50-52 Phillip Street, Sydney

Acoustics Report

Concept State Significant Development Application

Prepared for: Built Development Group Pty Ltd

Attention: Aston Weber

Date: 3 December 2020

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Stantec

Revision

Revision	Date	Comment	Prepared By	Approved By
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1. Executive Summary

This noise and vibration impact assessment has been prepared by Stantec (Australia) Pty Ltd to accompany a detailed State significant development (SSD) development application (DA) for the refurbishment of 50-52 Phillip Street, Sydney development located within the Sydney Central Business district (CBD).

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

This report concludes that the proposed refurbishment of 50-52 Phillip Street, Sydney is suitable and warrants approval subject to the implementation of the following measures moving forward:

- Detailed noise modelling and investigation of traffic noise emissions and impacts on the façade of the proposed development. This will determine whether any acoustically rated glazing, together with alternative means of natural ventilation is required to the residential spaces.
- Noise propagation modelling of building services plant and equipment to determine compliance with the NSW EPA NPI. Once plant and equipment selections have been made, this assessment should be conducted for the Detailed SSDA.
- An in-detail noise emissions model should be conducted for the Level 36 Terrace once the arrangement of the terrace, potential number of occupants and any other shielding structures have been nominated. An initial assessment of this terrace concluded the noise emissions would comply with the relevant noise criteria.
- A construction noise and vibration assessment has been conducted, with in-principle noise and vibration mitigation measures proposed. A detailed assessment should be conducted once the construction methodology has been established (for the Detailed SSDA).

Following the implementation of the above measures, the remaining impacts are appropriate.

2. Introduction

This report supports a Stage 1 State Significant Development (SSD) Development Application (DA) for the redevelopment of a new mixed use hotel and branded residential building at 50-52 Phillip Street, Sydney. The Staged SSD DA proposes a concept proposal or Stage 1 DA for the retention and refurbishment of the heritage building on the site, demolition of other existing buildings on the site and construction of a new mixed use building. The Stage 1 SSD DA specifically seeks consent for land uses, a maximum gross floor area, a maximum building envelope, pedestrian and vehicle access and circulation arrangements, and associated car parking provision.

Built is seeking to transform the current site to deliver a new and modern mixed use development which contributes to overcoming a shortage of hotel accommodation in Sydney, and positively contributes to the character and vibrancy of Sydney's Central Business District (CBD). As part of the redevelopment project, the existing heritage listed building on the site will be retained and refurbished for hotel purposes.

As the proposal is for the development of a predominately tourist related purpose, being a hotel, that has a capital investment value in excess of $100 million, it is SSD as prescribed in Schedule 1 of *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP).

The site is located in Central Sydney, along the eastern edge of Sydney's core Central Business District (CBD). The immediate surrounds of the site in the eastern edge of the Sydney CBD present a mix of commercial, residential, and tourism uses. The prevailing built form in the vicinity of the site includes a range of building typologies and heights, as well as several significant state-listed heritage buildings, such as the Chief Secretary's Building immediately to the north of the site.

The site itself is located at 50-52 Phillip Street, Sydney and has a total area of approximately 1,726m^2, with frontages to Phillip Street and Phillip Lane. Two commercial buildings sharing a built-to-boundary condition currently occupy the site. The heritage-listed sandstone building in the northern portion of the site is six generous storeys in height and contains commercial office space. The building located on the southern portion of the site is 12 storeys in height, and contains a ground level café/bar use, with commercial office space above.

Phillip Lane, which forms part of the 50 Phillip Street lot, connects through the site from Phillip Street at the northern boundary of the site. Phillip Lane is not proposed to be altered from its current form as an access point to the remainder of Phillip Lane at the rear of the site.

An aerial image of the site is provided at **Figure 1** and a photograph of the existing buildings fronting Phillip Street is provided at **Figure 2**.

Figure 1 **Aerial photograph of the Site**

Source: Nearmaps (edits by Ethos Urban)

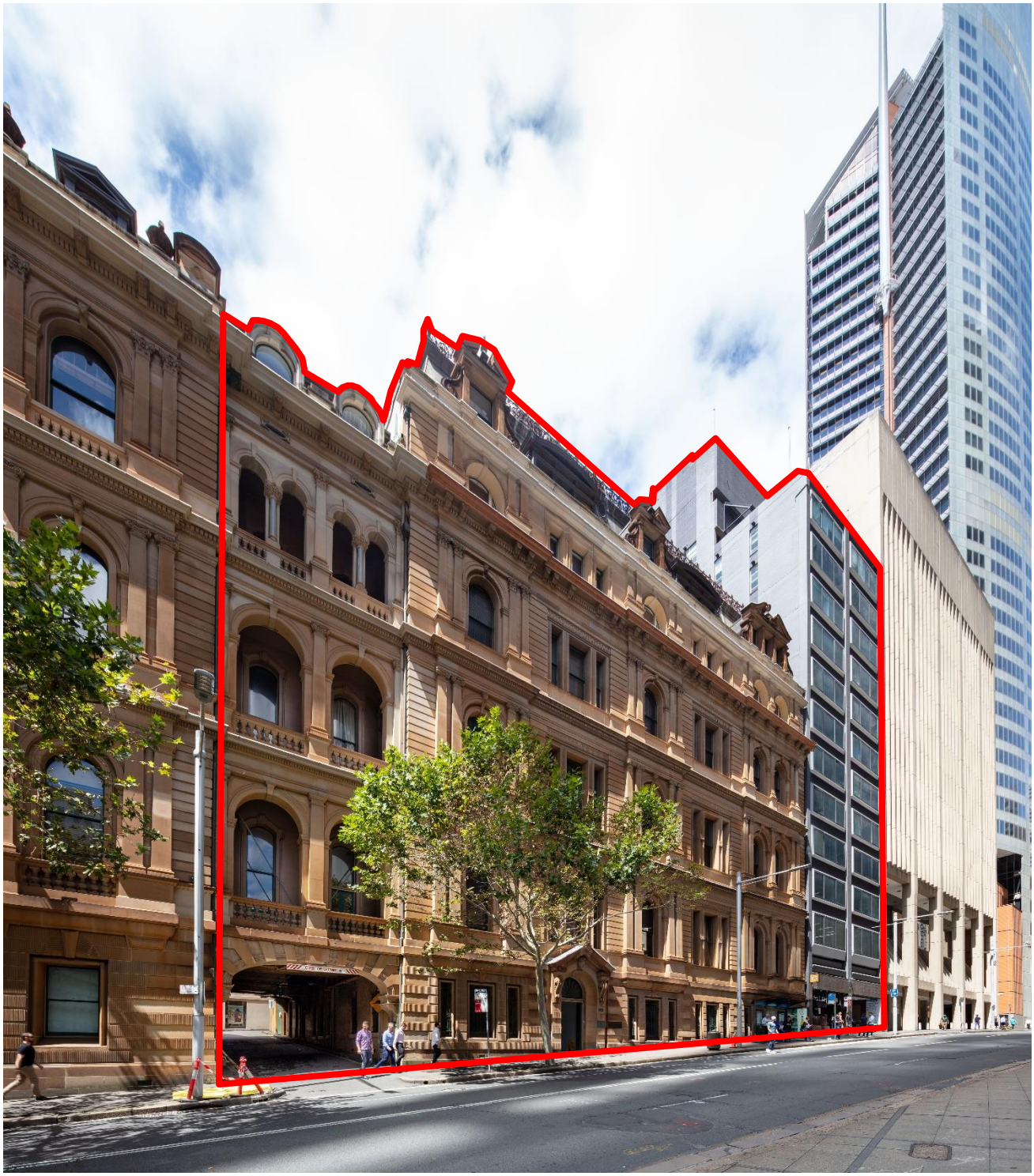


Figure 2 **Existing buildings fronting Phillip Street**

Source: Built

2.1 Sensitive Receivers

Due to the close proximity of different land uses surrounding the proposed development, Noise Catchment Areas (NCAs) have been established to identify the different receiver types that may be affected by the noise and vibration impacts of the proposed development. The appropriate criteria will be applied to the noise catchment areas depending on the receivers located withing the NCAs. This has been outlined in Table 1 below:

Table 1: Noise Catchment Areas (NCA) with applicable receiver types

Noise Catchment Area	Receiver type
NCA01	Commercial
	Hotel
NCA02	Commercial
NCA03	Commercial
	Hotel
	Residential

3. Background

3.1 Built Unsolicited Proposal

On 15 October 2019, the NSW Government published details of the Built Unsolicited Proposal for the leasehold purchase of 50 Phillip Street, Sydney to allow for the proposed hotel redevelopment. The Built proposal has progressed to Stage 2 of the Unsolicited Proposal process, and has been deemed unique as Built owns the adjacent property (52 Phillip Street, Sydney) to the Government owned 50 Phillip Street, Sydney. As there are no other privately owned properties immediately contiguous to 50 Phillip Street, Built possesses unique property ownership that enables it to amalgamate 50 and 52 Phillip Street, and take full advantage of the unused developable air space.

The proposed redevelopment project will combine both private and Government land, breathing new life into an underutilised heritage-listed NSW Government owned building and Built's aging privately-held commercial office building.

Built is well recognised for work in the refurbishment and restoration of iconic heritage properties across Australia. As such, a foremost principle of the project is to ensure that the integrity of the heritage listed Government building is not compromised. Rather, the heritage qualities of the building will be celebrated and revitalised for the people of NSW. The Chief Secretary's Building which fronts Bridge Street will not be leased as part of this redevelopment project, and it is intended to remain in Government ownership and control.

3.2 Project Vision

The vision for the redevelopment is to revitalise the lower end of Sydney's financial services district by delivering a new luxury mixed use hotel with a portion of branded residential apartments. The proposal will provide an important and much needed asset to the people of NSW and visitors. Sydney will have, as part of the amalgamation of the properties, its finest luxury hotel with associated retail areas providing ground floor public activation accessible to the general public and hotel guests alike.

Overall, the project will provide the following key public benefits:

- Job creation and benefits to the tourism industry from construction and operation of a new 5/6 star hotel in Central Sydney.
- Contribution to the NSW State's economic activity and Gross State Product, including the generation of construction phase revenue for the Government in the form of payroll tax, stamp duty and GST payments.
- Rejuvenation and adaptive reuse of a Government owned heritage building.
- Regeneration, enhancement and activation of the surrounding public domain, particularly upgrades to Phillip Lane.
- Creation of a heritage-tourism precinct with a new hotel as the centrepiece.
- A portion of branded residential apartments to support the deliver of the hotel and provide a variety of uses to contribute to the liveability of Central Sydney.
- The potential to deliver a capital return to Government to fund future Government investment in services and infrastructure.

4. Project Description

This SSD DA seeks consent for a concept proposal for a new landmark mixed use building with approximately 331 new hotel rooms and 23 branded residential apartments in Sydney's CBD. The Stage 1 SSD DA Concept Proposal will establish a maximum building envelope, land uses, a maximum total quantity of floor space, pedestrian, vehicle circulation, and drop-off arrangements and associated car parking provision.

Specifically, the Stage 1 SSD DA seeks concept approval for:

- In-principle site preparation works, including termination/relocation of site services and infrastructure, demolition of the existing buildings/structure on the site, excluding the existing heritage-listed building;
- A new 47 storey mixed use building envelope containing:
- lower level café/bar uses and associated servicing and back-of-house facilities;
- a new basement containing waste rooms, loading space, and car parking spaces;
- hotel uses on levels 1 to 35; and
- residential uses on levels 36 to 47.
- Retention of the existing heritage-listed building on the site, and refurbishment of this building for hotel purposes.
- A new driveway crossing over Phillip Street at the southern end of the site.
- Maintenance and retention of the existing vehicular access over Phillip Lane.

Development consent is not sought for any detailed component of development. A future separate Stage 2 SSD DA will be lodged for the detailed design and construction of the development, following the completion of a competitive design process.

A further detailed description of the proposal is contained in the supporting Environmental Impact Statement prepared for the SSD DA by Ethos Urban.

5. Methodology

To assess the noise and vibration impacts of the proposed development, the following process was carried out:

- Identify and classify the surrounding noise and vibration sensitive receivers surrounding the proposed development;
- Identify and classify the noise and vibration sources generated by the proposed development, together with external noise and vibration sources impacting on the proposed development;
- Review historical site noise investigations and carry out additional site noise investigations to quantify the background noise levels local to the proposed development;
- Determine the project noise and vibration criteria applicable to the proposed development in accordance with the requirements listed in the Secretary's Environmental Assessment Requirements (SEARs).
- Assess the operational and construction noise and vibration impacts of the noise and vibration sources generated by the proposed development to the surrounding noise-sensitive receivers together with any impacts on the occupants of the proposed development; and
- Provide details of mitigation measures required to alleviate noise and vibration impacts to achieve the project noise and vibration criteria.

The following operational noise and vibration assessments were conducted as part of this noise and vibration impact assessment:

- Noise impact from road and rail on the hotel accommodation.
- Noise and vibration impact of mechanical plant and equipment serving the proposed development on surrounding noise and vibration sensitive receivers;
- Noise impacts of additional traffic on surrounding local roads generated by the proposed development; and
- Noise impacts of additional traffic on surrounding local roads generated by the proposed development.

The following construction noise and vibration assessments were conducted as part of this noise and vibration impact assessment:

- Noise generated during the construction of the proposed development and associated impacts on the surrounding noise sensitive receivers; and
- Vibration generated during the construction of the proposed development and associated impacts on the surrounding vibration sensitive receivers.

6. Site Noise Investigations

Site surveys were undertaken to identify the existing noise environment. These site surveys have been conducted by Stantec Australia to obtain current background noise levels. Due to the noise being subdued as a result of the COVID-19 pandemic, Stantec Australia has used background noise levels previously taken of in the surrounding area as this is more representative of the current noise environment of the proposed development.

A glossary of acoustic terminology used throughout this report is included as Appendix A.

6.1 Location

Noise monitoring equipment was installed with consideration of other noise sources that may influence the measurements, accessibility and security, and with the consent of relevant landowners. The noise monitoring locations are presented in Figure 3.

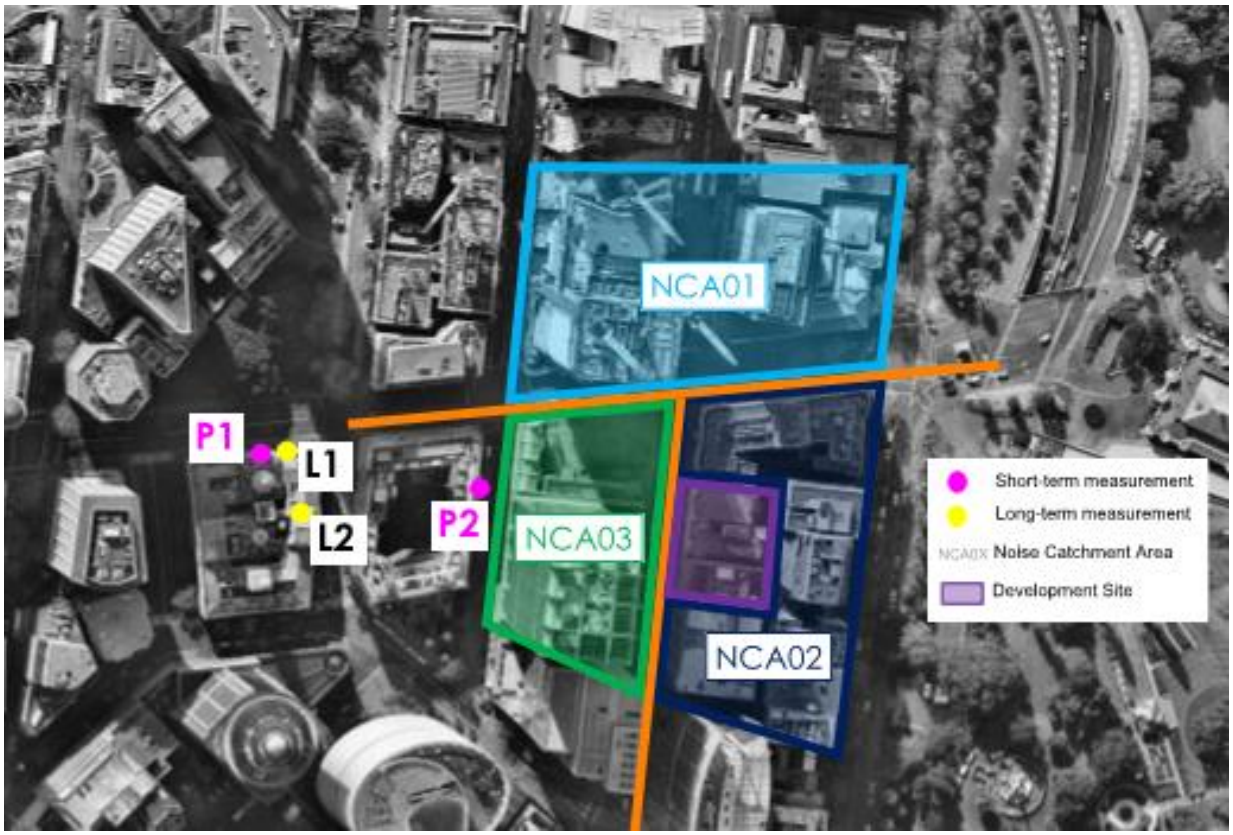


Figure 3: Overview of the Site and Measurements Location

6.2 Long-term (Unattended) Noise Surveys

Due to the current noise environment being subdued caused by the current COVID-19 pandemic, the results of a previous noise survey, that was taken between the 8th of June 2016 to the 24th of June 2016, are outlined in Table 2 below. These results are to be used as this is more representative of the current noise environment of the proposed development.

The background and traffic noise measurements conducted in 2016 should be higher than measurements conducted at the point in time of this submission due to a reduced traffic volume.

An ARL Rion Noise Environmental Logger Type EL-215 was used for the unattended noise surveys were used for this investigation.

Table 2: Long-term (Unattended) Noise Survey Locations

Noise Monitoring Location ID	Noise Monitoring Location Address	Equipment Serial Number
L1	Bridge Street, Sydney	194677
L2	Loftus Street	194560

6.2.1 Background Noise

The results of the unattended background and ambient noise survey is shown in Table 6 below (for the day, evening and night periods).

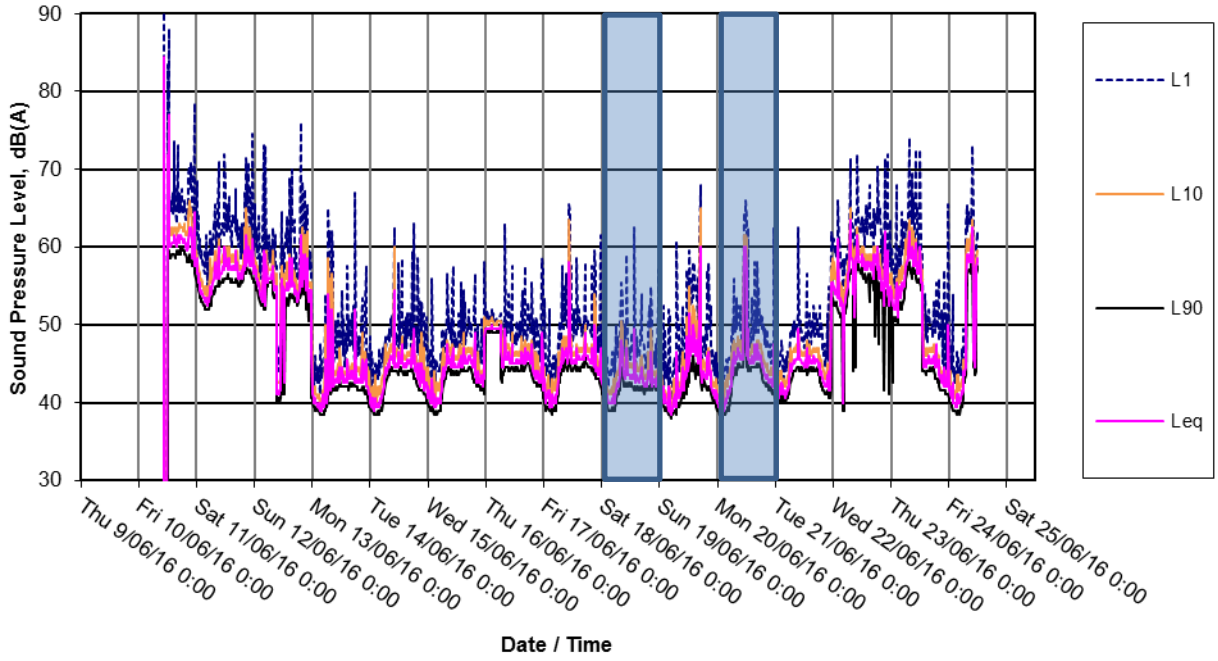
Table 3: Long-term (Unattended) Noise Survey Results – Background noise

Location	Equivalent Continuous Noise Level $L_{Aeq,period}$ - dB(A)			Background Noise Level RBL - dB(A)		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
L2	60	54	52	44	42	39

Note 1: Noise Policy for Industry (NPI) assessment periods – Daytime: 7:00 am to 6:00 pm Monday to Saturday, 8:00 am to 6:00 pm Sundays and Public Holidays; Evening: 6:00 pm to 10:00 pm; Night: 10:00 pm to 7:00 am Monday to Saturday, 10:00 pm to 8:00 am Sundays and Public Holidays.

The unattended background noise measurement was taken on the roof top of the Lands Building. This measurement was taken in absence of any industrial noise sources and is considered to representative of the background noise levels at nearest potentially most affected residential receivers.

Figure 4: Long-term background noise monitoring data – L2



: Data excluded due to rain. (Bureau of Meteorology, Daily Rainfall – June 2016)

6.2.2 Traffic Noise

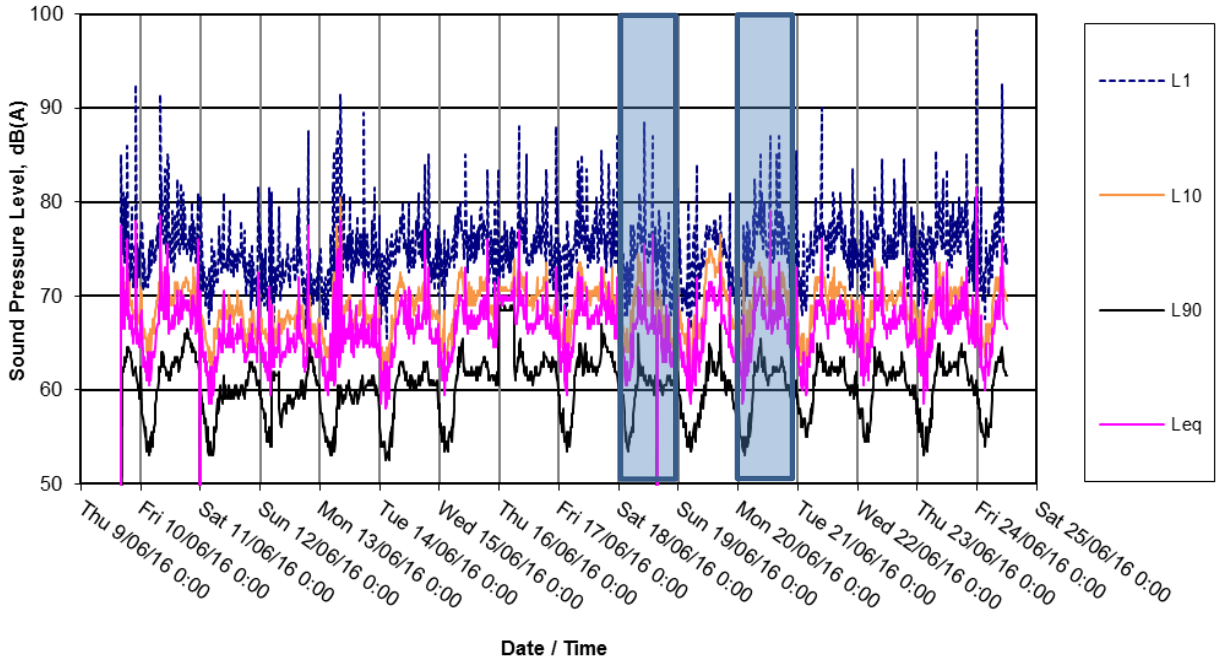
Noise monitors were placed at position L1 as shown in Figure 3 to measure the noise generated by vehicle movements during the noisiest 1-hour day and the noisiest 1-hour night established in the Sydney DCP 2012, and the 15-hour day and 9-hour periods established in the DPIE's Development near Rail Corridors and Busy Roads – Interim Guideline. Noise monitor L1 was installed from the 8th to the 24th of June 2016. The results for the long-term traffic noise surveys are shown in Table 7 below (for the day and night periods).

Refer to Figure 3 for the noise data. The local noise environment is generally that of an urban area with vehicle movements being the dominant source of noise for the majority of the day and evening periods.

Table 4: Long-term (Unattended) Noise Survey Results – Traffic noise

Location	Equivalent Continuous Noise Level LAeq,period - dB(A)		Equivalent Continuous Noise Level LAeq,1hour - dB(A)	
	Day[1] (15hr)	Night[1] (9hr)	Day[2] (Noisiest 1h)	Night[2] (Noisiest 1h)
L1	68	66	72	64

Figure 5: Long-term traffic noise monitoring data – L1



: Data excluded due to rain. (Bureau of Meteorology, Daily Rainfall – June 2016)

6.3 Short-term (Attended) Noise Surveys

6.3.1 Background Noise

Short-term noise measurements were conducted in the vicinity of surrounding noise-sensitive receivers to characterise the background and ambient noise associated with these receivers. The results of the background noise measurement conducted at location P2 (see Figure 3 for location) is provided in Table 5.

Table 5: Short-term (Attended) Background Noise Survey Results

Measurement Location	Measurement Time	$L_{Aeq, 15mins}$ dB(A)	L_{A90} dB(A)	L_{Amax} dB(A)	Comments
P2	10/06/2016 12:01	62.3	60.0	79.1	Background noise was taken from the roof of Lands Building

6.3.2 Traffic Noise

Short-term noise measurements of vehicle movements were carried out on Bridge Street, Sydney. A summary of the results of the short-term noise measurements of vehicle movements on this road conducted at location P1 (see Figure 3 for location) is provided in Table 9.

Table 6: Short-term (Attended) Traffic Noise Survey Results

Measurement Location	Measurement Time	$L_{Aeq, 15mins}$ dB(A)	L_{A90} dB(A)	L_{Amax} dB(A)	Comments
P1	23/03/2016 19:02	67.5	62.4	93.0	Background traffic noise of Bridge Street was taken from the street level, Department of Lands
	10/06/2016 12:27	67.5	62.4	91.9	Background traffic noise of Bridge Street was taken from the balcony at level 1, Department of Lands
	26/07/2016 17:45	70.4	62.3	94.5	Background traffic noise of Bridge Street was taken from the street level, Department of Lands

7. Project Noise & Vibration Criteria

7.1 Relevant Noise and Vibration Assessment Documents

The project noise and vibration criteria has been established considering the following documents:

- Sydney Development Control Plan (DCP) 2012;
- NSW EPA Noise Policy for Industry (NPI) 2017
- NSW Road Noise Policy, 2011 (RNP 2011);
- NSW EPA Interim Construction Noise Guideline 2009;
- NSW Liquor Act 2007
- Assessing vibration: A technical guideline 2006;
- British Standard BS5228 – Part 1:1997 “Noise and Vibration Control on Construction and Open Sites.”;
- British Standard BS7358:1993 “Evaluation and Measurement for Vibration in Buildings” – Part 2: “Guide to Damage Levels from Groundborne Vibration”; and
- German Standard DIN4150 – Part 3: “Structural vibration in buildings – Effects on structures”.

7.2 Operational Noise Criteria

7.2.1 Internal Noise Levels

Sydney Development Control Plan (DCP) 2012

The *Sydney DCP 2012* states the following with regards to internal noise limits for the residential spaces within the proposed development:

"The repeatable maximum LAeq (1 hour) for residential buildings and serviced apartments must not exceed the following levels:

- *for closed windows and doors:*
  - *35dB for bedrooms (10pm-7am); and*
  - *45dB for main living areas (24 hours)*
- *for open windows and doors:*
  - *45dB for bedrooms (10pm-7am); and*
  - *55dB for main living areas (24 hours)"*

Where natural ventilation of a room cannot be achieved, the repeatable maximum LAeq (1hour) level in a dwelling when doors and windows are shut and air conditioning is operating must not exceed:

- *38dB for bedrooms (10pm-7am); and*
- *48dB for main living areas (24 hours)"*

Project Internal Noise Limits

Table 7 below outlines the project internal noise level targets for the development site-wide for the various metrics, summarising the internal noise level requirements from Section 7.2.1 for closed windows. For closed windows, the ISEPP 2007 criteria have been adopted in accordance with the Design & Amenity Guidelines.

Table 7: Project internal noise limits – closed windows

Type of occupancy / activity	Metric	Standard	Noise Level Range dB(A)
Residential– Sleeping Areas	LAeq,9h (10pm – 7am)	ISEPP 2007	< 35
Residential - Other Habitable Rooms	LAeq,15h (At any time)	ISEPP 2007	< 40

Table 8 below outlines the project internal noise level targets for the development site-wide for the various metrics, summarising the internal noise level requirements from Section 7.2.1 for open windows.

Table 8: Project internal noise limits – open windows and doors

Type of occupancy / activity	Metric	Standard	Noise Level Range dB(A)
Residential - Bedrooms	LAeq,1h,noisiest (10pm – 7am)	Sydney DCP 2012	< 45
Residential – Other Habitable Rooms	LAeq,1h,noisiest (24 hours)	Sydney DCP 2012	< 55

In instances where the internal noise limits cannot be achieved while windows are open to achieve natural ventilation, an alternative means of ventilation will need to be designed to provide ventilation to the noise-affected habitable spaces with windows closed, whilst simultaneously complying with the internal noise limits outlined in Table 9.

Table 9: Project internal noise limits – closed windows & alternative means of ventilation operating

Type of occupancy / activity	Metric	Standard	Noise Level Range dB(A)
Residential - Bedrooms	LAeq,9h (10pm – 7am)	ISEPP 2007	< 45
Residential - Other Habitable Rooms	LAeq,15h (At any time)	ISEPP 2007	< 50

7.2.2 External Noise Emissions

NSW EPA Noise Policy for Industry (2017)

The NSW Noise Policy for Industry has been applied to address the noise emissions from the development to the surrounding noise-sensitive receivers. The NSW NPI sets out noise criteria to control the noise emission from industrial noise sources generated by the proposed development. Operational noise emissions from the development shall be addressed following the guideline in the NSW NPI.

The calculation is based on the results of the ambient and background noise unattended monitoring, addressing two components:

- Controlling intrusive noise into nearby residences (Intrusiveness Criteria)
- Maintaining noise level amenity for particular land uses (Amenity Criteria)

Once both criteria are established, the most stringent for each considered assessment period (day, evening, night) is adopted as the project noise trigger level (PNTL).

Intrusiveness Criteria

The NSW NPI states the following:

"The intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source (represented by the LAeq descriptor), measured over a 15minute period, does not exceed the background noise level by more than 5 dB when beyond a minimum threshold."

The intrusiveness criterion can be summarised as LAeq, 15 minute ≤ RBL background noise level plus 5 dB(A).

Receiver	Period	Noise Descriptor – dB(A)	Noise Criteria – dB(A)
NCA01,	Day (7:00am to 6:00pm)	$L_{Aeq,15min}$ ≤ RBL + 5	49
NCA02,	Evening (6:00pm to 10:00pm)	$L_{Aeq,15min}$ ≤ RBL + 5	47
NCA03	Night (10:00pm to 7:00am)	$L_{Aeq,15min}$ ≤ RBL + 5	39

Amenity Criteria

The NSW NPI states the following:

"To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance. The recommended amenity noise levels have been selected on the basis of studies that relate industrial noise to annoyance in communities (Miedema and Voss, 2004).

The applicable parts of Table 2.2: Amenity noise levels from Industrial Noise Sources – L_{Aeq}, dB(A) which are relevant to the project are reproduced below:

Table 10: NSW NPI Table 2.2 amenity criteria for external noise levels

Receiver	Type of Receiver	Noise amenity area	Time of Day	L_{Aeq}, dB(A) Recommended amenity noise level	Project amenity noise level $L_{Aeq,period}$
NCA01	Commercial	All	When in use	65	60
	Hotel	Urban	Day	65	60
			Evening	55	50
			Night	50	45
NCA02	Commercial	All	When in use	65	60
	Hotel	Urban	Day	65	60
			Evening	55	50
			Night	50	45
NCA03	Residential	Urban	Day	60	55
			Evening	50	45
			Night	45	40
	Commercial	All	When in use	65	60
	Hotel	Urban	Day	65	60
			Evening	55	50
			Night	50	45

Note 1: Hotels amenity noise are to be 5dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity are and time of day

Modifying Factor' Adjustments

The NSW NPI also states:

> *"Where a noise source contains certain characteristics, such as tonality, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level."*

In order to take into account, the potential annoying character of the noise an adjustment of 5 dB(A) for each annoying character aspect and cumulative of up to a total of 10 dB(A), is to be added to the measured value to penalise the noise for its potentially greater annoyance aspect.

Table C1 of Fact Sheet C of the NSW NPI (see Table 11 below) provides procedures for determining whether an adjustment should be applied for greater annoyance aspect.

Table 11: Table C1 from the NSW NPI – Modifying factor corrections

Factor	Assessment / Measurement	When to Apply	Correction[1]	Comments
Tonal Noise	One-third octave band analysis using the objective method for assessing the audibility of tones in noise – simplified method *(ISO1996.2-2007 – Annex D)*.	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: • 5 dB or more if the centre frequency of the band containing the tone is in the range 500–10,000 Hz • 8 dB or more if the centre frequency of the band containing the tone is in the range 160–400 Hz • 15 dB or more if the centre frequency of the band containing the tone is in the range 25–125 Hz.	5 dB[2,3]	Third octave measurements should be undertaken using unweighted or Z-weighted measurements. **Note**: Narrow-band analysis using the reference method in *ISO1996-2:2007, Annex C* may be required by the consent/regulatory authority where it appears that a tone is not being adequately identified, e.g. where it appears that the tonal energy is at or close to the third octave band limits of contiguous bands.
Low Frequency Noise	Measurement of source contribution C-weighted and A-weighted level and one-third octave measurements in the range 10–160 Hz	Measure/assess source contribution C- and A-weighted $L_{eq,T}$ levels over same time period. Correction to be applied where the C minus A level is 15dB or more and: • where any of the one-third octave noise levels in Table C2 are exceeded by up to and including 5 dB and cannot be mitigated, a 2dB(A) positive adjustment to measured/predicted A-weighted levels applies for the evening/night period • where any of the one-third octave noise levels in Table C2 are exceeded by more than 5 dB and cannot be mitigated, a 5-dB(A) positive adjustment to measured/predicted A-weighted levels applies for the evening/night period and a 2dB(A) positive adjustment applies for the daytime period.	2 or 5 dB[2]	A difference of 15 dB or more between C- and A-weighted measurements identifies the potential for an unbalance spectrum and potential increased annoyance. The values in Table C2 are derived from Moorhouse (2011) for DEFRA fluctuating low-frequency noise criteria with corrections to reflect external assessment locations.
Intermittent Noise	Subjectively assessed but should be assisted with measurement to gauge the extent of change in noise level.	The source noise heard at the receiver varies by more than 5 dB(A) and the intermittent nature of the noise is clearly audible.\	5 dB	Adjustment to be applied for **night-time only.**
Duration	Single-event noise duration may range from 1.5 min to 2.5 h	One event in any assessment period.	0 to 20 dB(A)	The project noise trigger level may be increased by an adjustment depending on duration of noise (see Table C3).
Maximum Adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated	Maximum correction of 10dB(A)[2] (excluding duration correction)	

1. Corrections to be added to the measured or predicted levels, except in the case of duration where the adjustment is to be made to the criterion.

2. Where a source emits tonal and low-frequency noise, only one 5-dB correction should be applied if the tone is in the low-frequency range, that is, at or below 160 Hz.

3. Where narrow-band analysis using the reference method is required, as outlined in column 5, the correction will be determined by the ISO1996-2:2007 standard.

Sleep Disturbance

The NPI establishes sleep disturbance criteria for residential receivers in close proximity to industrial noise sources during the night-time period, such as vehicle movements and car door slams on private roads. The criteria for protecting the amenity of surrounding residential receivers in regards to sleep disturbance is:

- $L_{Aeq,15min}$ 40 dB(A) or prevailing RBL plus 5dB, whichever is greater, and/or
- L_{AFmax} 52 dB(A) or prevailing RBL plus 15dB, whichever is greater

Table 12 summarises the sleep disturbance criteria for the proposed development.

Table 12: Sleep Disturbance Criteria

Period	Sleep Disturbance Criteria	
	L_{AFmax} – dB(A)	**$L_{Aeq,15min}$ – dB(A)**
Night (10:00pm to 7:00am)	54	44

Project Trigger Noise Level

Refer to Table 13 for the NSW NPI criteria applicable to the noise emissions generated from the operational activities from the proposed development. These project trigger noise levels are in accordance with the requirements of the NSW NPI and shall be assessed to the most affected point on or within the noise catchment area's boundary.

Table 13: Project Specific Noise Levels

Receiver	Type of Receiver	Period	Descriptor	PTNL dB(A)
NCA01	Commercial	All	When in use	63
	Hotel	Day	$L_{Aeq,15min}$	54
		Evening	$L_{Aeq,15min}$	52
		Night	$L_{Aeq,15min}$	44
			L_{AFmax}	59
NCA02	Commercial	All	When in use	63
	Hotel	Day	$L_{Aeq,15min}$	54
		Evening	$L_{Aeq,15min}$	52
		Night	$L_{Aeq,15min}$	44
			L_{AFmax}	59
NCA03	Residential	Day	$L_{Aeq,15min}$	49
		Evening	$L_{Aeq,15min}$	47
		Night	$L_{Aeq,15min}$	39
			L_{AFmax}	54
	Commercial	When in use	When in use	63
	Hotel	Day	$L_{Aeq,15min}$	54
		Evening	$L_{Aeq,15min}$	52
		Night	$L_{Aeq,15min}$	44
			L_{AFmax}	59

7.2.3 Traffic Noise Generation Criteria

The L_{Aeq} noise level or the "equivalent continuous noise level" correlates best with the human perception of annoyance associated with traffic noise.

Road traffic noise impact is assessed in accordance with the introduced NSW Road Noise Policy (Office of Environment and Heritage July 2011) which supersedes the *NSW Environmental Criteria for Road Traffic Noise* (ECRTN, Department of Environment Climate Change and Water 1999). The criterion (Table 3 – Road Traffic Noise Assessment Criteria for Residential Land Uses) 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 is shown below in Table 14.

Table 14: NSW Road Noise Policy – Traffic noise assessment criteria

Road Category	Type of project/land use	Assessment Criteria – dB(A)	
		Day (7am – 10pm)	Night (10pm – 7am)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq,1\ hour}$ 55 (external)	$L_{Aeq,1\ hour}$ 50 (external)
Sub-arterial	Existing residences affected by additional traffic on existing sub-arterial roads generated by land use developments	$L_{Aeq,15\ hour}$ 60 (external)	$L_{Aeq,9\ hour}$ 55 (external)

In the event that 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 level through feasible and reasonable measures to meet the criteria above.

If this is not achievable, Section 3.4.1 Process for applying the criteria – Step 4 states that 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'.

7.2.4 NSW Liquor Act 2007

The noise emission criteria from the NSW ILGA shall be applied to any music/entertainment and patrons from licensed premises. “Notwithstanding compliance with the above, the noise from the licensed premises shall not be audible within any habitable room in any residential premises between the hours of 12:00am midnight and 7:00am.”

The Liquor Act 2007 criteria is summarised below in Table 15.

Table 15: NSW Liquor Act 2007 Noise Criteria

Period	Octave Band Centred Frequencies (Hz)	Noise Descriptor dB(A)
7:00am – 12:00am	From 31.5Hz to 8000Hz	$L_{A10,\ Oct} \leq L_{A90,\ Oct} + 5$

Given the licensed premises is proposing to operate until 12:00am into the morning, project specific noise criteria must be set in accordance with the following:

- 7:00am – 12:00am – criteria must be set using the minimum $L_{A90,oct}$ measured on average each day during this period

The project specific noise criteria have been summarised in Table 5 below.

Table 5: Project specific noise criteria – NSW Liquor Act 2007

NCA	Noise Metric	Octave Band Centre Frequency								
		31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
NCA01 NCA02 NCA03	Minimum Measured L_{A90} (daily average) 7:00am – 12:00am dB(A)	8	21	27	33	36	37	34	26	14
	Criterion L_{A10} 7:00am – 12:00am dB(A)	13	26	32	38	41	42	39	31	19

7.3 Operational Vibration Criteria

The NSW Environment Protection Authority (EPA) developed a document, "Assessing vibration: A technical Guideline" in February 2006 to assist in preventing people from exposure to excessive vibration levels within buildings. The guideline does not however address vibration induced damage to structures or structure-borne noise effects. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent.

7.3.1 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 also 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.

Maximum allowable magnitudes of building vibration with respect to human response are shown in Table 23. It should be noted that the human comfort for vibration are more stringent than the building damage criteria.

Table 16: RMS values for continuous and impulsive vibration acceleration (m/s2) 1-80Hz

Location	Receiver	Assessment period[1]	Preferred values		Maximum values	
			z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration						
Residences	NCA03	Daytime	0.010	0.0071	0.020	0.014
		Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and place of worship	NCA01 NCA02 50 Phillip Street (Heritage)	Day or night time	0.020	0.014	0.040	0.028
Impulsive vibration						
Residences	NCA03	Daytime	0.30	0.21	0.60	0.42
		Night-time	0.10	0.071	0.20	0.41
Offices, schools, educational institutions and place of worship	NCA01 NCA02 50 Phillip Street (Heritage)	Day or night time	0.64	0.46	1.28	0.92

7.3.2 Human Comfort – Intermittent Vibration Criteria

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. Various studies support the fact that VDV assessment methods are far more accurate in assessing the level of disturbance than methods which is only based on the vibration magnitude.

Table 17: Acceptable Vibration Dose Values for Intermittent Vibration (m/s$^{1.75}$)

Location	Receiver	Daytime (7:00am to 10:00pm)		Night-time (10:00pm to 7:00am)	
		Preferred value	Maximum value	Preferred value	Maximum value
Residences	NCA03	0.20	0.40	0.113	0.26
Offices, schools, educational institutions and place of worship	NCA01 NCA02 50 Phillip Street (Heritage)	0.40	0.80	0.40	0.80

7.3.3 Structural Damage – Vibration Criteria

Ground vibration criteria is defined in terms of the levels of vibration emission from the construction activities which will avoid the risk of damaging surrounding buildings or structures. It should be noted that human comfort criteria are normally expressed in terms of acceleration whereas structural damage criteria are normally expressed in terms of velocity.

Most commonly specified structural vibration levels are defined to minimize the risk of cosmetic surface cracks and are set below the levels that have the potential to cause damage to the main structure. Structural damage criteria are presented in German Standard DIN4150-Part 3 “Structural vibration in buildings – Effects on structures” and British Standard BS7385-Part 2: 1993 “Evaluation and Measurement for Vibration in Buildings”. Table 25 indicates the vibration limits presented in DIN4150-Part 3 to ensure structural damage doesn’t occur.

Table 18: Guideline value of vibration velocity, vi, for evaluating the effects of short-term vibration

Line	Type of Structure	Vibration velocity, vi, in mm/s Foundation At a frequency of			Plane of floor of uppermost full storey
		Less than 10Hz	10 to 50Hz	50 to 100*Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	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					

Table 26 presents guide values for building vibration, based on the lowest vibration levels above which cosmetic damage has been demonstrated as per BS7385-Part 2:1993.

Table 19: Transient vibration guide values for cosmetic damage

Type of Building	Peak Particle Velocity in frequency range of predominant pulse (PPV)	
	4 Hz to 15 Hz	15 Hz and above
Residential or light commercial type buildings	15mm/s at 4Hz increasing to 20mm/s at 15Hz	20mm/s at 15Hz increasing to 50mm/s at 40Hz and above

7.4 Construction Noise Criteria

7.4.1 Interim Construction Noise Guideline (Interim)

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 20**, as presented in Section 4.1.1 Table 2 of the ICNG.

Table 20: 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: - 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) - 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 21 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, and at the most affected point within 50 metres of the area boundary for parks.

Table 21: Construction Noise Criteria for Other Land Uses

Land Use	Management Level, $L_{Aeq,15min}$ – applies when land use is being utilized
Passive recreation, parks	External noise level 60 dB(A)
Industrial premises	External noise level 75 dB(A)
Offices, retail outlets	External noise level 70 dB(A)

Based on the criteria in the tables above, the following noise management levels in Table 22 should be applied to the receivers C1 and R1. Construction during standard hours has been assumed.

Table 22: Project Specific Construction Noise Management Levels

Land Use	Receiver	Management Level, $L_{Aeq,15min}$
Commercial / Hotel	NCA01, NCA02	70 dB(A)
Residential	NCA03	49 dB(A) + 10 dB = **59 dB(A)**
Residential (Outside Recommended Standard Hours)	NCA03	49 dB(A) + 5 dB = **54 dB(A)**

It is important to note that operation falling outside the standard hours recommended within the ICNG will be assessed under the Outside Recommended Standard Hours criteria.

7.5 Construction Vibration Criteria

The NSW Environment Protection Authority (EPA) developed a document, "Assessing vibration: A technical Guideline" in February 2006 to assist in preventing people from exposure to excessive vibration levels within buildings. The guideline does not however address vibration induced damage to structures or structure-borne noise effects. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent.

7.5.1 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 also 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.

Maximum allowable magnitudes of building vibration with respect to human response are shown in Table 23. It should be noted that the human comfort for vibration are more stringent than the building damage criteria.

Table 23: RMS values for continuous and impulsive vibration acceleration (m/s2) 1-80Hz

Location	Receiver	Assessment period[1]	Preferred values		Maximum values	
			z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration						
Residences	NCA03	Daytime	0.010	0.0071	0.020	0.014
		Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and place of worship	NCA01 NCA02 50 Phillip Street (Heritage)	Day or night time	0.020	0.014	0.040	0.028
Impulsive vibration						
Residences	NCA03	Daytime	0.30	0.21	0.60	0.42
		Night-time	0.10	0.071	0.20	0.41
Offices, schools, educational institutions and place of worship	NCA01 NCA02 50 Phillip Street (Heritage)	Day or night time	0.64	0.46	1.28	0.92

7.5.2 Human Comfort – Intermittent Vibration Criteria

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. Various studies support the fact that VDV assessment methods are far more accurate in assessing the level of disturbance than methods which is only based on the vibration magnitude.

Table 24: Acceptable Vibration Dose Values for Intermittent Vibration (m/s$^{1.75}$)

Location	Receiver	Daytime (7:00am to 10:00pm)		Night-time (10:00pm to 7:00am)	
		Preferred value	Maximum value	Preferred value	Maximum value
Residences	NCA03	0.20	0.40	0.113	0.26
Offices, schools, educational institutions and place of worship	NCA01 NCA02 50 Phillip Street (Heritage)	0.40	0.80	0.40	0.80

7.5.3 Structural Damage – Vibration Criteria

Ground vibration criteria is defined in terms of the levels of vibration emission from the construction activities which will avoid the risk of damaging surrounding buildings or structures. It should be noted that human comfort criteria are normally expressed in terms of acceleration whereas structural damage criteria are normally expressed in terms of velocity.

Most commonly specified structural vibration levels are defined to minimize the risk of cosmetic surface cracks and are set below the levels that have the potential to cause damage to the main structure. Structural damage criteria are presented in German Standard DIN4150-Part 3 "Structural vibration in buildings – Effects on structures" and British Standard BS7385-Part 2: 1993 "Evaluation and Measurement for Vibration in Buildings". Table 25 indicates the vibration limits presented in DIN4150-Part 3 to ensure structural damage doesn't occur.

Table 25: Guideline value of vibration velocity, vi, for evaluating the effects of short-term vibration

Line	Type of Structure	Vibration velocity, vi, in mm/s Foundation At a frequency of			Plane of floor of uppermost full storey
		Less than 10Hz	10 to 50Hz	50 to 100*Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	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					

Table 26 presents guide values for building vibration, based on the lowest vibration levels above which cosmetic damage has been demonstrated as per BS7385-Part 2:1993.

Table 26: Transient vibration guide values for cosmetic damage

Type of Building	Peak Particle Velocity in frequency range of predominant pulse (PPV)	
	4 Hz to 15 Hz	15 Hz and above
Residential or light commercial type buildings	15mm/s at 4Hz increasing to 20mm/s at 15Hz	20mm/s at 15Hz increasing to 50mm/s at 40Hz and above

7.5.4 Construction Vibration Objectives

Table 27 indicates the construction vibration criteria applicable to the residential properties located adjacent to the development.

Table 27: Construction vibration criteria summary

Receiver	Period	Human Comfort Vibration Objectives			Building damage Objectives – Velocity (mm/s)
		Continuous mm/s^2 (RMS)		Intermittent m/s$^{1.75}$ (VDV)	
		z-axis	x- and y-axis		
NCA03	Daytime	10 - 20	7 - 14	0.20 - 0.40	5
	Night time	7 - 14	5 - 10	0.13 - 0.26	5
NCA01, NCA02	At any time	64 - 125	46- 92	0.40 - 0.80	20
50 Phillip Street, Sydney (sandstone heritage structure)	At any time	64 - 125	46- 92	0.40 - 0.80	3

8. Operational Noise and Vibration Assessments

8.1 External Noise Intrusion Impact Assessment

8.1.1 Noise Modelling and Assumptions

As summarised in Section 4.4, the driving internal noise targets for residential are the “window open” criteria of:

- 45 dBA $L_{Aeq(9hour)}$ for bedrooms (10pm-7am)
- 55 dBA $L_{Aeq(24hour)}$ for main living areas (24 hours)

A noise model should be generated to calculate the predicted noise levels at the façade generated by road traffic during the Stage 2 (Detailed) development application process in order to provide more detail on appropriate glazing and building envelope details in order to meet the acoustic performance demand.

Given the height of the tower where the residential apartments are to be located within proposed development, there are not expected to be any significant exceedances for the internal noise levels criteria outlined in Section 7.2.1.

To achieve compliance at these receivers, the internal floorplate layout should be developed such that living spaces (not bedrooms) are located at the opening locations which are found to not comply with the night-time criteria.

All glazing and solid areas of the external building fabric should also be designed such as to achieve compliance with the “windows closed” criteria in Section 7.2.1 for periods when occupants choose to close windows. This is considered to be possible with standard (i.e. “off-the-shelf”) construction materials including acoustic laminate glazing.

8.2 Mechanical Plant and Equipment Impact Assessment

As noise sources and locations within and surrounding the area are unknown at this early stage in the project, a noise impact assessment of potential operational mechanical noise emissions within the proposed development cannot be completed.

The potential noise impacts from all sources of industrial noise (mechanical included) from the proposed development will be undertaken for the detailed development application when more information regarding the various noise sources and locations are known.

Given the indicative locations of the plantrooms shown in the architectural documentation, it is anticipated that compliance with the final project trigger noise levels will be achievable with standard noise mitigation measures such as:

- Positioning mechanical plant away from nearby receivers
- Acoustic attenuators fitted to duct work
- Acoustic insulation within duct work
- Acoustic louvres

8.3 Traffic Noise Generation Impact Assessment

For the road traffic noise assessment, existing peak hour traffic count and traffic generation for the site was based on the Traffic Impact Assessment prepared by "ARUP.". This data has been used to calculate the expected noise increase due to traffic associated with the development onto Phillip Street and Macquarie Street. The results are summarised in Table 28.

Table 28: Existing and predicted traffic noise generation (peak hour)

Location	Existing vehicles AM	Existing vehicles PM	Predicted Increase AM	Predicted Increase PM	Noise Level Increase dB AM	Noise Level Increase dB PM
Phillip St	720	750	43	39	0.3	0.2
Macquarie St	2300	2500	43	39	0.1	0.1

Based on the results of the assessment, there is predicted to be less than a 1.3dB increase in traffic noise levels. Therefore, the proposed development is expected comply with the requirements of the NSW Road Noise Policy because the predicted increase is less than 2dB.

8.4 Level 36 Terrace Impact Assessment

For the early design of the proposed development, it understood that there is a outdoor pool are located on level 36 of the development. For this initial assessment, the following proposed activities have been assumed:

- People swimming in the pool, splashing and making noise
- People speaking at an amplified volume (loud)
- No background music has been conducted
- 1 person / 4sqm in the pool and bar area (total 58 people)
- Anticipating approximately 60-65dB(A) generated by each person within the pool area

The predicted noise level at the nearest sensitive receiver is outlined below:

Table 29: Predict noise level from Level 36 pool area

Receiver ID	**NPI Criteria (Evening Time)**	**Predicted Noise Level**	**Complies? (Yes/No)**
NCA02	52	47	Yes

At this early stage of the design, the predicted noise impact is not expected to exceed the criteria for the nearby sensitive receivers

Further assessments should be conducted during later stages of the design once more information is known regarding the space and use of area.

9. Construction Noise & Vibration Assessment

9.1 Potential Impacts on Astor Apartments

During the construction noise and vibration assessment, the Astor Apartments have been considered, due to the location of the sensitive receiver (NCA02), being the closest receiver to the site. While impacts during all construction phases it is not predicted to exceed significantly (see Section 9.2.4), Stantec propose that noise and vibration monitoring is to be conducted as per the program outlined in Section 10.3.

9.2 Construction Noise Assessment

9.2.1 Proposed Construction Activities

In this assessment, the noise impact from the construction works are considered. The construction works are expected to occur during the following hours:

- Monday to Friday: 7:00am to 6:00pm
- Saturday: 7:00am to 3:30pm
- Sunday and public holidays: no work
- Safety inspections are permitted from 7:00am

9.2.2 Expected Construction Equipment

The noise sources likely to be associated with the works listed in the previous section of this report are presented in Table 30. The equipment noise levels have been extracted from AS 2436:2010 Guide to *Noise and Vibration Control on Construction, Demolition and Maintenance Sites.*

Table 30: Cumulative impact - Construction equipment noise levels

Stages	Estimated Time	Equipment	Quantity	Sound Power Level – dB(A)	Acoustical Usage Factor (%)	Usage in 15-minute period (minutes)	Time Corrected Sound Power Level ($L_{Aeq,15min}$)
Early Works – Demolition & Dismantle	5 months	Jackhammer	1	113	20	3	106
		Electric hand tools	5	102	50	7.5	99
		Excavator 30 tonne	1	110	40	6	106
		Excavator breaker	1	115	40	6	111
		Bobcat	1	107	70	10.5	105
		Cherry picker	1	102	50	7.5	99
		Dump truck	2	108	40	6	104
Excavation, Retention and Foundation	7 months	Excavator 30 tonne	1	110	40	6	106
		Jackhammer	1	113	20	3	106
		Powered hand tool	4	102	50	7.5	99

Stages	Estimated Time	Equipment	Quantity	Sound Power Level – dB(A)	Acoustical Usage Factor (%)	Usage in 15-minute period (minutes)	Time Corrected Sound Power Level ($L_{Aeq,15min}$)
		Concrete pump	1	109	50	7.5	106
		Mobile crane	2	110	16	2.4	102
		Bored piling	1	110	16	2.4	102
		Generator	1	104	20	3	97
		Truck	2	108	40	6	104
Structural Works	9 months	Powered hand tool	4	102	50	7.5	99
		Concrete pump	1	109	50	7.5	106
		Mobile crane	2	110	16	2.4	102
		Bored piling	1	110	16	2.4	102
		Generator	1	104	20	3	97
		Truck	2	108	40	6	104
Structural Works & Façade and Finishes	12 months	Powered hand tool	11	102	50	7.5	99
		Concrete pump	1	109	50	7.5	106
		Mobile crane	2	110	16	2.4	102

9.2.3 Noise Modelling and Assumptions

In order to assess the noise impact from the site during the various construction stages, a noise model was prepared using commercial software SoundPLAN v8.1, which is a comprehensive software package for conducting three-dimensional complex noise propagation modelling. Using the software, a 3D model of the site and its surroundings was constructed including the nearby buildings, and the construction plant and equipment were positioned as noise sources. Within the model, the effects of the environment (built and natural) on propagation of sound were considered to reliably 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 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;
- The mitigation measures outlined in Section 10 are implemented; and
- Neutral weather conditions;

9.2.4 Predicted Noise Levels

The predicted noise levels have been presented in Table 31, Table 32, Table 33, Table 34, Table 35, Table 36 and Table 37 and have been assessed to the construction noise criteria established in Section 7.4.

Table 31: Predicted noise levels – Scenario 1: Early Works – Demolition & Dismantle

Receiver	Predicted Noise Level Range - Without Mitigation $L_{Aeq,15min}$	Predicted Noise Level Range – With Mitigation $L_{Aeq,15min}$	Noise Management Level $L_{Aeq,15min}$ dB	Noise Management Level Exceedance (dB)	Exceeds Highly Noise Affected Level? (> 75dBA)
NCA01	58-65	54-59	73	-	No
NCA02	58-72	55-66	73	-	No
NCA03	65-76	62-69	59	10	No

Table 32: Predicted noise levels – Scenario 2: Excavation, Retention & Foundations

Receiver	Predicted Noise Level Range - Without Mitigation $L_{Aeq,15min}$	Predicted Noise Level Range – With Mitigation $L_{Aeq,15min}$	Noise Management Level $L_{Aeq,15min}$ dB	Noise Management Level Exceedance (dB)	Exceeds Highly Noise Affected Level? (> 75dBA)
NCA01	57-62	54-57	73	-	No
NCA02	56-77	54-72	73	-	No
NCA03	64-74	61-68	59	9	No

Table 33: Predicted noise levels – Scenario 3: Structural Works (L1-L7)

Receiver	Predicted Noise Level Range - Without Mitigation $L_{Aeq,15min}$	Predicted Noise Level Range – With Mitigation $L_{Aeq,15min}$	Noise Management Level $L_{Aeq,15min}$ dB	Noise Management Level Exceedance (dB)	Exceeds Highly Noise Affected Level? (> 75dBA)
NCA01	55-60	53-56	73	-	No
NCA02	56-77	54-75	73	2	No
NCA03	63-72	60-67	59	8	No

Table 34: Predicted noise levels – Scenario 4: Structural Works (L8-L14)

Receiver	Predicted Noise Level Range - Without Mitigation $L_{Aeq,15min}$	Predicted Noise Level Range – With Mitigation $L_{Aeq,15min}$	Noise Management Level $L_{Aeq,15min}$ dB	Noise Management Level Exceedance (dB)	Exceeds Highly Noise Affected Level? (> 75dBA)
NCA01	57-61	54-59	73	-	No
NCA02	53-77	52-75	73	2	No
NCA03	64-74	62-68	59	9	No

Table 35: Predicted noise levels – Scenario 5: Structural Works (L15-21) & Façade and Finishes (L8-L14)

Receiver	Predicted Noise Level Range - Without Mitigation $L_{Aeq,15min}$	Predicted Noise Level Range – With Mitigation $L_{Aeq,15min}$	Noise Management Level $L_{Aeq,15min}$ dB	Noise Management Level Exceedance (dB)	Exceeds Highly Noise Affected Level? (> 75dBA)
NCA01	62-65	61-65	73	-	No
NCA02	64-77	59-75	73	2	No
NCA03	69-76	67-74	59	15	No

Table 36: Predicted noise levels – Scenario 6: Structural Works (L22-L28) & Façade and Finishes (L15-21)

Receiver	Predicted Noise Level Range - Without Mitigation $L_{Aeq,15min}$	Predicted Noise Level Range – With Mitigation $L_{Aeq,15min}$	Noise Management Level $L_{Aeq,15min}$ dB	Noise Management Level Exceedance (dB)	Exceeds Highly Noise Affected Level? (> 75dBA)
NCA01	58-63	57-63	73	-	No
NCA02	59-74	47-68	73	-	No
NCA03	65-72	61-68	59	9	No

Table 37: Predicted noise levels – Scenario 7: Structural Works (L29-L35) & Façade and Finishes (L22-L28)

Receiver	Predicted Noise Level Range - Without Mitigation $L_{Aeq,15min}$	Predicted Noise Level Range – With Mitigation $L_{Aeq,15min}$	Noise Management Level $L_{Aeq,15min}$ dB	Noise Management Level Exceedance (dB)	Exceeds Highly Noise Affected Level? (> 75dBA)
NCA01	58-61	57-61	73	-	No
NCA02	47-65	47-61	73	-	No
NCA03	61-65	60-64	59	5	No

Table 38: Predicted noise levels – Scenario 8: Structural Works (L36-L42) & Façade and Finishes (L29-L35)

Receiver	Predicted Noise Level Range - Without Mitigation $L_{Aeq,15min}$	Predicted Noise Level Range – With Mitigation $L_{Aeq,15min}$	Noise Management Level $L_{Aeq,15min}$ dB	Noise Management Level Exceedance (dB)	Exceeds Highly Noise Affected Level? (> 75dBA)
NCA01	59-61	57-60	73	-	No
NCA02	56-63	47-63	73	-	No
NCA03	61-64	60-63	59	4	No

Note 1: The highly noise affected level is predicted to be marginally exceeded, however a difference between 0-2dB is generally imperceptible to the human ear.

Given the exceedance in the noise management level at any given time during construction is predicted to be limited to approximately 5 dB(A) upon implementation of the mitigation measures outlined in Section 10, it is not expected there will be significant construction noise impacts on the surrounding noise-sensitive receivers.

9.3 Construction Vibration Assessment

The vibration associated with construction is dependent on a number of variables including the types of machinery, the proximity to the nearby receivers as well as the ground type.

Generic safe working distances for vibration impacts associated with various types of machinery at given distances are presented within the transport for NSW 'Construction Noise Strategy' document. This document presents the safe construction working limits for Cosmetic Damage to adjacent structures (in accordance with BS 7385) and Human Comfort (OH&E).

Table 39: Working Distances for Vibration Intensive Plant

Plant Item	Rating/Description	Safe Working Distance	
		Cosmetic Damage (BS 7385)	Human Response (OH&E Vibration Guideline)
Concrete Vibrator	<50 kN (Typically 1-2 tonnes)	5m	15m to 20m
	<100 kN (Typically 2-4 tonnes)	6m	20m
	<200 kN (Typically 4-6 tonnes)	12m	40m
	<300 kN (Typically 7-13 tonnes)	15m	100m
	>300 kN (Typically 13-18 tonnes)	20m	100m
	>300 kN (> 18 tonnes)	25m	100m
CFA Piling Rig	≤ 800mm	2m (nominal)	N/A
Excavator with hydraulic hammer (15t)	(900kg – 12 to 18t excavator)	7m	23m

Concrete vibrators are expected be used in close proximity to the nearby receivers when pouring the Level 01 slab. In addition to this, piling and excavating with a hammer attachment may be conducted in close proximity to nearby receivers. Mitigation measures to ensure vibration generated on the structure of the nearby receivers does not exceed the project vibration requirements are provided in Section 10.

10. Construction Noise & Vibration Mitigation Measures

10.1.1 Noise

A solid acoustic barrier (made from plywood or similar) ~~above the construction equipment~~2.4 metres above Ground Level is recommended ~~-~~to be erected around the perimeter of the site. The acoustic barrier could be either Class A or Class B type hoarding.

In addition, noise monitoring is recommended to be conducted at the most-affected noise-sensitive receivers in accordance with the monitoring programme proposed in Section 10.3.

Further assessment of construction noise should be undertaken during the Detailed SSDA to further consider noise impacts, once construction methodology has been established.

The flow chart presented in Figure 6 should be used to assist with noise mitigation and management measures in order to comply with the standards outlined in this report.

10.1.2 Vibration

When pouring the Level 01 slab and during the demolition and excavation stages, attended vibration measurements should be conducted on the structure of the Astor Apartments to ensure the vibration generated on the structure does not exceed the values for cosmetic damage and structural damage outlined in BS 7385 and DIN 4150 (project construction vibration limits established in Section 7.3).

Further assessment of construction vibration should be undertaken during the Detailed SSDA to further consider vibration impacts, once construction methodology has been established.

10.2 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 minimize the spread of noise and vibrations to the potential receivers.

10.2.1 Noise

If a process that generates significant noise levels cannot be avoided, the amount of noise reaching the receiver should be minimized. 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.

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. Practices that will reduce noise from the site include:

- Increasing the distance between noise sources and sensitive receivers.
- Reducing the line-of-sight noise transmission to residences or other sensitive land uses using temporary barriers (stockpiles, shipping containers and site office transportables can be effective barriers).
- Constructing barriers that are part of the project design early in the project to introduce the mitigation of site noise.
- Installing purpose-built noise barriers, acoustic sheds and enclosures.

10.2.2 Screening

On sites where distance is limited, the screening of noise may be beneficial, and this should be taken into account during the planning stages.

If structures such as stores, site offices and other temporary buildings are situated between the noisiest part of the site and the nearest dwellings, some of the noise emission from the site can be reduced. If these buildings are occupied, sound insulation measures may be necessary to protect workers inside the buildings.

A hoarding that includes a site office on an elevated structure offers superior noise reduction when compared with a standard (simple) hoarding. The acoustic performance is further enhanced when the hoarding is a continuous barrier.

Storage of building materials or the placement of shipping containers between the noise source and any noise-sensitive area may also provide useful screening and the same is true of partially completed or demolished buildings. 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 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.

Where such noise barriers are 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 can often be designed into the construction schedule or site arrangement for future landscaping.

Water pumps, fans and other plant equipment that operate on a 24-hour basis may not be an irritating source of noise during the day but may 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 provided this does not generate reverberant noise. In such cases, however, adequate ventilation should also be ensured. 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 may be a more reliable method of noise control than the imposition of restrictions on throttle settings.

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

The usefulness of a noise barrier will depend upon its length, its height, its position relative to the source and to the receiver, and the material from which it is made. A barrier designed to reduce noise from a moving source should extend beyond the last property to be protected to a distance of not less than ten times the shortest measurement from the property to the barrier. A barrier designed to reduce noise from a stationary source should, where possible, extend to a distance beyond the direct line between the noise source and the receiver to a distance equal to ten times the effective barrier height, which is the height above the direct line between source and receiver.

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

10.2.3 Crane (diesel operated)

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

10.2.4 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:

- 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.
- Variable-level alarms reduce the emitted noise levels by detecting the background noise level and adjusting the alarm level accordingly.
- Non-audible warning systems (e.g. flashing lights, reversing cameras) may also be employed, providing safety considerations, are not compromised.
- 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.
- Spotters or observers.

The above methods should be combined, where appropriate.

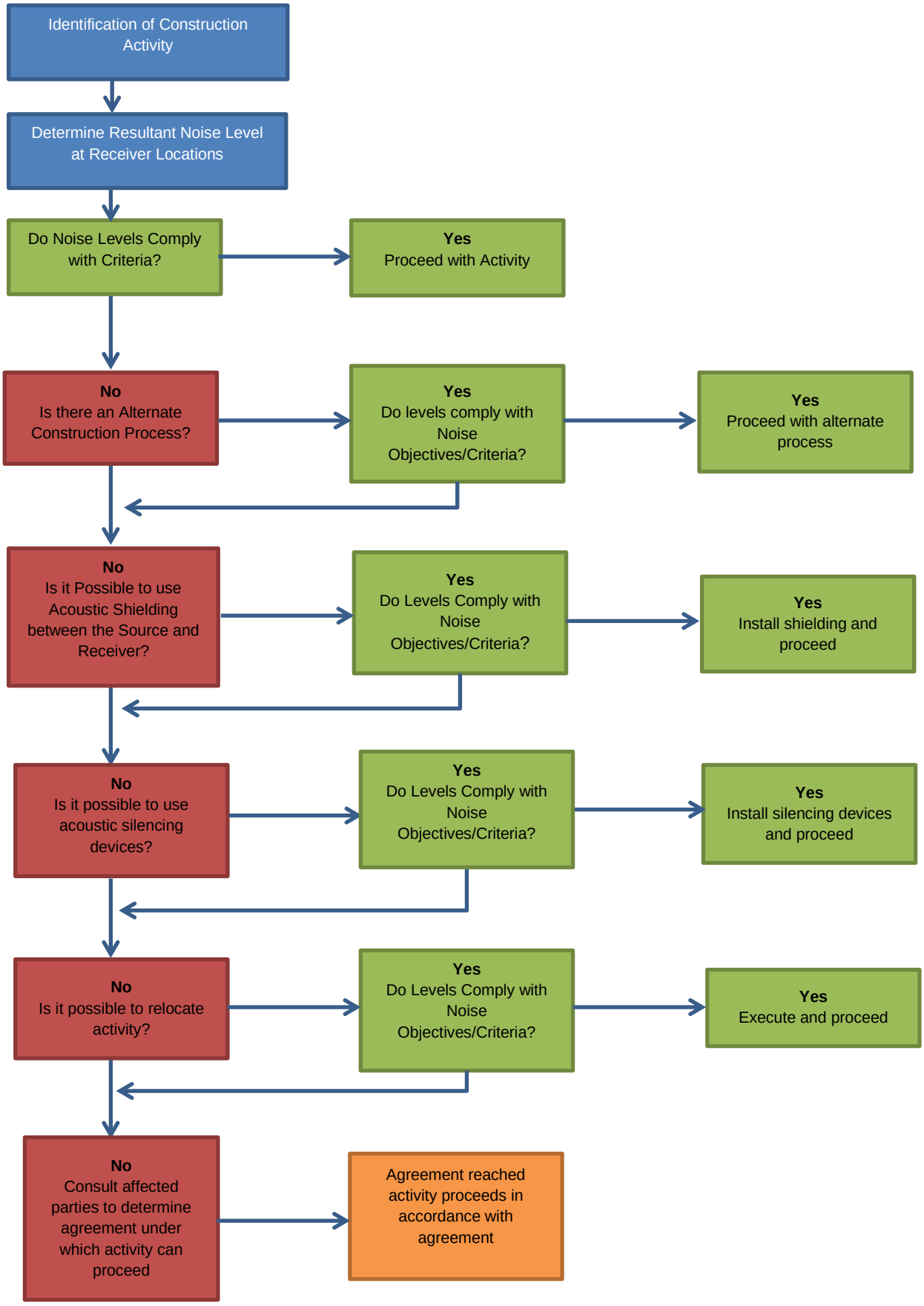


Figure 6: Noise mitigation management flow chart

10.3 Noise & Vibration Monitoring Strategy

10.3.1 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:

- Short term monitoring
- Long-term monitoring

10.3.2 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 letting them know when the noise and vibration criteria are exceeded allowing the selection of alternative method on construction or equipment selection in order to minimise noise and vibration impacts.

10.3.3 Long-term monitoring

Similarly, long-term monitoring uses noise and vibration loggers providing real-time alerts to the builder / site manager when the noise and vibration criteria are exceeded.

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 of 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.

10.3.4 Noise and Vibration Monitoring Programme

The proposed noise and vibration monitoring program during the construction works is outlined in Table 40.

Table 40: Proposed noise and vibration monitoring locations details

Sensitive Receiver Details	Proposed Monitoring Type and Phase
Astor Apartments (NCA02)	Noise – All Phases
	Vibration – Demolition & Excavation

The monitoring programme as shown above is to be carried out during the likely noisiest stages as agreed with the Acoustic Engineer and Contractor.

11. Conclusion

A noise and vibration impact assessment for the proposed development located at 50-52 Phillip Street, Sydney has been conducted. This document forms part of the documentation package to be submitted to local authorities as part of the State Significant Development Application process.

This report has provided criteria, in-principle treatment and design requirements which aim to achieve the statutory criteria discussed in Section 7. In terms of noise and vibration criteria, we have provided the following:

- Operational noise criteria for noise emissions from the development to noise-sensitive receivers (including the existing heritage building of 50 Phillip Street) in accordance with the NPI and NSW Liquor Act 2007 provided in Section 7.2;
- Traffic noise criteria for additional vehicle movements on public roads generated by the proposed development presented in Section 7.2.3;
- Operational vibration criteria for human comfort and structural damage, provided in Section 7.3;
- Construction noise criteria provided in Section 7.4; and
- Construction for human comfort and structural damage, provided in Section 7.5.

The noise impact of Phillip St and Bridge St on the hotel apartments was assessed and modelled, with the results of the assessment provided in Section 8.1. To meet the project internal noise limits, the mitigation measures outlined have been implemented in the design.

The noise levels at the surrounding noise-sensitive receivers by mechanical and electrical plant/equipment are predicted to not exceed the project noise trigger levels established in Section 7.2.2. Should the plant sound power levels exceed levels presented in this report, additional noise mitigation measures may be required. These measures will be developed and implemented in the detailed design phase of the project.

A construction noise and vibration assessment has been conducted to determine the noise and vibration impacts (if any) on the surrounding sensitive receivers (including the existing heritage building located at 50 Phillip Street). The results of the assessment and proposed mitigation measures are provided in Section 10.

Having given regard to the above listed conclusions, it is the finding of this noise and vibration assessment that the proposed development is compliant with the relevant noise and vibration criteria controls for this type of development, as it is expected to comply with all applicable regulations with regards to noise and vibration, particularly those listed above.

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 selection of air-conditioning units, layout of equipment, modifications to the building and introduction of any additional noise sources.

Appendix A Glossary of Acoustic Terms

NOISE	
Acceptable Noise Level:	The acceptable LAeq noise level from industrial sources, recommended by the EPA (Table 2.1, INP). Note that this noise level refers to all industrial sources at the receiver location, and not only noise due to a specific project under consideration.
Adverse Weather:	Weather conditions that affect noise (wind and temperature inversions) that occur at a particular site for a significant period of time. The previous conditions are for wind occurring more than 30% of the time in any assessment period in any season and/or for temperature inversions occurring more than 30% of the nights in winter).
Acoustic Barrier:	Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc. used to reduce noise.
Ambient Noise:	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment Period:	The period in a day over which assessments are made.
Assessment Location	The position at which noise measurements are undertaken or estimated.
Background Noise:	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level.
Decibel [dB]:	The units of sound pressure level.
dB(A):	A-weighted decibels. Noise measured using the A filter.
Extraneous Noise:	Noise resulting from activities that are not typical of the area. Atypical activities include construction, and traffic generated by holidays period and by special events such as concert or sporting events. Normal daily traffic is not considered to be extraneous.
Free Field:	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground
Frequency:	Frequency is synonymous to pitch. Frequency or pitch can be measured on a scale in units of Hertz (Hz).
Impulsive Noise:	Noise having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent Noise:	Level that drops to the background noise level several times during the period of observation.
LAmax	The maximum A-weighted sound pressure level measured over a period.
LAmin	The minimum A-weighted sound pressure level measured over a period.
LA1	The A-weighted sound pressure level that is exceeded for 1% of the time for which the sound is measured.
LA10	The A-weighted sound pressure level that is exceeded for 10% of the time for which the sound is measured.
LA90	The A-weighted level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
LAeq	The A-weighted “equivalent noise level” is the summation of noise events and integrated over a selected period of time.

LAeqT	The constant A-weighted sound which has the same energy as the fluctuating sound of the traffic, averaged over time T.
Reflection:	Sound wave changed in direction of propagation due to a solid object met on its path.
R-w:	The Sound Insulation Rating R-w is a measure of the noise reduction performance of the partition.
SEL:	Sound Exposure Level is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound Absorption:	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter:	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level:	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level:	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise:	Containing a prominent frequency and characterised by a definite pitch.

Appendix B Daily Long-Term (Unattended) Survey Results

Design with
community in mind

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