—Summary of consultation during CNVMP development

SUSAN WAKIL HEALTH BUILDING PROJECT

MEETING NOTES

MEETING WITH:	Centenary Institute
MEETING PURPOSE:	LORAC to consult with sensitive receivers re the Construction Noise and Vibration Management Plan (CNVMP) for the Susan Wakil Health Building
MEETING ATTENDEES:	LORA – Chris Paul, Susan Allton Centenary Institute – Natasha Yung, Nick Pearce
DATE OF MEETING:	Monday 30 July 2018
TIME OF MEETING:	1330-1415
LOCATION:	Centenary Institute

What LORAC advised RPAH:

- the CVNMP is one of a suite of management plans required for the construction of the Susan Wakil Health Building to address and manage various construction methodologies and impacts of construction

- it describes reasonable and practical measures to minimize/control construction noise and vibration

- consultation with adjacent sensitive receivers is required as part of the conditions of approval for the project

- construction methodology is still being finalized – LORAC described the overall methodology and schedule – piling, excavation, fill and vibratory rolling, scaffolding, concrete pump and pouring, tower crane, general building noise.

- There would be 40 concrete trucks per day with 2 concrete pours per week for 8 months from September 2018 (from 0730 for 5 to 6 hours)

- vibration effects of vibratory roller would occur for 5 days during compaction of sandstone rubble base for piling rig platform

- LORAC showed the 3-D model of the building and placement of equipment and access

- noise monitoring was undertaken at several sensitive receivers in order to draft the CNVMP, including RPAH which is closer to site than Centenary Institute

Noise predictions in the CNVMP:

- indicate construction noise will exceed relevant Noise Management Levels externally at Oval No. 1 (closest site to centenary Institute) by maximum 7dB for periodic construction works on site.

- closing doors and windows in buildings can reduce noise by up to 25 dB

Vibration predictions in the CNVMP:

- Using safe working distances for impacting equipment, there are no vibration impacts expected for adjacent buildings

- Impacts of people's comfort level would be limited to vibratory compaction works on construction site
- Vibration and noise monitors will be located at RPAH (27 mtrs from site), the Chapel (abutting the site), Wesley College and LAS in Bosch 1B

Construction measures to mitigate impacts:

- CFA piling will be used. It is bored piles and concrete poured as drill is extracted – less noise and vibration effect

- use of electric tower crane instead of diesel crane – initial use of generator for crane then mains power

- noise and vibration monitors around site perimeter and at RPAH and LAS which are closer to site than Centenary Institute

- there is the possibility to change the sequencing of vibratory roller to lessen impact during peak business times for closest stakeholders

- respite periods for noisy works

- where possible, plant emitting noise could be faced away from sensitive receivers

- avoid simultaneous operation of noisy plant close together

- turn off engines when plant not in use

- inductions and tool box talks include awareness of sensitive receivers

CENTENARY INSTITUTE COMMENTS:

- when CPC building adjacent to Institute used CFA piling method for construction, it had no impact on the animals, but 1 piece of equipment involved in an experiment was impacted, however, the Institute don't know cause

- the Institute has 2-photon microscopes and confocal microscopes on levels 1,2 and 3 – some of these are on vibration proof tables. LORAC requested the specifications of these instruments and we will provide to noise consultant

- there are 5,000 mice in cages on racks with wheels on level 4. The Institute noted that it is known that mice can stop breeding during construction activities

- overall, Institute was comfortable with what they were advised by Laing O'Rourke and our measures to mitigate

SUSAN WAKIL HEALTH BUILDING PROJECT

MEETING NOTES

MEETING WITH:	Wesley, St Andrew's and Women's Colleges
MEETING PURPOSE:	LORAC to consult with sensitive receivers re the Construction Noise and Vibration Management Plan (CNVMP) for the Susan Wakil Health Building
MEETING ATTENDEES:	LORA – Luke Allman, Gabriela Olivares, Susan Allton Wesley College – Glenn Weir St Andrew' College – Ian Smith Women's College – Peter Bull CIS **–** Barry Hayes
DATE OF MEETING:	Tuesday 17 July 2018
TIME OF MEETING:	1200-1300
LOCATION:	Women's College

What LORAC advised the Colleges:

- the CVNMP is one of a suite of management plans required for the construction of the Susan Wakil Health Building to address and manage various construction methodologies and impacts of construction

- it describes reasonable and practical measures to minimize/control construction noise and vibration

- consultation with adjacent sensitive receivers is required as part of the conditions of approval for the project

- construction methodology is still being finalized – LORAC described the overall methodology and schedule – piling, excavation, fill and vibratory rolling, scaffolding, concrete pump and pouring, tower crane, general building noise.

- Out of hours delivery of oversized plant – piling rig, tower crane and crane to erect tower crane

- all deliveries need to be booked through electronic booking system (Voyager Control Logistics). This allows us to track deliveries, block our times when no deliveries can occur, and all contractors must use this system to book in deliveries, allowing us to manage truck movements

- proposed traffic route is Western Ave to and from Parramatta Rd. All College accesses maintained

- There would be 40 concrete trucks per day with 2 concrete pours per week for 8 months from September 2018 (from 0730 for 5 to 6 hours)

- vibration effects of vibratory roller would occur for 5 days during compaction of sandstone rubble base for piling rig platform

- LORAC showed the 3-D model of the building and placement of equipment and access

- noise monitoring was undertaken at several sensitive receivers in order to draft the CNVMP, including Wesley College

Noise predictions in the CNVMP:

- indicate noise for various construction activities will exceed relevant Noise Management Levels externally at Wesley College by a maximum of 8-11dB when works are Monday to Friday and up to 16 dB when works occur on Saturdays. This will occur for all phases of construction except internal fitout.

- noise internally for most types of buildings can be reduced by up to 25dB by closing doors and windows

- noise from construction works are expected to comply with relevant requirements for St Andrew's and Women's Colleges

Vibration predictions in the CNVMP:

- Using safe working distances for impacting equipment, there are no vibration impacts expected for adjacent buildings, including Colleges
- Impacts of people's comfort level would be limited to vibratory compaction works close to construction site

Construction measures to mitigate impacts:

- CFA piling will be used. It is bored piles and concrete poured as drill is extracted – less noise and vibration effect

- use of electric tower crane instead of diesel crane – initial use of generator for crane then mains power

- noise and vibration monitors around site perimeter and at Wesley College

- there is the possibility to change the sequencing of vibratory roller to lessen impact during peak business times for closest stakeholders

- respite periods for noisy works

- where possible, plant emitting noise could be faced away from sensitive receivers

- avoid simultaneous operation of noisy plant close together

- turn off engines when plant not in use

- inductions and tool box talks include awareness of sensitive receivers

COLLEGES' COMMENTS:

- University Open Day is Saturday 25 August from 10am, so university will be busy with prospective students

- suggest LORAC checks any Saturday deliveries against use of ovals – busy with vehicles on Western Ave

- does the construction schedule account for exam periods? LORAC advised yes, as far as practicable

- need to avoid trucks arriving unplanned and early. LORAC referred to use of electronic booking system requirement

- when will landscaping phase be done? LORAC said it's scheduled for Christmas 2019 and January 2020. Wesley College said this was a good time as summer holidays

- the first university week of the year (Fresher week) is very busy with students arriving at Colleges.

- when Colleges have important events, they will aim to give LORAC a minimum of 48 hours notice in case of clashes with construction deliveries. LORAC requested that the Colleges provide it with a yearly program of College events now to assist the safe co-ordination of large deliveries

- Wesley commented it does not have air conditioning so windows are left open – likely to hear some construction noise

- Even though Women's College is the only building close listed on the State Heritage register, the whole of University of Sydney is about to be included on the register.

- St Andrew's College is soon to embark on a construction project. Piling is expected to begin in November 2018. Proposed traffic route is Carillon to Western Avenue, then into College grounds opposite Women's College

SUSAN WAKIL HEALTH BUILDING PROJECT

MEETING NOTES

MEETING WITH:	Elegancy Catering in The Grandstand
MEETING PURPOSE:	LORA to consult re the Construction Noise and Vibration Management Plan for the Susan Wakil Health Building
MEETING ATTENDEES:	LORA – Luke Allman, Chris Paul, Chris Stone, Gabriela Olivares, Susan Allton ELEGANCY - Luke Mitchell, Michelle Tanke Apology: USYD Union
DATE OF MEETING:	Monday 9 July 2018
TIME OF MEETING:	1330-1430
LOCATION:	Elegancy Catering, The Grandstand

What LORAC advised Elegancy:

- the CNVMP is one of a suite of management plans required for the construction of the Susan Wakil Health Building to address and manage various construction methodologies and impacts

- it describes reasonable and practical measures to minimize/control construction noise and vibration

- consultation with adjacent sensitive receivers is required as part of the conditions of approval for the project

- construction methodology is still being finalized – LORAC described the overall methodology – piling, excavation, fill and vibratory rolling, scaffolding, concrete pump and pouring, tower crane, general building noise

- LORAC explained the likely biggest noise impact for Elegancy would be the operation of a concrete pump located on the work site diagonally adjacent to The Grandstand. There would be 40 concrete trucks per day with 2 concrete pours per week for 8 months from September 2018 (from 0730 for 5 to 6 hours)

- also vibration effects of vibratory roller for 5 days while the piling rig pad is laid

- access maintained along The Shared Pathway

LORAC construction measures to mitigate impacts:

- CFA piling method which is bored piles and concrete poured as drill is extracted – less noise and vibration effect

- use of electric tower crane instead of diesel crane – initial use of generator for crane then mains power

- noise and vibration monitors around site perimeter

- possibility to change the sequencing of vibratory roller to lessen impact during peak business times for Elegancy or other stakeholders

- respite periods for noisy plant

Elegancy advised us that:

- busiest time is lunchtime 12pm to 2pm Monday to Friday
- excessive noise at lunchtimes would be adverse to trade
- need to maintain access along The Shared Pathway for deliveries and clients
- difficult to attract functions with a construction site adjacent
- need to keep dust down

SUSAN WAKIL HEALTH BUILDING PROJECT

MEETING NOTES

MEETING WITH:	The Glasshouse, Cadigal Lane
MEETING PURPOSE:	LORAC to consult with sensitive receivers re the Construction Noise and Vibration Management Plan (CNVMP) for the Susan Wakil Health Building
MEETING ATTENDEES:	LORA – Gabriela Olivares, Susan Allton The Glasshouse – Carolina Cuenca Cardozo
DATE OF MEETING:	Tuesday 10 July 2018
TIME OF MEETING:	1030-1100
LOCATION:	LORAC site office, level 2, Bosch 1B

What LORAC advised The Glasshouse:

- the CVNMP is one of a suite of management plans required for the construction of the Susan Wakil Health Building to address and manage various construction methodologies and impacts of construction

- it describes reasonable and practical measures to minimize/control construction noise and vibration

- consultation with adjacent sensitive receivers is required as part of the conditions of approval for the project

- construction methodology is still being finalized – LORAC described the overall methodology and schedule – piling, excavation, fill and vibratory rolling, scaffolding, concrete pump and pouring, tower crane, general building noise.

- There would be 40 concrete trucks per day with 2 concrete pours per week for 8 months from September 2018 (from 0730 for 5 to 6 hours)

- vibration effects of vibratory roller would occur for 5 days during compaction of sandstone rubble base for piling rig platform

- noise monitoring was undertaken at several sensitive receivers in order to draft the CNVMP

Noise predictions in the CNVMP:

- LORAC said it is unlikely that people working occasionally in The Glasshouse would be adversely affected by construction noise as it is shielded by the work compound and Bosch 1A

Vibration predictions in the CNVMP:

- Using safe working distances for impacting equipment, there are no vibration impacts expected for adjacent buildings
- It is unlikely that people working in The Glasshouse would feel vibration

Construction measures to mitigate impacts:

- CFA piling will be used. It is bored piles and concrete poured as drill is extracted – less noise and vibration effect

- use of electric tower crane instead of diesel crane – initial use of generator for crane then mains power

- noise and vibration monitors around site perimeter and at sensitive receivers

- there is the possibility to change the sequencing of vibratory roller to lessen impact during peak business times for closest stakeholders

- respite periods for noisy works

- where possible, plant emitting noise could be faced away from closest buildings

- avoid simultaneous operation of noisy plant close together

- turn off engines when plant not in use

- inductions and tool box talks include awareness of sensitive receivers

THE GLASSHOUSE COMMENTS:

- Asked about any impact on the structural integrity of The Glasshouse. LORAC explained that there will be no impact on the structural integrity of The Glasshouse
- Plants in The Glasshouse are not affected by small levels of vibration
- It is important that for any construction works, that The Glasshouse's air conditioning, temperature monitoring and water is unaffected

SUSAN WAKIL HEALTH BUILDING PROJECT

MEETING NOTES

MEETING WITH:	Laboratory Animal Services, ground level, Bosch 1B
MEETING PURPOSE:	LORAC to consult with sensitive receivers re the Construction Noise and Vibration Management Plan (CNVMP) for the Susan Wakil Health Building
MEETING ATTENDEES:	LORA – Luke Allman, Gabriela Olivares, Susan Allton LAS – Bill Phillips CIS – Barry Hayes
DATE OF MEETING:	Wednesday 11 July 2018
TIME OF MEETING:	1000-1040
LOCATION:	LORAC site office, level 2, Bosch 1B

What LORAC advised LAS:

- the CVNMP is one of a suite of management plans required for the construction of the Susan Wakil Health Building to address and manage various methodologies and impacts of construction

- it describes reasonable and practical measures to minimize/control construction noise and vibration

- consultation with adjacent sensitive receivers is required as part of the conditions of approval for the project

- construction methodology is still being finalized – LORAC described the overall methodology and schedule – piling, excavation, fill and vibratory rolling, scaffolding, concrete pump and pouring, tower crane, general building noise.

- There would be 40 concrete trucks per day with 2 concrete pours per week for 8 months from September 2018 (from 0730 for 5 to 6 hours)

- vibration effects of vibratory roller would occur for 5 days during compaction of sandstone rubble base for piling rig platform

- LORAC showed the 3-D model of the building and placement of equipment and access

- noise monitoring was undertaken at several sensitive receivers in order to draft the CNVMP

Noise predictions in the CNVMP:

- indicate construction noise will exceed relevant external Noise Management Levels at closest buildings when works occur on the southern side of the construction site ie, outside LAS. This will occur for all phases of construction except internal fitout

Vibration predictions in the CNVMP:

- Using safe working distances for impacting equipment, there are no vibration impacts expected for adjacent building structures
- Impacts of people's comfort level would be limited to vibratory compaction works adjacent to construction site
- We will aim to stay below 2mm/sec in LAS for the animals

Construction measures to mitigate impacts:

- CFA piling will be used. It is bored piles and concrete poured as drill is extracted – less noise and vibration effect

- use of electric tower crane instead of diesel crane – initial use of generator for crane then mains power

- noise and vibration monitors around site perimeter and vibration monitors in LAS

- there is the possibility to change the sequencing of vibratory roller to lessen impact during peak business times for closest stakeholders

- respite periods for noisy works

- where possible, plant emitting noise could be faced away from Bosch 1B

- avoid simultaneous operation of noisy plant close together

- turn off engines when plant not in use

- inductions and tool box talks include awareness of sensitive receivers

LAS COMMENTS:

- Reiterate it's mainly vibration that's of concern to LAS as it affects the rodent breeding
- Excessive continuous noise would be an issue for staff
- Aside from vibration and noise, maintaining deliveries and rubbish removal are critical for LAS

SUSAN WAKIL HEALTH BUILDING PROJECT

MEETING NOTES

MEETING WITH:	Library study area, level 3, Bosch 1B
MEETING PURPOSE:	LORAC to consult with sensitive receivers re the Construction Noise and Vibration Management Plan (CNVMP) for the Susan Wakil Health Building
MEETING ATTENDEES:	LORA – Chris stone, Gabriela Olivares, Susan Allton Library Study area – Matthew Davis, Crystal Choi
DATE OF MEETING:	Tuesday 10 July 2018
TIME OF MEETING:	1645 – 1730
LOCATION:	LORAC site office, level 2, Bosch 1B

What LORAC advised Library Study Area:

- the CVNMP is one of a suite of management plans required for the construction of the Susan Wakil Health Building to address and manage various construction methodologies and impacts of construction

- it describes reasonable and practical measures to minimize/control construction noise and vibration

- consultation with adjacent sensitive receivers is required as part of the conditions of approval for the project

- construction methodology is still being finalized – LORAC described the overall methodology and schedule – piling, excavation, fill and vibratory rolling, scaffolding, concrete pump and pouring, tower crane, general building noise.

- There would be 40 concrete trucks per day with 2 concrete pours per week for 8 months from September 2018 (from 0730 for 5 to 6 hours)

- vibration effects of vibratory roller would occur for 5 days during compaction of sandstone rubble base for piling rig platform

- LORAC showed the 3-D model of the building and placement of equipment and access

- noise monitoring was undertaken at several sensitive receivers in order to draft the CNVMP

Noise predictions in the CNVMP:

- indicate construction noise will exceed slightly, the relevant Noise Management Levels outside the closest receivers (Bosch 1B) when works occur on the western side of the construction site. This will occur for all phases of construction except internal fitout

Vibration predictions in the CNVMP:

- Using safe working distances for impacting equipment, there are no vibration impacts expected for adjacent buildings
- Impacts of people's comfort level would be limited to vibratory compaction works on the construction site

Construction measures to mitigate impacts:

- CFA piling will be used. It is bored piles and concrete poured as drill is extracted – less noise and vibration effect

- use of electric tower crane instead of diesel crane – initial use of generator for crane then mains power

- noise and vibration monitors around site perimeter and at sensitive receivers

- there is the possibility to change the sequencing of vibratory roller to lessen impact during peak business times for closest stakeholders

- respite periods for noisy works

- where possible, plant emitting noise could be faced away from sensitive receivers

- avoid simultaneous operation of noisy plant close together

- turn off engines when plant not in use

- inductions and tool box talks include awareness of sensitive receivers

LIBRARY STUDY AREA COMMENTS:

- Asked if they would feel the vibration from the vibratory roller – LORAC said that this would be unlikely on the top floor of Bosch 1B but likely on the ground floor

- Request for additional liaison prior to exam periods – library to advise exam periods – noting that the medical students have a different timetable to other students and they are the predominant users of this study area

- Question relating services impacts to existing buildings - LOR noted services diversions are underway to ensure no impact on neighbours

- Question regarding - lecture theatres remaining in use. LORAC's understanding is the 2 in Bosch 1A will stay in use however LORAC has requested no exams are booked in

SUSAN WAKIL HEALTH BUILDING PROJECT

MEETING NOTES

MEETING WITH:	RPAH
MEETING PURPOSE:	LORAC to consult with sensitive receivers re the Construction Noise and Vibration Management Plan (CNVMP) for the Susan Wakil Health Building
MEETING ATTENDEES:	LORA – Chris Stone, Gabriela Olivares, Susan Allton RPAH – Graeme Angus, Dean Benke, Rowena Morgan, Joseph Jewitt CIS **–** Barry Hayes
DATE OF MEETING:	Tuesday 10 July 2018
TIME OF MEETING:	1600-1645
LOCATION:	KGV Building level 5

What LORAC advised RPAH:

- the CVNMP is one of a suite of management plans required for the construction of the Susan Wakil Health Building to address and manage various construction methodologies and impacts of construction

- it describes reasonable and practical measures to minimize/control construction noise and vibration

- consultation with adjacent sensitive receivers is required as part of the conditions of approval for the project

- construction methodology is still being finalized – LORAC described the overall methodology and schedule – piling, excavation, fill and vibratory rolling, scaffolding, concrete pump and pouring, tower crane, general building noise.

- There would be 40 concrete trucks per day with 2 concrete pours per week for 8 months from September 2018 (from 0730 for 5 to 6 hours)

- vibration effects of vibratory roller would occur for 5 days during compaction of sandstone rubble base for piling rig platform

- LORAC showed the 3-D model of the building and placement of equipment and access

- noise monitoring was undertaken at several sensitive receivers in order to draft the CNVMP, including RPAH

Noise predictions in the CNVMP:

- indicate construction noise will exceed relevant Noise Management Levels externally at RPAH and Gloucester House by a maximum of 5-6dB when works occur on the western side of the construction site. This will occur for all phases of construction except internal fitout.

Vibration predictions in the CNVMP:

- Using safe working distances for impacting equipment, there are no vibration impacts expected for adjacent buildings, including RPAH and Gloucester House

- Impacts of people's comfort level would be limited to vibratory compaction works on western side of construction site

Construction measures to mitigate impacts:

- CFA piling will be used. It is bored piles and concrete poured as drill is extracted – less noise and vibration effect

- use of electric tower crane instead of diesel crane – initial use of generator for crane then mains power

- noise and vibration monitors around site perimeter and at RPAH

- there is the possibility to change the sequencing of vibratory roller to lessen impact during peak business times for closest stakeholders

- respite periods for noisy works

- where possible, plant emitting noise could be faced away from RPAH

- avoid simultaneous operation of noisy plant close together

- turn off engines when plant not in use

- inductions and tool box talks include awareness of sensitive receivers

RPAH COMMENTS:

- RPAH will provide LORAC with a list of movement sensitive equipment and their specifications

- Asked LORAC to include in inductions that RPAH has a/hrs managers and their contacts

- Asked LORAC to include in inductions that there are previous instances of mental patients who break into construction sites and end up in hospital emergency department

Questions:

- Does the CNVMP specifically mention the Chapel and anatomical building? Answer – no, but LORAC will ask the noise and vibration consultant to note and check any effects on these buildings. A pre-condition survey has been conducted on the Chapel.

Appendix B—Typical plant sound power levels

Table B-1 summarises the assumed sound power levels (L_W) for the major construction noise sources which we expect would be on site during each phase. The sound power levels have been based on data obtained from previous measurements conducted by Resonate and those within the UK Department for Environment, Food and Rural Affairs (DEFRA) *Update of noise database for prediction of noise on construction and open sites*. An overall sound power level for each phase has also been assumed based on the loudest typical source(s) operating for each works phase.

Table B-1 Construction stage sound power levels

Plant item	Sound power level, dB(A)	Plant expected for scenario				
		Site establishment	Substructure	Superstructure and facade	Internal works and fitout	External landscaping
Large excavator	111	x	x			x
Vibratory roller	107	x				x
Concrete truck	109	x	x	x		
Concrete pump	107	x	x	x		
Large truck	108	x	x	x		x
Bored piling rig	111		x	x		
Crane / mobile crane	106		x	x		
Pneumatic jackhammer	109			x		
General hand tools	98			x	x	
Compressor	94				x	
Portable generator	95				x	
Grader	112					x
Paver	112					x
Typical worst-case sound power level per scenario, dB(A)[1]		**112**	**114**	**111**	**84[2]**	**113**

(1) Based on typical loudest plant item, or combination of plant items, operating.

(2) Includes a 15 dB(A) indoor-to-outdoor reduction in noise levels for internal works.