4 - 6 Bligh Street, Sydney

Construction Noise & Vibration Management Plan

8/12/2022

Ref: 301351060

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Revision

Revision	Date	Comment	Prepared By	Approved By
001	10/11/2022	For comments	Ali Ahmadi	Mathew McGrory
002	8/12/2022	Additional clarifications	Ali Ahmadi	Mathew McGrory

Contents

1. Executive Summary

This Construction Noise Management Plan (CNVMP) has been prepared by Stantec to accompany a detailed State Significant Development Application (SSDA) for the mixed-use redevelopment proposal at 4-6 Bligh Street, Sydney. The site is legally described as Lot 1 in Deposited Plan 1244245.

This report has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued for the project (SSD-48674209).

This report concludes that the proposed mixed-use hotel and commercial development is suitable and warrants approval subject to the implementation of the following mitigation measures.

- Management plans
- Temporary noise barriers

Following the implementation of the above mitigation measures, the remaining impacts are reasonable for construction works and manageable.

2. Introduction

This report has been prepared to accompany an SSDA for the for the mixed-use redevelopment proposal at 4-6 Bligh Street, Sydney.

The Council of the City of Sydney, as delegate for the Minister for Planning and Public Spaces (the Minister), is the Consent Authority for the SSDA under an Instrument of Delegation issued by the Minister on 3 October 2019.

The application seeks consent for the construction of a 59-storey mixed-use hotel and commercial development. The purpose of the project is to revitalise the site and deliver new commercial floorspace and public realm improvements consistent with the City's vision to strengthen the role of Central Sydney as an international tourism and commercial destination.

A separate development consent (D/2018/892) relating to early works for the proposed application was granted for the site on 31 January 2020. Consent was granted for the demolition of the existing site structures, excavation and shoring of the site for three basement levels (to a depth of RL9.38m) to accommodate the proposed mixed-use hotel and commercial development. As such, this application does not seek consent for these components and instead seeks to rely upon and activate D/2018/892 for early works.

Specifically, development consent is sought for:

- Site establishment, including removal of two existing trees along the Bligh Street frontage and de- commissioning and removal of an existing substation (s2041) on the site.
- Construction of a 59-storey hotel and commercial office tower. The tower will have a maximum building height of RL225.88 (205m) and a total gross floor area (GFA) provision of 26,796sqm, and will include the following elements:
    - Five basement levels accommodating a substation, rainwater tank, hotel back of house, plant and services. A porte cochere and four service bays will be provided on basement level 1, in addition to 137 bicycle spaces and end of trip facilities on basement level 2.
    - A 12-storey podium accommodating hotel concierge and arrival at ground level, conference facilities, eight levels of commercial floor space and co-working facilities, and hotel amenities including a pool and gymnasium at level 12.
    - 42 tower levels of hotel facilities including 417 hotel keys comprising standard rooms, suites and a penthouse.
    - Two tower levels accommodating restaurant, bar, back of house and a landscaped terrace at level 57.
    - Plant, servicing and BMU at level 59 and rooftop.

- Increase to the width of the existing Bligh Street vehicular crossover to 4.25m and provision of an additional 4m vehicular crossover on Bligh Street to provide one-way access to the porte cochere and service bays on basement level 1.
- Landscaping and public domain improvements including:
    - Replacement planting of three street trees in the Bligh Street frontage,
    - Construction of a landscape pergola structure on the vertical façade of the north-eastern and south-eastern podium elevations,
    - Awning and podium planters, and
    - Provision of a feature tree at the level 57 terrace.
- Identification of two top of awning building identification signage zones with a maximum dimension of 1200mm x 300mm. Consent for detailed signage installation will form part of a separate development application.
- Utilities and service provision.
- Installation of public art on the site, indicatively located at ground level.

This report has been prepared in response to the requirements contained within the Secretary's Environmental Assessment Requirements (SEARs) dated 01 October 2022 and issued for the SSDA. Specifically, this report has been prepared to respond to the SEARs requirement issued below.

Item	Description of requirement	Section reference (this report)
12. Noise and Vibration	Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures that would be implemented.	Section 7

3. The Site

The site for the purposes of this SSDA is a single allotment identified as 4-6 Bligh Street, Sydney and known as Lot 1 in Deposited Plan 1244245. The site has an area of 1,218sqm, and is identified in Figure 1.

The site is relatively flat, with a slight slope ranging from 21m AHD in the north-western corner to 19.5m AHD in the south-western corner.

The site is located within the north-eastern part of Central Sydney in a block bound by Bligh Street to the west, Hunter Street to the south, Chifley Square/Phillip Street to the east, and Bent Street to the north. The surrounding buildings are generally characterised by a mix of commercial office and hotel uses with ground level retail, restaurant and café uses and are of varying heights, ages and styles, including a number of State and local listed heritage buildings.

The site is also located in proximity to a number of Sydney Metro City & Southwest (opening 2024) and Sydney Metro West (opening 2030) station sites.

Specifically, the site is located to the immediate east of the Sydney Metro Hunter Street station (east site), which is located on the corner of Hunter Street and Bligh Street, and approximately 350m east of the Sydney Metro Hunter Street station (west site). The Hunter Street station sites are part of the Sydney Metro West project. SEARs for the preparation of Concept SSDAs for the sites were issued in August 2022.

Approximately 150m to the south of the site is Sydney Metro Martin Place Station site, located to the south of Hunter Street between Castlereagh Street and Elizabeth Street. The Martin Place Station site is currently under construction and forms part of the Sydney Metro City & Southwest project.

The site is occupied by a vacant commercial office building with ground floor retail and basement car parking known as "Bligh House". Completed in 1964, Bligh House is a 17-storey tower inclusive of a three-storey podium with the podium levels built to the Bligh Street alignment and the tower setback from the street frontage. The building was designed by Peddle Thorp

and Walker and was constructed as part of the post-World War II development boom in the Sydney CBD. The podium overhang along the footpath provides continuous pedestrian protection. Vehicle access to the site is off Bligh Street via a single 2.6m wide driveway that is restricted by a security gate under one-lane, two-way access arrangements. The driveway provides access to the basement car park, containing 21 car parking spaces.

The site contains no vegetation; however, two existing street trees are located adjacent to the site boundary on Bligh Street. Development consent for the demolition of the existing site structures, excavation and shoring of the site for three basement levels (to a depth of RL9.38m) was granted by City of Sydney on 31 January 2022 (D/2018/892).

Source: nearmap.com

Figure 1: Site Identification Plan

4. Project Description

4.1 Project Overview

The overall works related to building for the proposed development are described below and are expected to occur across approximately 13 months for demolition and excavation and 31 months for new construction. The works are generally split into three periods which are:

1. Demolition
    - Existing office building demolition
    - Basement demolition
2. Excavation
    - Shoring
    - Bulk excavation
    - Piling
    - Detailed excavation
3. Structure
    - Piling
    - Basement slab and walls
    - Concrete structures for podium and tower
    - Installing façade elements

This report will consider the structure period and its relevant noise and vibration impacts. Acoustic impacts from demolition and excavation are not addressed here as these works are subject to a separate development application. However, certain tasks will be carried out concurrently with other tasks for particular time periods that are significant in duration. In a given combination of events, the noise emitted by performing the tasks simultaneously will be considered.

The assessment has been prepared with the following references:

- Interim Construction Noise Guideline (ICNG), NSW DECC, 2009
- Noise Policy for Industry (NPI), NSW EPA, 2017
- Assessing Vibration: A Technical Guideline, NSW DEC, 2006
- AS 2436:2010 *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites*
- British Standard BS 5228: Part 1:1997 *Noise and Vibration Control on Construction and Open Sites*
- British Standard BS 7358:1993 *Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Ground-borne Vibration*
- German Standard DIN 4150-Part 3 *Structural vibration in buildings – Effects on structures*

The predicted noise levels are based on the proposed construction program and equipment lists provided in this report

4.2 Noise & Vibration Sensitive Receivers

The site is identified as 4-6 Bligh Street, Sydney (the site) as illustrated in Figure 2. The nearest noise and vibration-sensitive receivers are the Sofitel hotel, and commercial buildings located adjacent to the development and to the west across Bligh St. The commercial facilities include retail spaces and offices. The site location, measurement positions and the nearest sensitive receivers are shown in Figure 2.

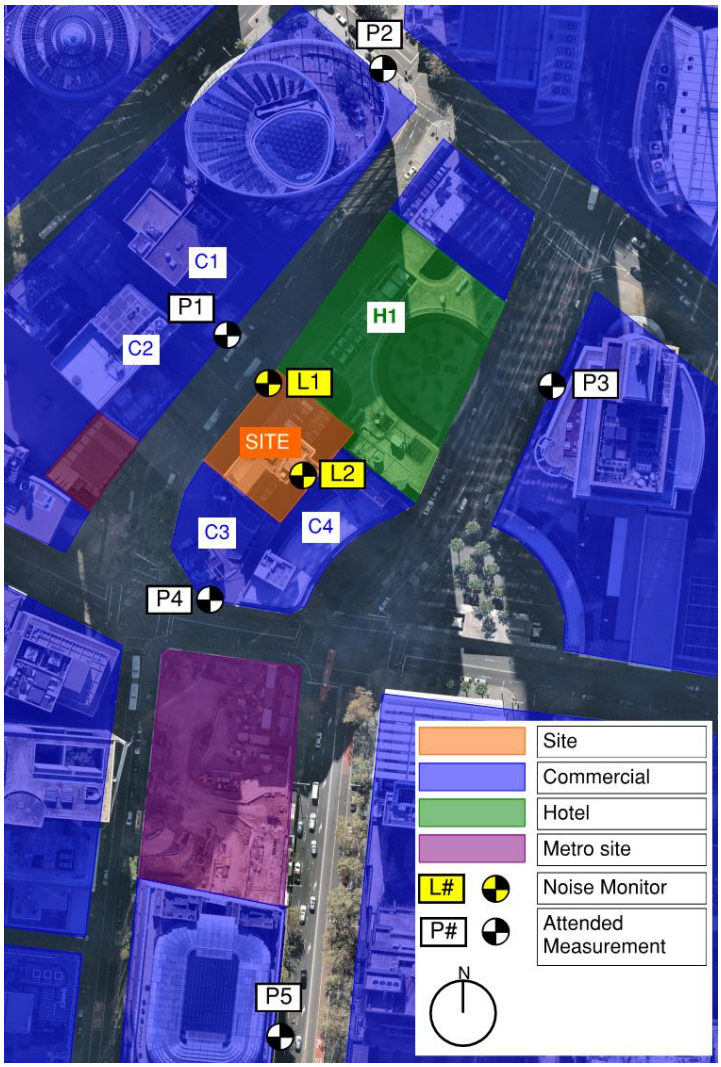


Figure 2: Site Aerial View and Noise Monitoring Locations.

4.3 Existing Noise & Vibration Environment

The existing noise environment is dominated by road traffic noise on the surrounding local roads. The traffic consists of a relatively large proportion of heavy vehicles as Bligh St serves as a waiting location between shifts for the inner-city buses. The results from the noise loggers show a typical traffic noise trend with periods of busy traffic starting early mornings and quieting down late evenings. Additionally, the rooftop mechanical equipment on the surrounding buildings contributes to the noise levels at higher elevations.

The current vibration environment is also dominated by road traffic, but more recently the excavation works for the new Sydney Metro tunnels have been conducted below the site. The rail tunnels are going to pass on the western and eastern sides of the site footprint, potentially overlapping slightly on the eastern corner. The tunnels are located deeper underground than the lowest proposed basement level of the development. However, depending on the relative location of the first reserve of the Sydney Metro and the proposed building foundations further noise and vibration assessments may be required.

5. Background and Ambient Noise Monitoring

Two noise monitors were installed in June 2019 at positions L1 and L2, as shown in Figure 2, to measure the existing background noise and traffic noise around the site. The loggers were on site for the duration of 11 days, from 4th to 14th June 2019. An additional second round of measurements was undertaken in June 2019 at positions L1 and L2, as shown in Figure 2. The loggers were on site for the duration of 10 and 7 days, from the 20th to the 30th June 2019 and between the 20th and the 27th June 2019 respectively.

Logger L1 was placed on the parapet of the podium roof (Level 3) of the existing building on site. The logger was at a height of approximately 10 metres. Logger L2 was installed on the rooftop of the existing building on site, more precisely on top of a large water tank. The building was estimated to be approximately 64 metres tall. The data from L1 is considered to represent the existing noise environment at the nearest receivers along Bligh St (H1, C1, C2 and C3). The analysis of the noise monitoring data has been further detailed in the acoustic report addressing the operational noise impact from the development (report by WGE, ref. AC-RE-002-SSDA Operational_004). The noise sources surrounding the site in 2019 and the noise environment, are expected to be similar to the existing noise environment. Therefore, previous long-term monitoring results are deemed representative of the current noise environment.

The results for the unattended background noise surveys are shown in Table 1 below (for the day, evening and night periods); the noise data from each noise monitor is illustrated as weekly graphs in Figure 3 to Figure 6. Note that any rain-affected data during the period of logging has been excluded from the calculations.

Table 1: Unattended Noise Measurements – Background and Ambient Noise.

Location	Equivalent Continuous Noise Level $L_{Aeq,period}$, dB(A)			Background Noise Level RBL, dB(A)		
	Day	Evening	Night	Day	Evening	Night
L1 – 4th to 14th June 2019	67	66	62	64	61	55
L1 – 20th to 27th June 2019	65	64	61	62	60	54
L2 – 4th to 14th June 2019	63	63	61	58	62	58
L2 – 20th to 30th June 2019	63	61	59	62	59	56

Note: The time periods are defined as: day 7am-6pm, evening 6pm-10pm, night 10pm-7am.

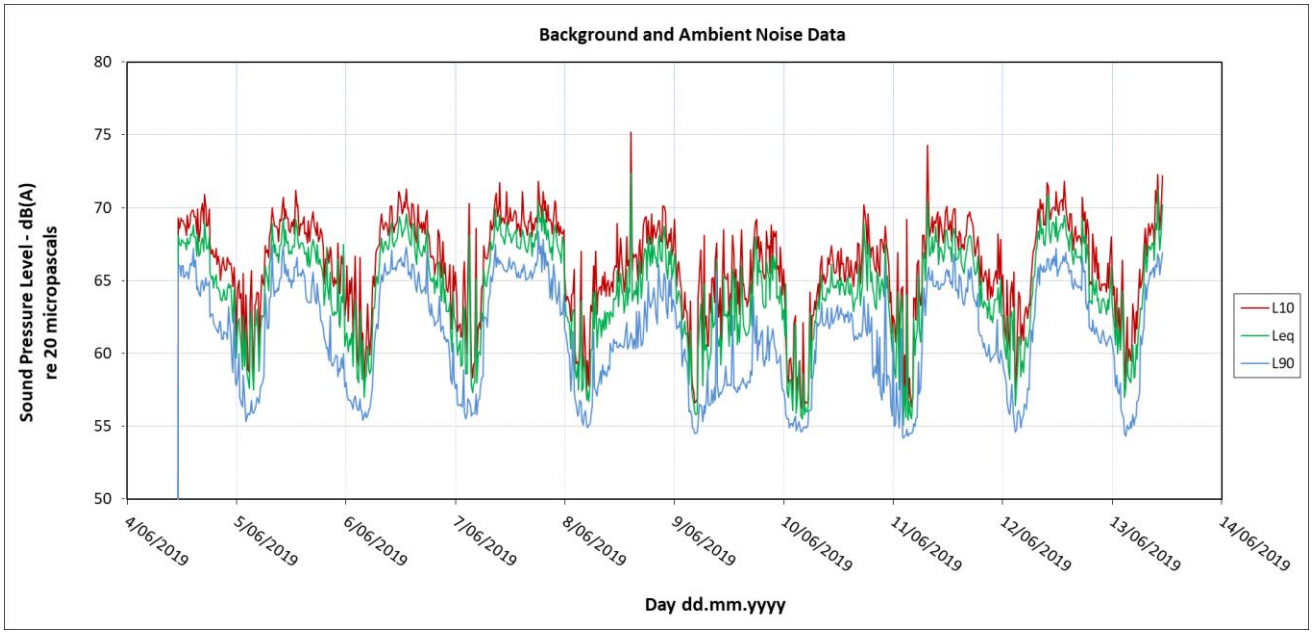


Figure 3: Unattended Noise Monitor Data (04/06/2019 – 14/06/2019) – L1.

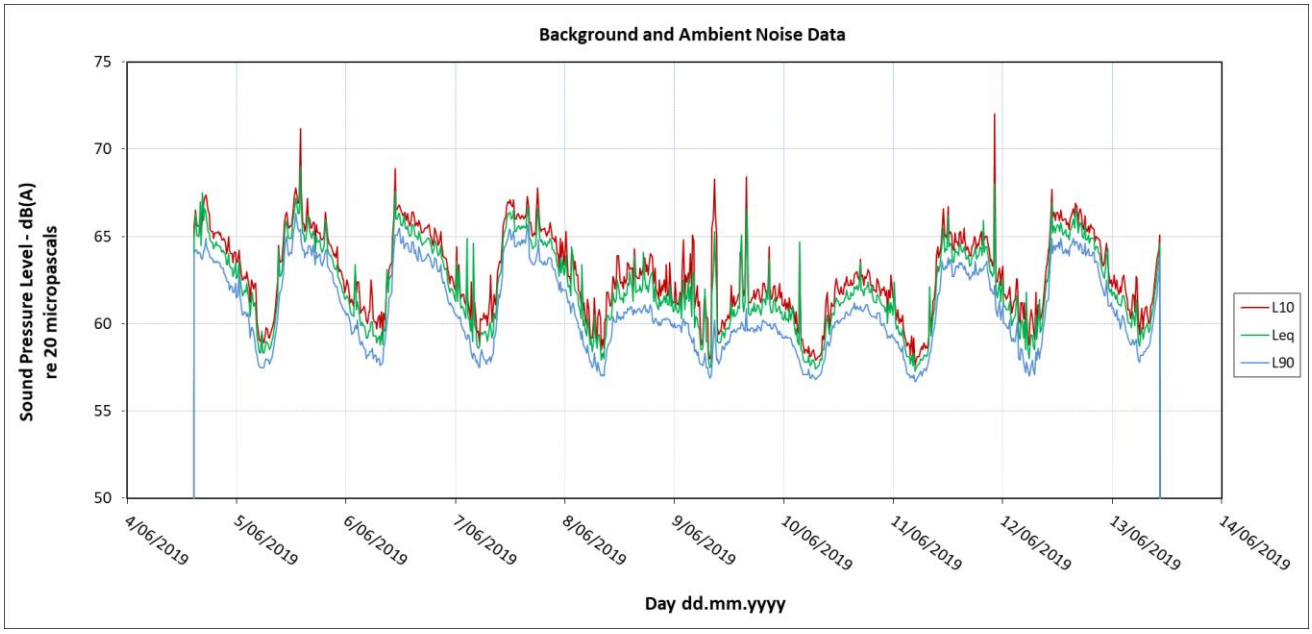


Figure 4: Unattended Noise Monitor Data (04/06/2019 – 14/06/2019) – L2.

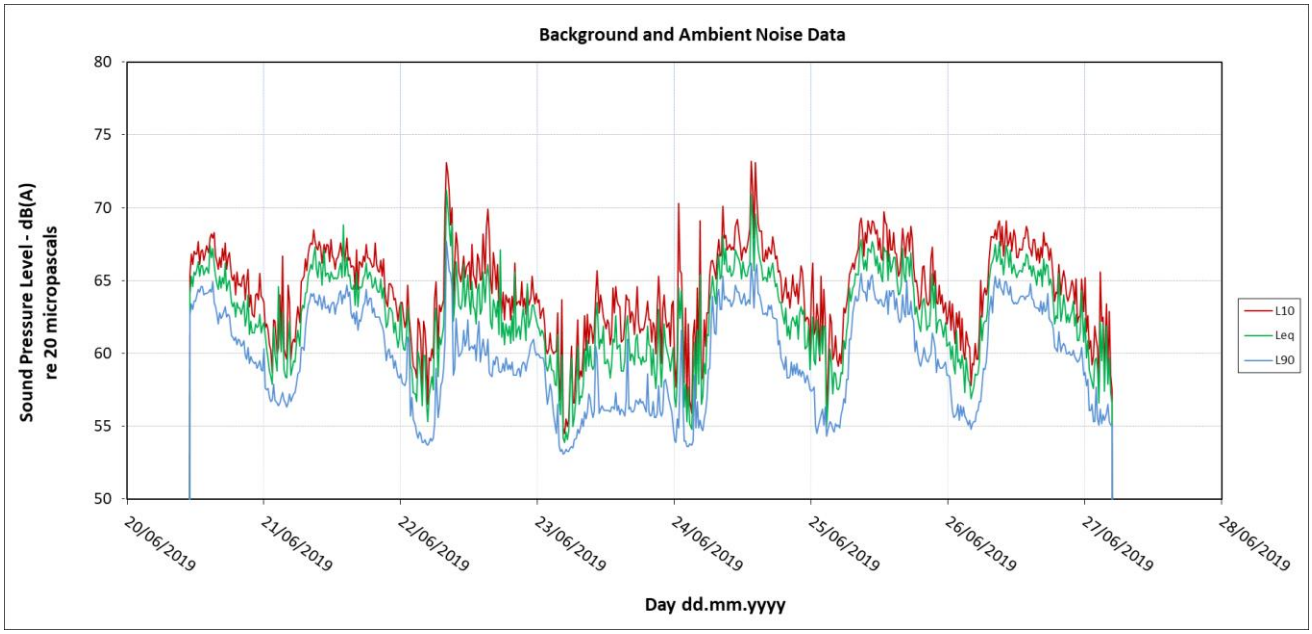


Figure 5: Unattended Noise Monitor Data (20/06/2019 – 27/06/2019)– L1.

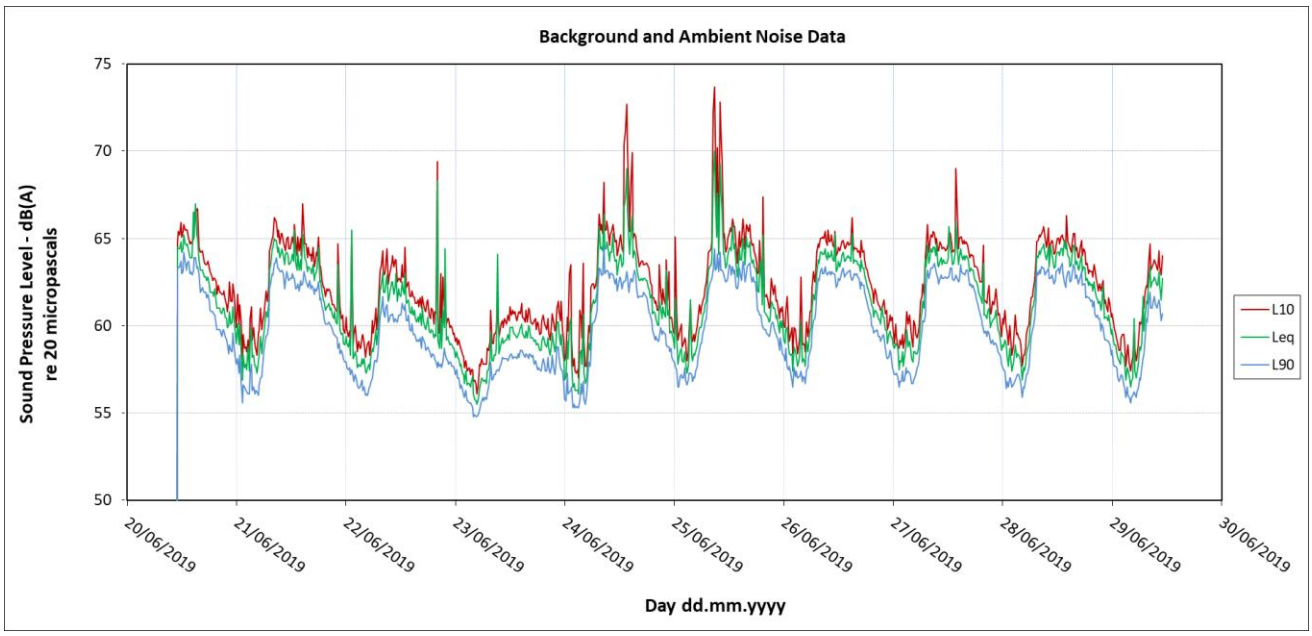


Figure 6: Unattended Noise Monitor Data (20/06/2019 – 30/06/2019)– L2.

The local ambient noise environment is typically that of an urban environment, traffic noise being the dominant and constant source of noise. Nearby construction related activities are also likely to have contributed to the measured noise levels, mainly in the form of occasional truck movements. Additionally, there are several large plant on the rooftops of the surrounding buildings.

The noise levels are relatively constant during the day and gradually decrease in the evening. The quietest period during the night typically lasts from midnight to approximately 6am. The difference between daytime and quietest night time noise levels is approximately 10dB near street level and 5dB on the rooftop level.

6. Acoustic Criteria

6.1 Construction Noise Criteria

6.1.1 Airborne Noise

The *Interim Construction Noise Guideline* (ICNG) by NSW DECC recommends the following standard hours of construction:

- Monday to Friday: 7am to 6pm
- Saturday: 8am to 1pm
- Sunday and public holidays: no work

In this report, it is assumed that all works are performed during these standard hours.

The noise criteria associated with construction and its related activities are shown in Table 2 for residences, as presented in Section 4.1.1 Table 2 of the ICNG.

Table 2: Construction Noise Criteria at Residences.

Time of Day	Management Level $L_{Aeq,15min}$	How to Apply
Recommended Standard Hours:	Noise Affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq,15min}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residences of the nature of works to be carried out, the expected noise levels and duration as well as contact details.
	Highly Noise Affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur in, taking into account: 1. Times identified by the community when they are less sensitive to noise (such as before and after school, for works near schools, or mid-morning or mid-afternoon for works near residences) 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside Recommended Standard Hours	Noise Affected RBL + 5dB	• 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 noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2. of the ICNG

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

Table 3 below (Section 4.1.3 of the ICNG) sets out the noise management levels for other land uses, including commercial premises. The external noise levels should be assessed at the most affected occupied point for commercial and industrial uses.

However, for other noise-sensitive receivers (e.g. hotels), the guideline recommends the 'maximum' internal noise levels recommended in Australian/New Zealand Standard AS/NZS 2107:2000 *Acoustics—Recommended design sound levels and reverberation times for building interiors* (AS2107:2000), in determining relevant noise levels.

Table 3: Construction Noise Criteria for Other Land Uses.

Land Use	Noise Management Level, applies when land use is being utilized
Offices, retail outlets	External $L_{Aeq,15min}$ 70 dB(A)
Hotel	Internal $L_{Aeq,1hr}$ 35 dB(A)

Based on the criteria in the tables above, the following noise management levels in Table 3 should be applied to the noise sensitive receivers. These criteria apply to airborne noise emissions related to construction activity during the recommended standard hours only. Where internal noise levels cannot be measured, external noise levels may be used. A conservative estimate of the difference between internal and external noise levels is 10 dB for commercial buildings and 30 dB for the hotel near the site.

Table 4: Project Specific Construction Noise Management Levels

Receiver	Land Use	Noise Management Level (external), $L_{Aeq,15min}$	Highly Noise Affected Level, $L_{Aeq,15min}$
C1 o C4	Offices, retail outlets	70 dB(A)[1]	N/A
H1	Other sensitive receivers – Hotel (Sleeping areas)	65 dB(A) [1]	N/A

Note: 1- The management level for non-residential receivers, is not distinguished in ICNG as either noise affected, or Highly Noise affected. Therefore, a single Noise management Level is used for this receiver.

Some community reaction to noise levels above the Noise Management Levels in Table 4 is considered likely. However, noise levels exceeding the Highly Noise Affected level may trigger a strong community reaction to noise. Where the noise affected management level is predicted to be exceeded, the ICNG requires that all feasible and reasonable work practices be employed. Where it is predicted that the highly noise affected management level will be exceeded, respite periods may need to be considered.

6.1.2 Construction Traffic Noise Criteria

The noise impacts from traffic generation from the medical hotel development are assessed in accordance with the NSW 'Road Noise Policy' (NSW RNP), where the traffic is on public roads. The criterion (Table 5) divides land use developments into different categories and lists the respective criteria for each case. The category that is relevant to the proposed use of the site (traffic generated by land use developments) is shown below in Table 5.

Table 5: Table C1 from the NSW NPI – Modifying factor corrections

Road Category	Description	$L_{Aeq,\ (15\ hour)}$	$L_{Aeq,\ (9\ hour)}$
Freeway/ arterial/ sub-arterial roads	Existing residences affected by noise from redevelopment of existing local roads	55 (external)	50 (external)

If the traffic noise at the site is already in excess of the criteria noted above, the NSW RNP states that the primary objective is to reduce the existing noise level through feasible and reasonable measures to meet the criteria above. If this is not

achievable, for existing residences affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise should be limited to 2 dB above that of the corresponding 'no build option'.

6.1.3 Ground-Borne Noise

Ground-borne noise can be generated when vibration transmits through the ground and into a structure that has the possibility to radiate the vibration energy as noise into a space. If such works happen completely underground, the ground-borne noise impact can be greater than that from airborne noise.

In the ICNG, noise criteria for ground-borne noise are only given for residences to protect the acoustic amenity and sleep of the occupants. Consequently, the criteria focus on the evening and night periods and are thus not relevant for the proposed development, provided that the works only occur during standard construction hours.

6.2 Construction Vibration Criteria

6.2.1 Human Comfort – Continuous and Impulsive Vibration Criteria

Structural vibration in buildings can be detected by occupants and can affect them in many ways including reducing their quality of life and their working efficiency. Complaint levels from occupants of buildings subject to vibration depend upon their use of the building and the time of the day. The vibration emitted from construction works should be such that it does not exceed the maximum limits set out in the criteria presented in Table 6 and Table 7. The guide on preferred values for human comfort have been extracted from the NSW DEC *Assessing Vibration: A Technical Guideline* (2006). The criteria for continuous and impulsive vibration are summarized in Table 6.

Table 6: Criteria for Exposure to Continuous and Impulsive Vibration

Place	Time	Vibration Acceleration (m/s^2)			
		Preferred		Maximum	
Continuous Vibration		z axis	x and y axis	z axis	x and y axis
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices	Day or night-time	0.020	0.014	0.040	0.028
Impulsive Vibration		z axis	x and y axis	z axis	x and y axis
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices	Day or night-time	0.64	0.46	1.28	0.92

Disturbance caused by vibration will depend on its duration and its magnitude. This methodology of assessing intermittent vibration levels involves the calculation of a parameter called the Vibration Dose Value (VDV) which is used to evaluate the cumulative effects of intermittent vibration. The criteria applicable when considering periods of intermittent vibration are presented in Table 7.

Table 7: Acceptable Vibration Dose Values for Intermittent Vibration (1.75 m/s)

Location	Daytime		Night-time	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions, and places of worship	0.40	0.80	0.40	0.80

6.2.2 Cosmetic/Structural Damage – Vibration Criteria

Ground vibration criteria are defined in terms of levels of vibration emission from construction activities that will not cause cosmetic or structural damage to surrounding buildings or structures. It should be noted that human comfort criteria are

normally expressed in terms of acceleration whereas cosmetic/structural damage criteria are normally expressed in terms of velocity. The human comfort criteria are also often exceeded long before a risk of cosmetic/structural damage occurs.

Cosmetic and structural damage criteria are presented in German Standard DIN 4150-Part 3 *Structural vibration in buildings – Effects on structures* and British Standard BS 7385-2:1993 *Evaluation and Measurement for Vibration in Buildings*. The British Standard BS 7385-2:1993 establishes vibration values for buildings based on the lowest vibration levels above which damage has been credibly demonstrated. These values are evaluated to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as 95% probability of no effect. The aforementioned values are summarised in Table 8.

Table 8: Transient Vibration Guide Values for Cosmetic Damage – BS 7385-2:1993

Type of Building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures Industrial or light commercial type buildings	50mm/s	N/A
Unreinforced or light framed structures Residential or light commercial type buildings	15mm/s	20mm/s (50mm/s at 40Hz and above)

The BS 7385 Part 2-1993 state that the guide values in Table 8 relate to transient vibration which does not give rise to resonant responses in structures and to low-rise buildings. This standard recognises adjustments to the guide values in Table 8 depending on the type of activity and the vibration receiver. For construction activities involving intermittent vibration sources (i.e. rock breakers, piling rigs, vibratory rollers, excavators), guide values in Table 8 may need to be reduced by up to 50% as a conservative vibration damage screening levels.

It is understood that no heritage item that is considered structurally un-sound or sensitive is identified. The construction methodology, particularly during the excavation stage, must be designed to prevent any damage to structurally sensitive building. It should be noted that for structurally sensitive buildings (e.g. heritage buildings) a more conservative vibration target must be considered. The German DIN 4150.3 – *Effects of Vibration on Structures* recommends more stringent vibration levels for heritage buildings. This standard is to be used to assess potential vibration impacts at any sensitive heritage structures surrounding the project. indicates the vibration limits presented in DIN 4150-Part 3 for sensitive structures.

Table 9: Guideline Value of Vibration Velocity (vi) for Evaluating Effects of Short-Term Vibration – DIN 4150-Part 3

Line	Type of Structure	Vibration velocity, v_i, in mm/s			
		Foundation At a frequency of			Plane of floor of uppermost full storey
		Less than 10Hz	10 to 50Hz	50 to 100Hz *	All Frequencies
1	Structures that, because of their particular sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8
*For frequencies above 100Hz, at least the values specified in this column shall be applied.					

7. Construction Noise Assessment

7.1 Proposed Construction Activities

The proposed overall works related to building the proposed development will consist of three phases listed below, and are expected to occur over a period of 13 months for demolition and excavation and 31 months for new construction. In this assessment, the noise impact from the following structure related construction works are considered. The three phases are:

- Piling
- Concrete structures for podium and tower
- Installing façade elements

7.2 Construction Hours

The hours of work are expected to occur during '*Standard Hours'* as per ICNG:

- Monday to Friday: 7am to 6pm
- Saturday: 8am to 1pm
- Sunday and public holidays: no work

If construction hours outside the recommended Standard Hours are required, an assessment of noise outside of Standard Hours will be required.

7.3 Construction Evaluation Scenario

At this early stage, the construction plan and staging are not available. For the purpose of this assessment, the noise impact from the **worst-case** scenarios for both commercial and the hotel receivers are covered. This means construction works spread out across the site footprint, with parts of the works occurring concurrently.

7.4 Expected Construction Equipment

The noise sources likely to be associated with the structure works listed in the previous section of this report are presented in Table 10. The structure works have been divided into three stages to represent the works progressing at different heights as the structure becomes taller. The equipment noise levels have been extracted from AS 2436:2010 *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites*.

Table 10: Construction Equipment Noise Levels.

Stages	Equipment	Sound Power Level (each), dB(A)	Duration per 15min	Resulting SWL (each), dB(A)
Piling	1 x Pilling rig (operating in the middle of the site)	111	15	111
	1 x Truck	107	5	102
Structure – Low-rise	1 x Crane (diesel)	105	10	103
	4 x Powered hand tools (electric)	102	5	97
	1 x Line pump	113	15	113
	1 x Truck	107	15	107
Structure – Mid-rise (podium)	Crane (diesel)	105	10	103
	4 x Powered hand tools (electric)	102	5	97
	3 x Line pump (at GF, L5 and L10)	113	15	113
	1 x Truck	107	15	107
	1 x Hoist	95	10	93
Structure – High-rise (tower) & facade	1 x Crane (diesel), material lifting	105	10	103
	1 x Crane, jump form	105	10	103
	1 x Floor crane	102	10	100
	4 x Powered hand tools (electric)	102	5	97
	6 x Line pump (at GF, L5, L10, L15, L20 and L25)	113	15	113
	1 x Truck	107	15	107
	1 x Hoist	95	10	93

7.5 Noise Model

In order to assess the noise impact from the site during the various structure stages, a noise model was established in the commercial software SoundPLAN v8.2, which is a comprehensive software package for estimating noise impacts in varying situations. In the software, a 3D model of the site and its surroundings was constructed, including the nearby buildings and the construction plant and equipment as the relevant noise sources. Within the model, the effects of the environment (built and natural) on propagation of sound were taken into account to estimate the resulting noise effects on the surrounding noise sensitive receivers.

The noise model represents the reasonable worst-case periods of construction activities, meaning that all the equipment of each stage is operating simultaneously according to Table 10 during a 15-minute observation period. The assumptions that were made within the assessment include the following:

- The predicted noise levels represent the worst-case scenario for each receiver. Façades containing windows and/or balconies were considered.
- Due to the short distance between the site and the nearest sensitive receivers, the noise levels have been assessed at various heights in addition to ground level.
- An additional concrete pump is required every 16 metres of the tower from ground level to rooftop.
- Noise shielding provided by structures already built on site has not been taken into account.
- The predicted noise levels at the nearby sensitive receivers have been assessed with the acoustic recommendations as shown in Section 9 implemented. This includes erecting a solid barrier along the north-eastern and north-western site boundaries and using temporary barriers around concrete pumps at higher elevations.
- The noise levels have been assessed using neutral weather conditions.

The noise levels at the surrounding sensitive receivers have been based on the assumptions and aforementioned sound power levels of the equipment. The results of the predicted noise levels are presented in the following section.

7.6 Construction Noise Results

The predicted construction noise levels have been presented in Table 11 to Table 16 at each receiver location for the three structure stages respectively. Worst-case receiver height was assumed for each receiver.

Table 11: Predicted Noise Levels – Structure Piling (Ground Level).

ID	Receiver	Structure – Low-Rise			
		Predicted Noise Level $L_{eq,15min}$ dB(A)	Noise Management Level $L_{eq,15min}$ dB(A)	Noise Management Level Exceedance (dB)	Compliance
H1	Hotel	68	65	3	No
C1	Commercial	69	70	-	No
C2	Commercial	71	70	1	No
C3	Commercial	66	70	-	No
C4	Commercial	81	70	11	No

Table 12: Predicted Noise Levels – Structure Piling (Level 1).

ID	Receiver	Structure – Low-Rise			
		Predicted Noise Level $L_{eq,15min}$ dB(A)	Noise Management Level $L_{eq,15min}$ dB(A)	Noise Management Level Exceedance (dB)	Compliance
H1	Hotel	78	65	13	No
C1	Commercial	73	70	3	No
C2	Commercial	73	70	3	No
C3	Commercial	75	70	5	No
C4	Commercial	81	70	11	No

Table 13: Predicted Noise Levels – Structure Low-Rise (Ground Level).

ID	Receiver	Structure – Low-Rise			
		Predicted Noise Level $L_{eq,15min}$ dB(A)	Noise Management Level $L_{eq,15min}$ dB(A)	Noise Management Level Exceedance (dB)	Compliance
H1	Hotel	72	65	7	No
C1	Commercial	71	70	1	No
C2	Commercial	74	70	4	No
C3	Commercial	69	70	-	Yes
C4	Commercial	82	70	12	No

Table 14: Predicted Noise Levels – Structure Low-Rise (Level 1).

ID	Receiver	Structure – Low-Rise			
		Predicted Noise Level	Noise Management Level	Noise Management	Compliance

		$L_{eq,15min}$ dB(A)	$L_{eq,15min}$ dB(A)	Level Exceedance (dB)	
H1	Hotel	81.5	65	17	No
C1	Commercial	73.6	70	4	No
C2	Commercial	76.7	70	7	No
C3	Commercial	79.6	70	10	No
C4	Commercial	82	70	12	No

Table 15: Predicted Noise Levels – Structure Mid-Rise (Approx. Level 10).

		Structure – Mid-Rise			
ID	Receiver	Predicted Noise Level $L_{eq,15min}$ dB(A)	Noise Management Level $L_{eq,15min}$ dB(A)	Noise Management Level Exceedance (dB)	Compliance
H1	Hotel	78	65	13	No
C1	Commercial	77	70	7	No
C2	Commercial	78	70	8	No
C3	Commercial	77	70	7	No
C4	Commercial	80	70	10	No

Table 16: Predicted Noise Levels – Structure High-Rise & Façade (Approx. Level 17).

		Structure – High-Rise & Façade			
ID	Receiver	Predicted Noise Level $L_{eq,15min}$ dB(A)	Noise Management Level $L_{eq,15min}$ dB(A)	Noise Management Level Exceedance (dB)	Compliance
H1	Hotel	78	65	13	No
C1	Commercial	76	70	6	No
C2	Commercial	78	70	8	No
C3	Commercial	77 (at top floor)	70	7	No
C4	Commercial	80 (at top floor)	70	10	No

7.7 Discussion

Based on the results of this assessment, the following conclusions were made:

- Highest management level exceedances of 10-12dB are observed at C4 to the east of the site as some windows are overlooking the site directly and have no noise shielding.
- The noise impact on C1 to C3 is estimated to be the same across the structure stages.
- The impact on H1 and C4 slightly decreases as the building becomes taller and works spread out more evenly over height.
- The management level exceedances during the different stages vary in the range of 0-13dB during the pilling stage, 0-17dB during the low-rise stage, 7-13dB during the mid-rise stage and 6-13dB during the high-rise stage at typical worst-case assessment locations.

The proposed construction activities have the potential to have adverse noise impacts at the identified receivers based on the expected noise levels with the acoustic recommendations provided in Section 9 adopted. Therefore, efforts should be made on site to assist in reducing the overall noise emissions on site, as per the recommendations in 9.4. Once the builder is appointed and detailed construction methodology and schedule of equipment is available, a detailed CNVMP will be required to be prepared.

8. Construction Vibration Assessment

During the Structure phase, only piling works are identified as vibration intensive works and assessed further in this report. Generated vibration levels due to pilling works are expected to be significantly lower than equipment typically used excavation and demolition works. On this basis, the risks of structure damage to the surrounding buildings and human response due to the pilling works are expected to be significantly lower than those during the demolition and excavation phases of the project. Vibration impacts during the Demolition and Excavation phases are not addressed in this report as these periods are subject to a separate development application.

Indicative 'Safe working' distances for the equipment likely to be used during the pilling works are provided in Table 17. At distances beyond the Safe working distances, the applicable targets are unlikely to be exceeded.

Table 17: Recommended safe working distances for vibration intensive plant

Plant Item	Safe Working Distance (metres)		
	Cosmetic Damage (BS 7385)		Human Response (OH&E Vibration Guideline)
	Non-sensitive structures	Sensitive structures	
Bored piling[1]	2	5	1

Notes: 1- NSW's *Construction Noise Strategy* (2013)

At this early stage the exact location of the piles are not finalised. However, it is unlikely that the pilling works will be proposed to occur within 2m of non-sensitive structures. Therefore, human discomfort and structure damage due to the vibration emission associated with the Structure phase is unlikely.

If pilling works are proposed to occur within 5m of any sensitive structures, a detailed evaluation of vibration levels specific to the site, a review of the schedule of equipment and the location of each specific item of equipment is recommended to ascertain the impact of construction activities and ensure that vibration levels remain below the levels at which cosmetic damage to the building. In this case, vibration monitoring at this location based on the detailed evaluation of vibration is recommended.

Where vibration-intensive activities are proposed to be conducted within the Safe Working distances, site measurements and alternative equipment or methodologies should be considered as per the recommendations in Section9.1.2. Moreover, once the builder is appointed and a detailed construction methodology and schedule of the equipment are available, a detailed vibration assessment and management plan will be required to be prepared. Vibration guidelines, mitigation and recommendations in this report should be reviewed as part of the detailed vibration management plan.

9. Noise & Vibration Management Strategies

9.1 Project-Specific Recommendations

9.1.1 Noise

Project specific recommendations and required mitigation methods have been listed below. For further noise and vibration mitigation and management measures refer to Section 9.2 in order to comply with the standards outlined in this report.

The concrete pumps located at various levels during concrete pouring are predicted to produce the highest noise levels during the structure stages. Methods should be sought to manage the noise emanating from the construction site to the surrounding most affected sensitive receivers, being the commercial receivers at C1 to C4 and a hotel at H1, see Figure 2.

A 2.5-metre high sound attenuating barrier should be erected at least along the north-eastern and north-western boundaries during all stages, as indicated in Figure 7. This barrier would provide noise shielding to street level receivers. The construction of the barrier should be impervious of gaps and cracks, which would compromise its performance, and it should be comprised of acoustically suitable materials such as 17mm thick plywood. The barrier is able to reduce the noise levels experienced at street level by 1-5dB depending on the exact observation point. Locating site amenities on top of the barrier further increases its effective height and shielding capability.

Due to the concrete pumps at higher levels being significant sources of noise, temporary min. 1.5-metre high noise barriers or acoustic enclosures surrounding the pumps should be installed for the duration of concrete pouring. Existing building structures can also be used for the purpose. Noise reductions of 1-4dB can be achieved at the most-affected receivers by enclosing all the additional pumps. The ground level pump and concrete truck should be located within the site, behind the ground level noise barrier. In addition to the sound attenuating barriers, at least one respite period 12:00pm – 1:00pm should be offered per day during the most intensive periods of concrete pouring. Frequent and proactive communication with the commercial tenants and the hotel is also encouraged, thus enabling tuning the works schedule to accommodate possible important business meetings or hotel guests and allowing the tenants to prepare their expectations on the changing noise environment. More details regarding communication with the community can be found in Section 9.3.

Source: nearmap.com

Figure 7: Acoustic Barrier Location

9.1.2 Vibration

If pilling works are proposed to occur within 5m of any sensitive structures, there may be exceedances of the cosmetic damage criteria. Prior to the use of the vibration generating equipment identified in this report, or other equipment not yet identified, attended vibration measurements during their early use should be conducted to determine if there is an exceedance of the vibration limits set out in this report.

Real-time attended vibration measurements for relevant equipment should be carried out by a suitably qualified acoustic and vibration engineer to:

- Review the implementation of this document, including the mitigation and management measures;
- Determine *'Compliance'* distances specific to the particular equipment and local geotechnical conditions;

Additionally, long-term vibration monitoring should be undertaken to ensure acceptable levels of vibration are satisfied during the use of the identified vibration intensive equipment as per vibration limits set out in this report.

9.2 General Acoustic Recommendations for Construction

According to AS 2436 – 2010 *Guide to noise and vibration control on construction, demolition and maintenance sites* the following techniques could be applied to minimise the spread of noise and vibrations to the potential receivers.

9.2.1 Noise

Figure 8 demonstrates the preferred order of actions taken to mitigate excessive construction noise emissions. If a process that generates significant noise levels cannot be avoided, the amount of noise reaching the receiver should be minimised. Two ways of achieving this are to either increase the distance between the noise source and the receiver or to introduce noise reduction measures such as screens. Practices that will reduce noise from the site include:

a. Increasing the distance between noise sources and sensitive receivers.

b. Reducing the line-of-sight noise transmission to residences or other sensitive land uses using temporary barriers (stockpiles, shipping containers and site office demountables can be effective barriers).

c. Constructing barriers that are part of the project design early in the project to introduce the mitigation of site noise.

d. Installing purpose-built noise barriers, acoustic sheds and enclosures.

Physical methods to reduce the transmission of noise between the site works and residences, or other sensitive land uses, are generally suited to works where there is longer-term exposure to the noise. A few of these methods have been introduced below.

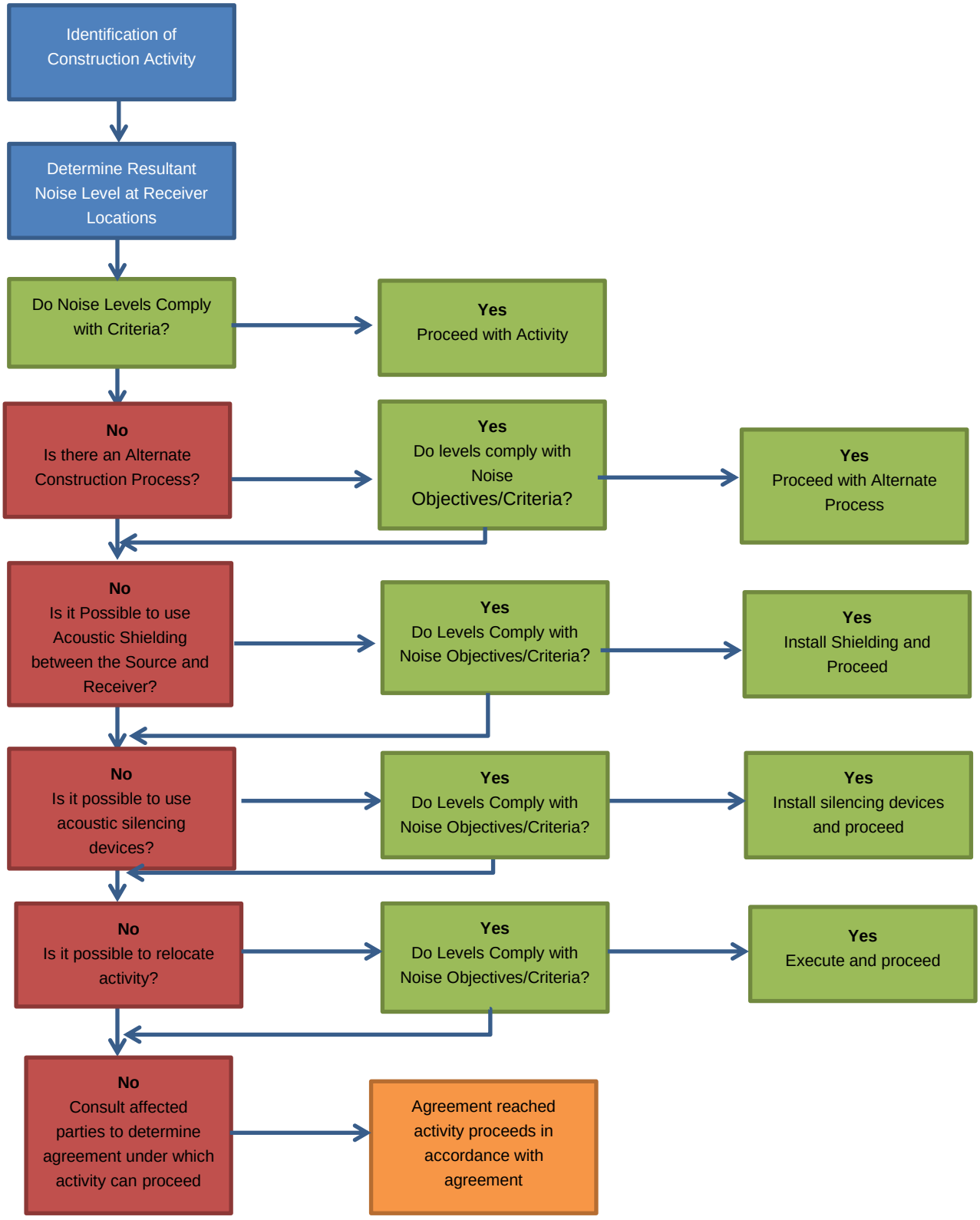


Figure 8: Noise Mitigation Management Flow Chart.

Screening

On sites where distance is limited, screening of noise may be beneficial or even the only way to reduce construction noise impacts on the nearby receivers. Below, screening options for various situations have been introduced. Constructing and utilising these screening methods should be taken into account already during the planning stages.

Temporary buildings: One option to introduce screening is to position structures such as stores, storage piles, site offices and other temporary buildings between the noisiest part of the site and the nearest sensitive receivers. Due to shielding provided by these buildings, some of the noise emission from the site can be reduced. If the buildings are occupied, however, sound insulation measures may be necessary to protect site workers inside the buildings.

Hoarding: Another way of implementing screening is to build hoarding that includes a site office on an elevated structure. This option offers superior noise reduction when compared with a standard, simple hoarding. The acoustic performance is further enhanced when the hoarding is a continuous barrier.

Partial building structures: On some sites, partially completed or demolished buildings can be used as noise shields for certain equipment. A noisy, stationary plant can be placed in a basement, the shell of which has been completed, provided reverberant noise can be controlled. Where compressors or generators are used in closed areas, it is also necessary to ensure that the exhaust gases are discharged directly to the outside air and that there is good cross-ventilation to prevent the build-up of poisonous carbon monoxide fumes and to allow an adequate air supply to maintain efficiency when operating the equipment.

Earth mounds and embankments: Where constructing noise barriers and using partial building shells is not practical, a worthwhile reduction in noise can be obtained by siting the plant behind and as close as possible to mounds of earth, which may effectively screen any noise sensitive areas from the plant. These mounds can often be designed into the construction schedule or site arrangement for future landscaping.

Long, temporary earth embankments can provide quite an effective noise screen for mobile equipment moving, for example, on a haulage road. When the earthworks are complete, the earth mounds should be removed, if possible, with smaller quieter excavators. A noise barrier like this may be a more reliable method of noise control than the imposition of restrictions on throttle settings.

Where earth noise barriers are not practical due to lack of space, consideration should be given to the possibility of constructing temporary screens from wood or any equivalent material in surface density.

Equipment operating 24h: When it comes to water pumps, fans and other plant equipment that operate on a 24-hour basis, they may not be an irritating source of noise during the day but can be problematic at night. They should therefore be effectively screened by either situating them behind a noise barrier or by being positioned in a trench or a hollow in the ground. Again, generated reverberant noise must be minimised and adequate ventilation should be ensured.

General remarks:

In many cases, it is not practical to screen earthmoving operations effectively, but it may be possible to partially shield a construction plant at the early stages of the project with protective features required to screen traffic noise.

The usefulness of a noise barrier will depend upon its length, its height, its position relative to the source and the receiver, and the material of which it is made. A barrier designed to reduce noise from a moving source should extend beyond the last property to be protected by at least ten times the shortest distance from the said property to the barrier. A barrier designed to reduce noise from a stationary source should, where possible, extend beyond the direct line of sight between the noise source and the receiver by a distance equal to ten times the effective barrier height, which is the height above the direct line between the source and receiver.

If the works are already predominantly located within nominally closed structures, careful consideration should be given to reducing noise breakout at any openings.

Crane (diesel operated)

An appropriate silencer on the muffler and acoustic screen around the engine bay are recommended to attenuate the noise from the machine.

Reversing and warning alarms

Community complaints often involve the intrusive noise of alarms commonly used to provide a safe system of work for vehicles operating on a site. Beeper reversing alarm noise is generally tonal and may cause annoyance at significant distances from the work site.

There are alternative warning alarms capable of providing a safe system of work that are equal to or better than the traditional "beeper", while also reducing environmental noise impacts. The following alternatives should be considered for use on construction sites as appropriate:

e. Broadband audible alarms incorporating a wide range of sound frequencies (as opposed to the tonal-frequency 'beep') are less intrusive when heard in the neighbourhood.

f. Variable-level alarms reduce the emitted noise levels by detecting the background noise level and adjusting the alarm level accordingly.

g. Non-audible warning systems (e.g. flashing lights, reversing cameras) may also be employed, provided that safety considerations are not compromised.

h. Proximity alarms that use sensors to determine the distance from objects, such as people or structures, and generate an audible alarm in cabin for the driver.

i. Spotters or observers.

The above methods should be combined, where appropriate.

9.2.2 Vibration

Below, vibration impacts from construction works and their mitigation methods are discussed at a general level. As this report only considers the structure period of the works related to the proposed development and no vibration intensive activities are expected to occur, this section is mainly provided for information.

Vibration can be more difficult to control than noise, and there are few generalisations that can be made about its control. It should be kept in mind that vibration may cause disturbance by causing structures to vibrate and radiate noise in addition to perceptible movement. Impulsive vibration can, in some cases, provide a trigger mechanism that could result in the failure of building components that had previously been in a stable state. Vibrations can also trigger annoyance, which might get elevated into action by occupants of exposed buildings and should therefore be included in the planning of communication with impacted communities.

It should be remembered that failures, sometimes catastrophic, can occur as a result of conditions not directly connected with the transmission of vibrations, e.g. the removal of supports from retaining structures to facilitate site access. BS 7385-2 provides more information on managing ground-borne vibration and its potential effects on buildings. Where site activities may affect existing structures, a thorough engineering appraisal should be made at the planning stage.

General principles of seeking minimal vibration at receiving structures should be followed in the first instance. Predictions of vibration levels likely to occur at sensitive receivers are recommended when they are relatively close, depending on the magnitude of the source of the vibration or the distance associated. Relatively simple prediction methods are available in textbooks, codes of practice and standards, however, it is preferable to assess site transmission and propagation characteristics between source and receiver locations through measurements.

Guidance for measures available for the mitigation of vibration transmitted can be sought in more detailed standards, such as BS 5228-2 or policy documents, such as the NSW DEC *Assessing Vibration: A Technical Guideline*. Identifying the strategy best suited to the control of vibration follows a similar approach to that of noise: avoidance, control at the source, control along the propagation path, control at the receiver, or a combination of these.

It is noted that vibration sources can include stationary plants (pumps and compressors), portable plants (jackhammers and pavement vibrators), mobile plants, pile-drivers, tunnelling machines and activities, and blasting, amongst others. Unusual ground conditions, such as a high water-table, can also cause a difference to expected or predicted results, especially when considering the noise propagated from piling.

9.3 Complaint Handling Procedures and Community Liaison

It is recommended that the builder directly contact adjacent noise sensitive receivers and provide them with the following information:

a. The contact details for a nominated representative in order to make noise / vibration complaints.

b. Explain the timeframe for the construction works and the proposed activities, i.e. the proposed start / stop dates of work and a description of the noise producing equipment that will be used.

c. Notify the noise sensitive receivers and City of Sydney in a timely manner should there be any need for an extension to the proposed arrangements.

d. Provide them with a copy of this report as approved by the NSW DPIE.

e. City of Sydney should be notified of the nature and details of complaints received (time, complainant etc.) and what remedial action has taken place, if any.

f. Where noise is demonstrated as being compliant with criteria, this should not limit the proponent in undertaking further additional reasonable and feasible steps to reduce noise emissions.

To assist in the management of noise and vibration complaints various procedures are to be followed. These include:

- Clearly visible signage identifying any key personnel along with their contact details to be erected along the perimeter of the building site including;
  - A 24 hour contact name, phone number and email address provided for the resident to address any complaint. The signage will declare; “For any enquiry, complaint or emergency relating to this site at any time please contact…”
- Give complaints a fair hearing.
- Have a documented complaints process, including an escalation procedure so that if a complaint is not satisfied there is a clear path to follow.
- Call back as soon as possible to keep people informed of action to be taken to address noise problems. Call back at night time only if requested by the complainant to avoid further disturbance.
- Implement all feasible and reasonable measures to address the source of the complaint.
- A register is to be kept by the contractor to keep a record of complaints and detail any information associated with them. The contents of the register will include:
  - The name and the address of the complainant
  - Time and date of the complaint
  - The nature of the complaint (Noise/Vibration)
  - Subsequent details
  - Remedial action undertaken

The contents of the register will be maintained and updated with any new complaint without delay. The complaints will be reported to both City of Sydney and the Contractor. The investigation of the complaint and any remedial actions will be performed by the builder and/or client representative.

In the event of noisy works scheduled, the builder will notify residents 5 business days in advance.

9.4 Noise & Vibration Monitoring Strategy

9.4.1 General Methodology

Noise and vibration levels should be monitored from time to time to ensure that noise generated as a result of remediation and construction activities does not disturb local businesses and residents.

Monitoring may be in the form of regular checks by the builder or indirectly by an acoustic consultant engaged by the builder and in response to any noise or vibration complaints. Where noise and vibration criteria are being exceeded or in response to valid complaints, noise and / or vibration monitoring should be undertaken. This would be performed inside the premises of the affected property and on site adjacent to the affected receivers.

Monitoring is to be undertaken by an experienced noise and vibration monitoring professional or an acoustic consultant. The results of any noise or vibration monitoring are to be provided to the relevant party or person in a timely manner allowing the builder to address the issue and respond to the complaints.

Noise and vibration monitoring can take two forms:

1. Short-term monitoring
2. Long-term monitoring

Both of these approaches are elaborated below.

Short-term monitoring

Short-term monitoring consists of attended monitoring when critical stages of the construction are occurring. This normally provides real-time assistance and guidance to the subcontractor on site, telling them when the noise and vibration criteria are exceeded. Thus, the selection of alternative method on construction or equipment selection is allowed in order to minimise noise and vibration impacts.

Long-term monitoring

Similarly to short-term monitoring, long-term monitoring provides real-time alerts to the builder / site manager when the noise and vibration criteria are exceeded. Instead of someone being on site measuring, noise and vibration loggers are used.

Typically, the noise and vibration loggers stay on site for a period of several months for the critical construction stages of the project. Sometimes the period of construction noise and vibration monitoring is dictated by the local authorities through the DA conditions.

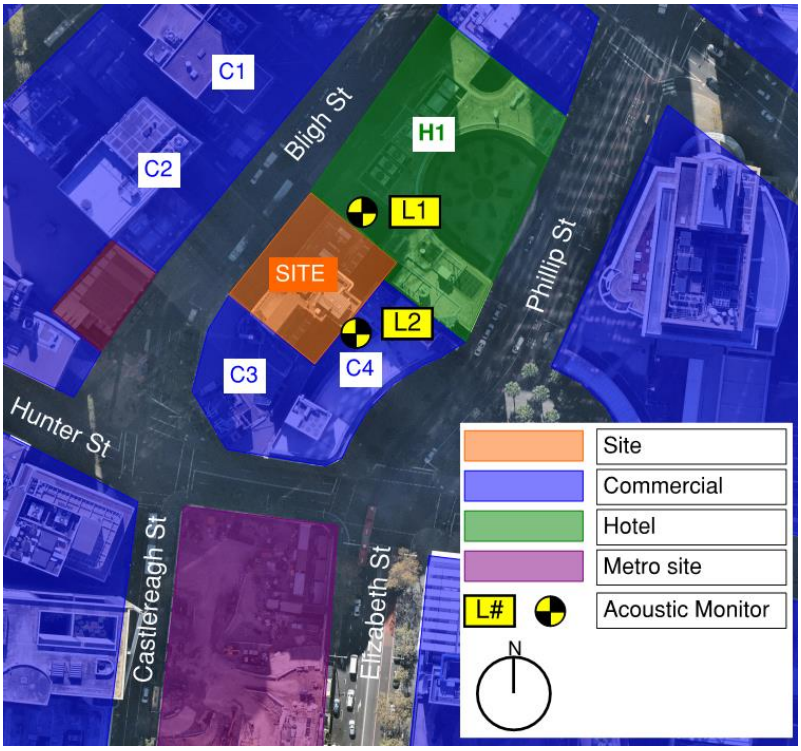
Both methodologies are complementary and normally used simultaneously providing a significant amount of data via the long-term monitoring, but also providing information on the sources of noise and vibration generating exceedances via the short-term or attended monitoring.

9.4.2 Noise & Vibration Monitoring Program

The following monitoring program is proposed for this project. Refer to Figure 9 for the approximate monitoring locations:

1. Unattended noise monitor installed at H1 and C3 / C4 during all structure stages, at least for a time period representing the average works.
2. Attended noise and vibration monitoring at the start of new work phases likely to result in an adverse change in the noise emissions, and in the case of complaints.

The monitoring programme as shown above is to be carried out during the likely noisiest stages as agreed with the Acoustic engineer and Contractor. The final monitoring locations are subject to agreement with the relevant stakeholders associated with the surrounding receivers.



Source: nearmap.com

Figure 9: Proposed Noise and Vibration Monitoring Locations.

If pilling works are proposed to occur within 5m of any sensitive structures, unattended vibration monitoring is required to record and notify if the cosmetic damage criteria was exceeded.

Note: once the builder is appointed and a detailed construction methodology and schedule of the equipment are available, a detailed vibration assessment and management plan will be required to be prepared. Vibration guidelines, mitigation and recommendations in this report should be reviewed as part of the detailed vibration management plan. As such, other equipment not identified in this report may require short-term or long-term vibration monitoring.

10. Conclusion

A Construction Noise and Vibration Management Plan has been provided for the construction works to be conducted at 4-6 Bligh St, Sydney. Reasonable and feasible mitigation methods have been provided to limit the noise and vibration impacts on the nearest sensitive receivers during the structure period as described in this report.

The details of the noise and vibration assessments undertaken to predict the impacts on sensitive receivers have been presented in Sections 7 and 8. As shown in Section 7.6, the noise levels are expected to exceed the noise management levels by 4-11dB during the standard hours of construction at the nearby commercial receivers, whereas the noise levels at the hotel receiver are likely to exceed the management levels by 5-7dB.

As this report only considers the works related to the building structure, no vibration intensive activities are expected to be conducted during these stages. The vibration levels at the nearest sensitive receivers are thus estimated to comply with all the relevant criteria.

In order to reduce the noise and vibration impacts on the sensitive receivers, noise and vibration management strategies have been proposed in Section 9. Through the implementation of these proposed project-specific mitigation methods and all other feasible and reasonable methods to minimise the noise and vibration impacts, compliance with the requirements of the relevant regulations can be achieved despite the predicted noise impacts exceeding the corresponding management levels. The project-specific noise mitigation methods include erecting a 2.5-metre sound attenuating barrier along the north-eastern and north-western site borders along with temporary noise barriers around concrete pumps.

The information presented in this report shall be reviewed if any modifications to the features of the development specified in this report occur, including and not restricted to a selection of equipment/machinery and modifications to the early works construction program.

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