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SICEEP - THE HAYMARKET

NOISE AND VIBRATION ASSESSMENT

TG015-01F05 (REV 7) STAGE 1 ACOUSTIC ASSESSMENT

15 MARCH 2013

Prepared for:

Lend Lease

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1 INTRODUCTION

1.1 Overview

This report supports a State Significant Development Application (SSD 12_5752) submitted to the Minister for Planning and Infrastructure pursuant to Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Application seeks approval for the establishment of building envelopes and design parameters for a new neighbourhood and a community hub (referred to as The Haymarket) as part of the Sydney international convention, exhibition and entertainment precinct SICEEP Project at Darling Harbour.

The project will develop The Haymarket into one of Sydney's most innovative residential and working districts. Through the delivery of the overall project, Daring Harbour will also become home to Australia's largest convention and exhibition facilities, Sydney's largest red carpet entertainment venue, and a hotel complex of up to 900 rooms. The SICEEP Project importantly forms a critical element of the NSW Government's aspiration to "make NSW number one again".

1.2 Overview of Proposed Development

The proposal relates to a staged development application and seeks to establish concept plan details for The Haymarket, located within the southern part of the SICEEP Site.

The Haymarket will include student housing, public car parking, a commercial office building, and four mixed use development blocks (retail/commercial/residential podium with residential towers above) centred around a new public square to be named Haymarket Square.

More specifically concept approval is sought for the following:

- Demolition of existing site improvements, including the existing Sydney entertainment Centre (SEC), Entertainment car park, and part of the pedestrian footbridge connected to the Entertainment car park and associated tree removal;
- North-west block – construction of a part public car park and part commercial/office building;
- North-east block – construction of a mixed use podium (comprising retail, commercial, above ground parking, and residential) with three residential buildings above;
- South-east block - construction of a mixed use podium (comprising retail, commercial, above ground parking, and residential) with three residential buildings above;
- South-west block - construction of a mixed use podium (comprising retail, commercial, above ground parking, and residential) with three residential buildings above;

- North block – construction of a mixed use building comprising retail, commercial and residential;
- Student housing – construction of two buildings providing for up to 1,000 beds;
- Public domain improvements including a new square, water features, new pedestrian streets and laneways, streetscape embellishments, and associated landscaping. (It is intended that a Stage 2 DA seeking approval for parts of the public domain (The Boulevard and Haymarket Square) will be lodged with the first residential stage);
- Reconfiguration and upgrade of Darling Drive (part);
- Remediation strategy; and
- Car parking rates.

1.3 Background

The existing convention, exhibition and entertainment centre facilities at Darling Harbour were constructed in the 1980s and have provided an excellent service for Sydney and NSW.

The facilities however have limitations in their ability to service the contemporary exhibition and convention industry which has led to a loss in events being held in Sydney.

The NSW Government considers that a precinct-wide renewal and expansion is necessary and is accordingly committed to Sydney reclaiming its position on centre stage for hosting world-class events with the creation of the Sydney international convention, exhibition and entertainment precinct.

Following an extensive and rigorous Expressions of Interest and Request for Proposals process, Darling Harbour Live (formerly known as 'Destination Sydney'- a consortium comprising AEG Ogden, Lend Lease, Capella Capital and Spotless) was announced by the NSW Government in December 2012 as the preferred proponent to transform Darling Harbour and create the new Sydney international convention, exhibition and entertainment Precinct.

Key features of the Darling Harbour Live Preferred Master Plan include:

- Delivering world-class convention, exhibition and entertainment facilities, including:
  - Up to 40,000m^2 exhibition space;
  - Over 8,000m^2 of meeting rooms space, across 40 rooms;
  - Overall convention space capacity for more than 12,000 people;
  - A ballroom capable of accommodating 2,000 people; and
  - A premium, red-carpet entertainment facility with a capacity of 8,000 persons.
- Providing up to 900 hotel rooms in a hotel complex at the northern end of the precinct.

- A vibrant and authentic new neighbourhood at the southern end of the precinct, called 'The Haymarket', home to an IQ Hub focused on the creative industries and high-tech businesses, apartments, student accommodation, shops, cafes and restaurants.
- Renewed and upgraded public domain, including an outdoor event space for up to 25,000 people at an expanded Tumbalong Park.
- Improved pedestrian connections linking to the proposed Ultimo Pedestrian Network drawing people between Central, Chinatown and Cockle Bay Wharf as well as east-west between Ultimo/Pyrmont and the City.

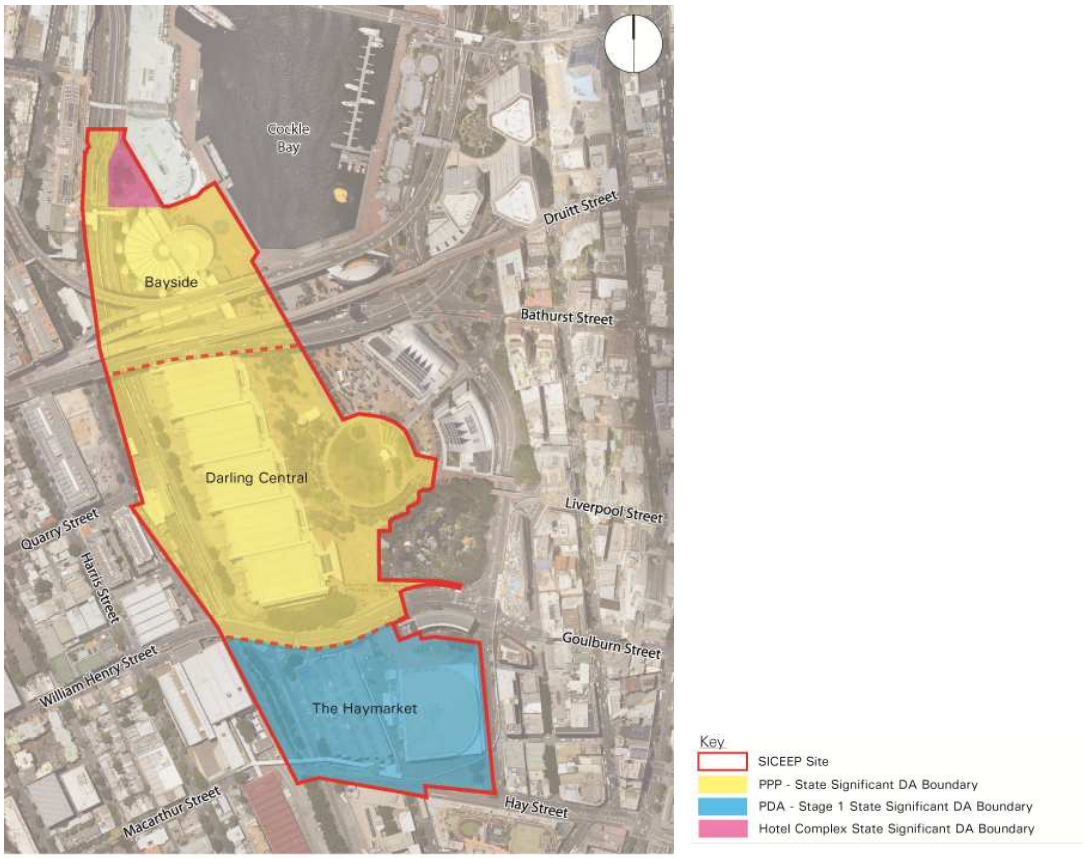
1.4 Site Description

The SICEEP Site is located within Darling Harbour. Darling Harbour is a 60 hectare waterfront precinct on the south-western edge of the Sydney Central Business District that provides a mix of functions including recreational, tourist, entertainment and business.

With an area of approximately 20 hectares, the SICEEP Site is generally bound by the Light Rail Line to the west, Harbourside shopping centre and Cockle Bay to the north, Darling Quarter, the Chinese Garden and Harbour Street to the east, and Hay Street to the south.

The SICEEP Site has been divided into three distinct redevelopment areas (from north to south) – Bayside, Darling Central and The Haymarket. The Application Site area relates to The Haymarket as shown in Figure 1 below.

Figure 1 - Aerial View of Existing Site



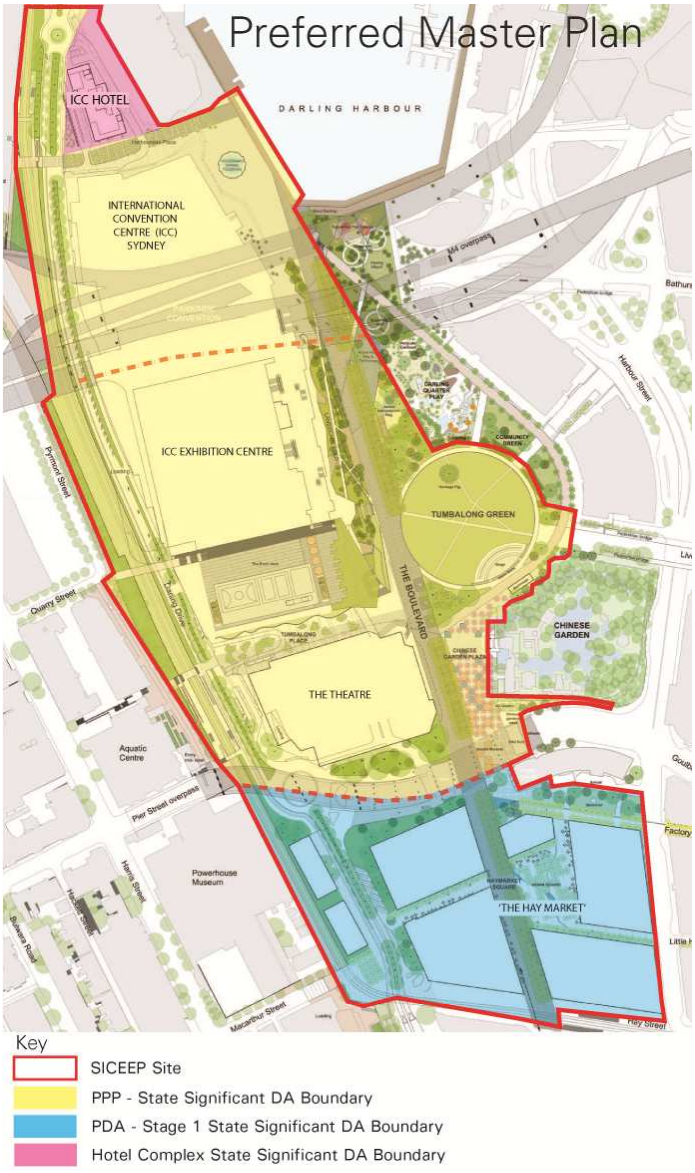
1.5 Planning Approvals Strategy

In response to separate contractual agreements with the NSW Government and staging requirements Lend Lease (Haymarket) Pty Ltd is proposing to submit a number of separate development applications for key elements of the overall Project.

This staged development application involves the establishment of building envelopes and design parameters for a new neighbourhood and a community hub (The Haymarket) within the southern part of the SICEEP Site. Detailed development applications will accordingly follow seeking approval for specific aspects of The Haymarket in accordance with the approved staged development application.

Separate development applications will be lodged for the PPP component of the SICEEP Project (comprising the convention centre, exhibition centre, entertainment facility and associated public domain upgrades) and Hotel complex.

Figure 2 – Proposed Concept Master Plan of SCEEP



1.6 Acoustic Assessment Requirements

Renzo Tonin & Associates has been engaged to prepare a construction and operational noise & vibration assessment of the Stage 1 application for The Haymarket. This report presents an assessment of noise and vibration, in accordance with the Director General's Requirements, and in relation to:

- Demolition and construction noise;
- Operational noise emission from the site such as mechanical services, restaurants and entertainment venues; and
- Noise onto the site from existing sources such as traffic and light rail.

1.6.1 Director General's Requirements

The Director General's Requirements (DGRs) issued by the Department of Planning and Infrastructure for application number SSD 5752-2012 specifically require:

> *Identify the main noise and vibration generating sources and activities at all stages of construction (including demolition), and any noise sources during operation. Outline measures to minimise and mitigate the potential noise impacts to the surrounding area.*
>
> *Relevant Policies and Guidelines:*
>
> - *NSW Industrial Noise Policy (EPA (EPA, 2000)*
> - *Interim Construction Noise Guideline (DECC, 2009)*
> - *Assessing Vibration: A Technical Guideline (DEC, 2006)*
> - *Environmental Criteria for Road Traffic Noise (EPA, 1999)*
> - *State Environmental Planning Policy – Infrastructure 2007*
> - *Development Near Rail Corridors and Busy Road-Interim Guideline*

The above policies and guidelines have been addressed in this report as follows:

Policy or Guideline	Assessment Outline	Report Section
NSW Industrial Noise Policy (EPA (EPA, 2000)	Operational noise from the development and its potential impact on surrounding development	Section 3
Interim Construction Noise Guideline (DECC, 2009)	Assessment of noise during the demolition and construction phase of the development and its potential impact on surrounding development	Section 6
Assessing Vibration: A Technical Guideline (DEC, 2006)	The primary potential for vibration impact generated by the development is during the demolition and construction phase. Also referenced in the State Environmental Planning Policy – Infrastructure 2007 with regard to rail vibration.	Section 6 Section 5.1

Policy or Guideline	Assessment Outline	Report Section
Environmental Criteria for Road Traffic Noise (EPA, 1999)	Assessment of road traffic generated by the development on the local road network and its potential impact on surrounding development.	Section 4
State Environmental Planning Policy – Infrastructure 2007	Assessment of noise onto the development from busy roads and rail corridors.	Section 5.1
Development Near Rail Corridors and Busy Road-Interim Guideline	Supporting guideline for the State Environmental Planning Policy – Infrastructure 2007.	Section 5.1

1.7 Scope of Assessment

Given that the application seeks approval for the Stage 1 application only, the following outlines the scope of assessment with respect to the above policies and guidelines:

- Examine the proposed concept plan to identify all acoustic components of the demolition, construction, and operation of the developments, in accordance with the Director General's Requirements.
- Identify the sensitive receiver locations, including existing receivers affected by construction works, and future receivers affected by operations.
- Conduct noise level monitoring to establish the existing noise environment at the site and surrounding receiver locations for the purpose of quantifying the applicable noise targets for the project.
- Where data to an appropriate detail is available, carry out a quantitative acoustic assessment of potential impacts and compare against the relevant criteria.
- Where further design development is required to carry out a quantitative assessment, a qualitative assessment has been used to identify in-principle methods by which noise and vibration impact can be addressed in the design.
- Provide description of the assessment methodology to be adopted during the detailed design phase.

2 EXISTING NOISE ENVIRONMENT & NEAREST SENSTIVE RECEIVERS

2.1 Nearest Sensitive Receivers

The nearest potentially affected receivers to the development site are presented in Table 1. Figure 3 on the following page presents the site and surrounds of the study area along with the assessment locations and measurement locations detailed in this Section.

Table 1 – Nearest Receivers

Receiver ID	Receiver Location	Distance from Boundary of Site (Approx. m)
	Residential/Hotel Receivers	
R1	The Peak Apartments (Market City) - 2 Quay St	70
R2	Holiday Inn Hotel – 68 Harbour St	25
R3	Southern Cross on Harbour (Seasons Darling Harbour) – 38 Harbour St	75
R4	Novotel Rockford Hotel – 17 Little Pier St	30
	Commercial Receivers	
C1	Market City – 9-13 Hay St	20
C2	Restaurants on Harbour St, between Hay St & Goulburn St	25
C3	Pumphouse – (Heritage building) – 17 Little Pier St	15
C4	The Powehouse Museum – 500 Harris St	20
	Other Sensitive Receivers	
E1	UTS – Quay St	15

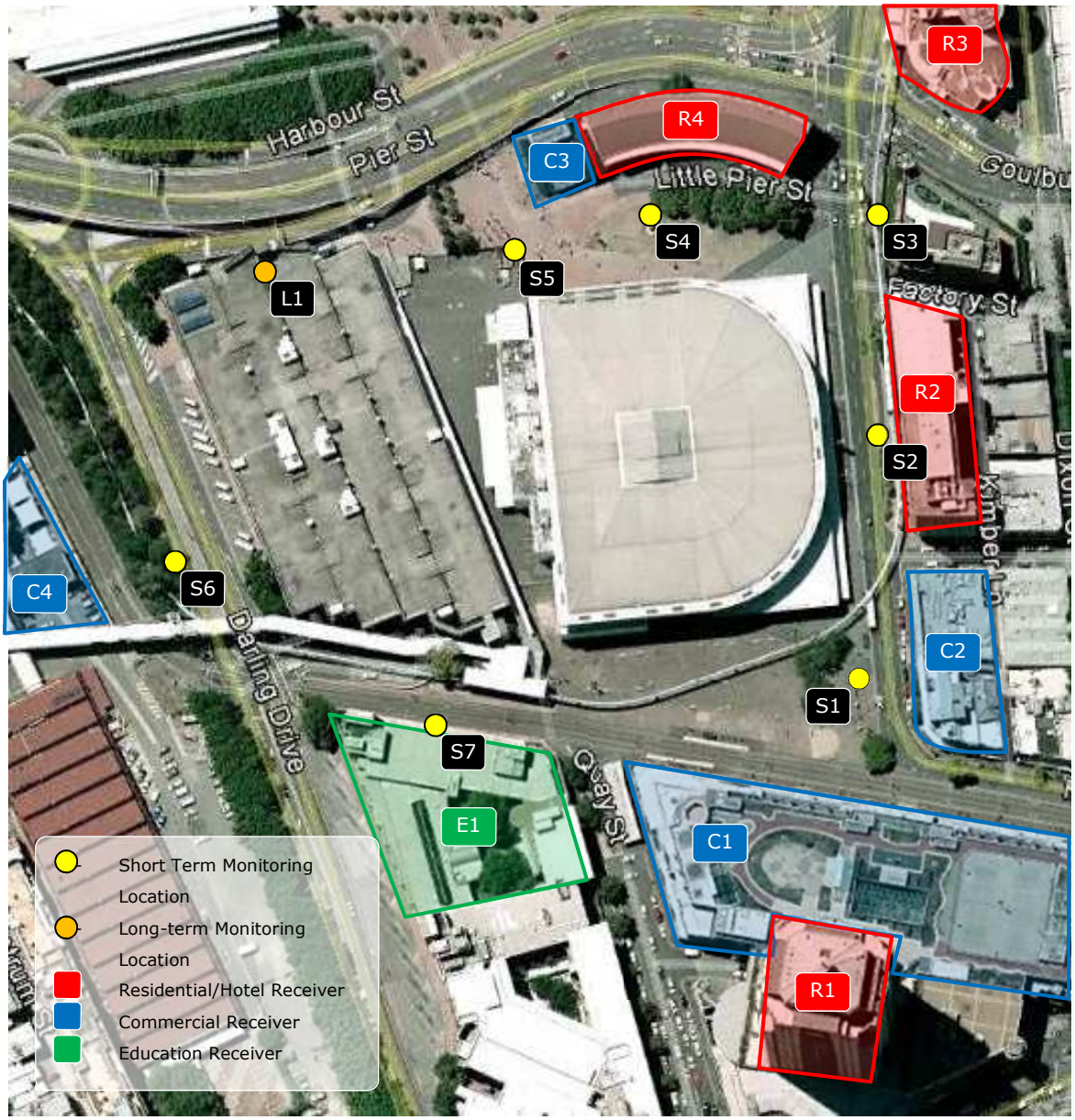


Figure 3 – Locality Map showing Receiver and Measurements Locations

2.2 Existing Noise Environment

Noise impact at the residential receiver locations is assessed against noise goals established from the existing noise environment of the area prior to the subject development. Appendix B of the NSW EPA Industrial Noise Policy (INP) presents two methods of determining the background noise levels of an area being '*B1 – Long-term background noise method*' and '*B2 – Short-term background noise method*'. For the subject assessment, a combination of long-term and short-term noise monitoring was undertaken to establish the existing acoustic environment.

Background noise varies over the course of any 24 hour period, typically from a minimum at 3am in the morning to a maximum during morning and afternoon traffic peak hours. Therefore, the NSW *Industrial Noise Policy* (INP, Environment Protection Authority 2000) requires that the level of background and ambient noise be assessed separately for the daytime, evening and night-time periods. The INP defines these periods as follows:

- **Day** is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
- **Evening** is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
- **Night** is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.

2.2.1 Long-term noise monitoring

Long-term noise measurements were undertaken by AECOM as part of a previous acoustic assessment of the SICEEP development [*SICEEP Acoustic Design Brief*. Document No. SICEEP-ES-AC-R-0-001, dated 24th August 2012]. Of the four long-term monitoring locations, one location was relevant to The Haymarket.

- Location L1 Sydney Entertainment Centre Rooftop Car Park

  On the roof top level of the multi storey car park, in the 'free field', approximately 15m from Pier Street. Noise data represents the ambient and background noise for the proposed development in the north-west area of The Haymarket. Monitoring was carried out between 21st May and 29th May 2012.

Existing background and ambient noise levels are presented in Table 2 below.

Table 2 – Measured Existing Background (L_{90}) & Ambient (L_{eq}) Noise Levels, dB(A)

Location	L_{90} Background Noise Levels			L_{eq} Ambient Noise Levels		
	Day	Evening	Night	Day	Evening	Night
Location L1 – Entertainment Centre Rooftop Car Park	60	58	51	68	66	64

Notes: Day is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
Night is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.

2.2.2 Short-Term Attended Noise Monitoring

In order to supplement the long-term noise monitoring, and provide greater detail of the noise environment surrounding the site, short-term noise measurements were undertaken at the following locations during the daytime of Wednesday 6th and night time of Friday 8th February 2013.

Table 3 – Short-term monitoring Locations

Measurement Location ID	Location Description
S1	Harbour St, near Hay St, Haymarket Western side of Harbour St, opposite Xi'an Cuisine restaurant, 5m from the curb, in the free field. Noise data represents the existing background and ambient noise incident on the proposed residential development in the south east corner of the precinct.
S2	Harbour St, Holiday Inn Hotel, Haymarket Eastern side of Harbour St, 10m north of the Holiday Inn lobby entrance, 3.5m from the façade, in the free field. Noise data represents existing background and ambient noise for residents of the Holiday Inn hotel.
S3	Harbour St, near Goulbourn St, Haymarket Eastern side of Harbour St, in front of the Harbour Plaza building, next to the entrance to the Red Chilli Sichuan Restaurant, 3.5m from the curb, in the free field. Noise data represents the existing background noise for the commercially used Harbour Plaza building.
S4	Novotel Hotel, Little Pier St, Haymarket South side of Little Pier St, opposite the Novotel lobby, 20m from building, in the free field. Noise data represents existing background noise for residents of the Novotel hotel.
S5	The Pumphouse Restaurant & Bar, Little Pier St, Haymarket South side of Pumphouse building, public thoroughfare area, 15m from outdoor area of bar, in the free field. Noise data represents existing operational noise levels from licenced venue, incident on proposed residential development.
S6	Darling Drive, Haymarket Nature strip on western side of Darling Drive, 6m from the edge of the inside lane of traffic, in the free field. Opposite the Sydney Entertainment Centre car park. Noise data represents existing background noise, incident on the proposed residential development.
S7	UTS building, Quay St, Haymarket North side of the UTS building, facing the light rail lines, 3.5m from the building façade, approximately 5m from the eastern side of the building, in the free field. Noise data represents existing background noise for the UTS educational building.

The equipment used for the noise measurements was a Brüel & Kjær Type 2250 precision sound level analyser which is a Class 1 instrument having an accuracy suitable for field and laboratory use. The instrument was calibrated prior and subsequent to measurements using a Bruel & Kjaer Type 4231 calibrator. No significant drift in calibration was observed. All instrumentation complies with AS IEC 61672.1 2004 "Electroacoustics - Sound Level Meters" and carries current NATA certification (or if less than 2 years old, manufacturers certification).

A detailed summary of the short-term measurement data is presented for reference in Appendix B. The short-term monitoring has been referenced against the long-term noise monitoring undertaken by AECOM so as to establish indicative day, evening and night background and ambient noise levels for the standard INP assessment periods. This has been carried out for the residential receiver locations only. It is recommended that detailed long-term noise monitoring be carried out for the design development phase of the project to confirm noise levels at existing receiver locations.

Table 4 – Measured Existing Background (L_{90}) & Ambient (L_{eq}) Noise Levels, dB(A)

Location	L_{90} Background Noise Levels			L_{eq} Ambient Noise Levels		
	Day	Evening	Night	Day	Evening	Night
R1 – Peak Apartments	55	53	51	61	59	58
R2 – Holiday Inn	57	57	51	67	66	64
R3 - Southern Cross on Harbour	60	58	51	68	66	64
R4 – Novotel	58	56	51	61	59	58

Notes: Day is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
Night is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.

3 OPERATIONAL NOISE

3.1 Operational Noise Criteria

3.1.1 EPA Industrial Noise Policy

In accordance with the DGRs, noise impact from the general operation of the proposed development is to be assessed against the NSW Industrial Noise Policy (INP). The assessment procedure in terms of the INP has two components:

- Controlling intrusive noise impacts in the short term for residences
- Maintaining noise level amenity for particular land uses for residences and other land uses.

In accordance with the INP, noise impact should be assessed in terms of both intrusiveness and amenity. Table 5 sets out the established noise criteria based on the background and ambient noise monitoring carried out at the nearest affected residential locations.

Table 5 – Project Specific Industrial Noise Criteria

Receiver ID	Intrusiveness Criteria $L_{Aeq,15min}$			Amenity Criteria[1] $L_{Aeq, period}$		
	Day	Evening	Night	Day	Evening	Night
R1 - The Peak	60	58	56	58	43	41
R2 - Holiday Inn	62	62	56	57	47	41
R3 - Seasons	65	63	56	52	48	41
R4 - Novotel Rockford	63	61	56	56	46	41
C1 - Market City	-	-	-	65 (when in use)		
C2 - Restaurants on Harbour St	-	-	-	65 (when in use)		
C3 - Pumphouse	-	-	-	65 (when in use)		
C4 - The Powerhouse	-	-	-	65 (when in use)		
E1 - UTS	-	-	-	35 (Internal - Noisiest 1hr when in use)		

Notes: *Residential locations have been categorised as 'Urban'.*

Conservatively, the amenity criterion have been modified in accordance with Table 2.2 assuming the existing industrial noise contribution equals the measured background level, and that the existing noise level is unlikely to decrease in the future.

The high traffic noise environmental criteria has not been applied in the criteria above as noise level measurements were carried out at street level and lo0wer noise levels are expected at upper levels of development.

The INP amenity criterion requires assessment of total industrial noise emission/impact. In the case of a large development site such as SICEEP, the cumulative impact of the development needs to be considered to the surrounding receivers.

3.1.2 Licensed Premises

It should be noted that licensed premises will be subject to separate Development Applications for their specific use. Notwithstanding, the following information is provided with regard to operational noise from liquor licensed premises within the City of Sydney Council area.

City of Sydney Council's Standard Conditions of Development Consent (revised 2 April 2012) Condition 61 refers to Noise related to Licensed Premises. This is generally in-line with the Office of Liquor Gaming and Racing's 'Standard Noise Condition' except for part d) which relates to assessment within commercial premises;

a) The L_{A10} noise level emitted from the licensed premises shall not exceed the background noise level in an Octave Band Centre Frequency (31.5Hz – 8kHz inclusive) by more than 5dB between 7:00am and 12:00 midnight at the boundary of any affected residence.

b) The L_{A10} noise level emitted from the licensed premises shall not exceed the background noise level in an Octave Band Centre Frequency (31.5Hz – 8kHz inclusive) between 12:00 midnight and 7:00am at the boundary of any affected residence.

c) Notwithstanding compliance with (a) and (b) above, the noise from the licensed premises shall not be audible within any habitable room in any residential premises between the hours of 12:00 midnight and 7:00am.

d) The L_{10} noise level emitted from the use must not exceed the background noise level (L_{90}) in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) by more than 3dB when assessed indoors at any affected commercial premises.

e) The use of the premise must be controlled so that any emitted noise is at a level so as not to create an "offensive noise" as defined in the Protection of the Environment Operations Act 1997 to any affected receiver.

3.1.3 Residential Air Conditioning

The *Protection of the Environment Operations (Noise Control) Regulation 2008* limits the amount of noise generated in residential areas. Provisions relating to the use of air conditioners on residential premises aim to minimise the impact from this specific noise source.

Noise generated by air conditioners on residential premises is limited by Part 52 'Air conditioners' of the *Protection of the Environment Operations (Noise Control) Regulation 2008*. The Regulation states that:

1. A person must not cause or permit an air conditioner or heat pump water heater to be used on residential premises in such a manner that it emits noise that can be heard within a habitable room in any other residential premises (regardless of whether any door or window to that room is open):

   (a) Before 8am or after 10pm on any Saturday, Sunday or public holiday, or
   (b) Before 7am or after 10pm on any other day.

   Maximum penalty: 100 penalty units in the case of a corporation, 50 penalty units in the case of an individual.

2. A person is not guilty of an offence under subclause (1) in relation to a heat pump water heater if the conduct alleged to give rise to the offence occurs within 6 months after the commencement of this Regulation.
3. A person is not guilty of an offence under subclause (1) unless:

    (a) the person has, within 7 days after causing or permitting an air conditioner or heat pump water heater to be used in such a manner, been warned by an authorised officer or enforcement officer not to cause or permit the air conditioner or heat pump water heater to be used in that manner, and
    (b) the person causes or permits an air conditioner or heat pump water heater to be used in that manner within 28 days after the warning has been given.

4. In this clause: **"heat pump water heater"** means a device that heats water using the energy generated from the compression of a gas.

As prescribed in The *Protection of the Environment Operations Act 1997* (PEO Act), non-compliance with the above is deemed 'offensive noise', which is defined in the Act as follows:

(a) that, by reason of its level, nature, character or quality, or the time at which it is made or any other circumstances:

    (i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or
    (ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or

(a) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in any other circumstances prescribed by the regulations.

3.2 Assessment and Recommendations

The operational noise sources associated with the development are considered to be:

- Mechanical plant and equipment, including residential air-conditioners; and
- Activity associates with restaurants, cafes and other retail uses, which could include patrons, music and loading docks etc.

3.2.1 Mechanical Plant Noise

The scope of this report is to present the noise criteria and objectives for the Concept Plan only as insufficient detail is available at this stage to allow a quantitative assessment. Detailed acoustic assessment of mechanical plant noise emission will occur during the design development phase of each development, at a time when specifications and plant selection have been made.

Noise emission from mechanical plant equipment, including residential air-conditioners, serving each building will be assessed with regard to both existing and future land uses surrounding the site. The specific noise targets for mechanical plant noise emission from each development within the precinct must also have regard to any cumulative noise impacts, in accordance with the INP amenity criteria requirements. As the SICEEP development will be staged, the cumulative noise of all mechanical noise cannot be assessed at any one point in time during the design phase. Therefore noise goals should be set during the first detailed development assessment (Stage 2 Development Application) to ensure that allowance is made for any potential cumulative impact of the Haymarket. With regard to the cumulative impact of the Haymarket and Darling Central (SSDA1), there were no common sensitive receptors identified other than the Novotel. However, as Darling Central would be assessed to the northern façade of the Novotel, and the Haymarket assessed to the southern façade, the two components of the SICEEP are not expected to result in any adverse cumulative impact at Novotel site.

The design development of the mechanical services equipment should give due regard to the following recommendations:

- As noise control treatment can affect the performance of the mechanical services system, it is recommend that consultation with an acoustic consultant be made during the initial phase of mechanical services system design in order to reduce the need for revision of mechanical plant and noise control treatment;
- Mechanical plant noise emission can be controllable by appropriate mechanical system design and implementation of common engineering methods that may include any of the following:
    - procurement of 'quiet' plant ;
    - strategic positioning of plant away from sensitive neighbouring premises, maximising the intervening shielding between the plant and sensitive neighbouring premises ;
    - commercially available silencers or acoustic attenuators for air discharge and air intakes of plant;
    - acoustically lined and lagged ductwork;
    - acoustic screens and barriers between plant and sensitive neighbouring premises; and/or
    - partially-enclosed or fully-enclosed acoustic enclosures over plant, particularly where receptor locations are in close proximity or overlooking plant equipment locations.
- Mechanical plant shall have their noise specifications and their proposed locations checked prior to their installation on site; and
- Fans shall be mounted on vibration isolators and balanced in accordance with Australian Standard 2625 “Rotating and Reciprocating Machinery – Mechanical Vibration”.

Given the location of future buildings and their proximity to one another, the design and extent of any mechanical plant noise mitigation is expected to be governed by the assessment to the future development within the SICEEP site, rather than existing receivers surrounding the site.

3.2.2 Retail Operations

The concept plans indicate that the proposed ground floor occupancies of the proposed buildings in The Haymarket are to include commercial/retail use. This may include liquor licensed venues, cafes, restaurants and retail shops. As the specific uses are not defined within this application, the uses would be subject to detailed design at a later stage of the development, such as the Stage 2 Development Applications.

In regards to noise management, current noise policy places the onus of noise control on the noise generator, and therefore the proposed ground floor retail uses would need to give consideration to potential impact upon any existing and future residential premises. The proximity of the existing and future residential receivers to the retail precinct may result in the imposition of noise management and mitigation measures for the retail premises. This may determine design aspects such as operating hours, patron capacities, building envelope design and internal acoustic treatment. This matter is also discussed within Section 5.3 in regards to impact onto the future residential premises. It has been considered that noise mitigation at the future receptor locations may also be considered within the Precinct.

In regards to loading docks, all docks are to be enclosed within the lower level of each building, therefore being acoustically shielded from sensitive receiver locations. The loading docks are proposed to be accessed via the primary car park entries off Harbour St and Darling Drive. Notwithstanding their location, assessment of each loading dock should be carried out during the design development stage of each building, so as to confirm whether any additional noise control or management measures are required, inclusive of acceptable operating hours.

4 ROAD TRAFFIC GENERATED BY DEVELOPMENT

4.1 Noise Criteria

Noise impact as a result of increased traffic generated on the surrounding road network is required to be assessed in accordance with the EPA *Environmental Criteria for Road Traffic Noise* (ECRTN) as prescribed in the DGRs. Whilst reference is made to the ECRTN, it is noted that this policy has been superseded by the EPA's 'Road Noise Policy' (RNP, 2011). The road traffic noise assessment presented in this report has been made against the most current policy.

4.1.1 Residential Receivers

The RNP is used to assess the potential traffic noise impact from both road infrastructure developments and from additional traffic generated by developments. The RNP criteria for residential type receivers, relevant to the subject proposal, are presented in Table 6.

Table 6 – Road Traffic Noise Assessment Criteria for Residential Land Uses

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

4.1.2 Sensitive Land Use Developments

The RNP also sets guidelines for the assessment of traffic noise on sensitive land uses such as schools, hospitals, places of worship and recreation areas. The University of Technology Sydney building located on Quay Street contains classrooms directly adjacent to the proposed development and may be subject to additional traffic noise from Darling Drive. The applicable road traffic noise criterion is set out in Table 4 of the RNP and is presented in Table 7 below.

Table 7 – Road traffic noise assessment criteria for non-residential land uses affected by proposed road projects and traffic generating developments

Existing sensitive land use	Assessment Criteria, dB(A)		Additional considerations
	Day (7am-10pm)	Night (10pm-7am)	
School classrooms	$L_{Aeq,(1\ hour)}$ 40 (internal) when in use	–	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2000 (Standards Australia 2000).

4.2 Road Traffic Assessment

Road traffic generated by the proposed SICEEP development has been assessed in the Hyder *Traffic and Transport Assessment* prepared for this application. The report includes existing and future traffic flows for the roads surrounding the precinct. Assessment is required for the impact upon existing receivers in the area. A summary of the predicted noise levels and the applicable criteria for assessment and are presented below.

The roads providing access around the SICEEP precinct are classed as arterial and sub arterial roads, and will retain these classifications upon development, incorporating any increase in traffic flow. The Hyder report examines the cumulative impact of traffic resulting from the entire SICEEP development, however assessment described in this report is focussed specifically on The Haymarket. The roads surrounding The Haymarket include:

- Hay Street;
- Harbour Street;
- Pier Street; and
- Darling Drive.

Table 8 provides a summary of the existing and predicted traffic flows for The Haymarket from the Hyder report. Traffic flows were measured at the intersections connecting the subject roads. Whilst traffic noise impacts on sub-arterial and arterial roads are to be assessed against the 15-hour (7am – 10pm) and 9 hour (10pm – 7am) periods, the traffic predictions are for the peak 1-hour periods only, being Friday evening from 5:30pm to 6:30pm and Saturday between 7:00pm and 11:00pm. The assessment therefore assumes that the relative increase in road traffic is equivalent to that forecast for the peak periods.

Further to the above, the assessment has been carried out in terms of the relative increase in noise. By reference to the NSW ECRTN, an increase of no more than 2dB(A) is accepted even if existing noise levels exceeded the relevant criteria. The predicted noise levels increases, as shown in Table 8, are all below 2dB(A) which is considered acceptable.

Table 8 – Predicted Increase in Road Traffic Noise

Location	Existing (vehicles/hr)	Future growth + Development (vehicles/hr)	Percentage Increase	Increase in Noise Level (dB)
Friday pm Peak Period				
Hay St West of Sussex St	465	667	43%	1.6
Harbour St South of Goulburn St	468	538	15%	0.6
Pier St East of Darling Dr	987	1314	33%	1.2
Pier St West of Harbour St	2503	2836	13%	0.5
Darling Dr South of Pier St	674	1046	55%	1.9

Location	Existing (vehicles/hr)	Future growth + Development (vehicles/hr)	Percentage Increase	Increase in Noise Level (dB)
Saturday pm Peak Period				
Hay St West of Sussex St	465	635	37%	1.4
Harbour St South of Goulburn St	439	510	16%	0.7
Pier St East of Darling Dr	1175	1500	28%	1.1
Pier St West of Harbour St	2241	2571	15%	0.6
Darling Dr South of Pier St	728	1046	44%	1.6

5 NOISE IMPACT UPON DEVELOPMENT

5.1 Overview

Noise from the existing environment onto the proposed SICEEP development should be considered and assessed in the design of the buildings for their specific uses. Noise sources for consideration and relevant criteria and potential mitigation measures are discussed below.

5.2 Road Traffic & Light Rail

In accordance with the DGRs, impact from road and rail should be assessed in accordance with the NSW the State Environmental Planning Policy (Infrastructure) 2007 (known as the 'ISEPP').

In regards to road traffic, all of the surrounding roads are identified as being below 20,000AADT [http://www.rta.nsw.gov.au/publicationsstatisticsforms/downloads/traffic_volume_maps/uts_esa_map_16.pdf] and therefore do not require assessment in accordance with the ISEPP.

Assessment of light rail is however required. The rail noise criteria stipulated in the ISEPP are as follows:

8*7 Impact of rail noise or vibration on non-rail development*

1. *This clause applies to development for any of the following purposes that is on land in or adjacent to a rail corridor and that the consent authority considers is likely to be adversely affected by rail noise or vibration:*

    f) a building for residential use,
    g) a place of public worship,
    h) a hospital,
    i) an educational establishment or child care centre.

2. *Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Director-General for the purposes of this clause and published in the Gazette.*
3. *If the development is for the purposes of a building for residential use, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:*

    a) in any bedroom in the building--35 dB(A) at any time between 10.00 pm and 7.00 am,
    b) *anywhere else in the building (other than a garage, kitchen, bathroom or hallway)-40 dB(A) at any time*.

5.2.1 Development in Rail Corridors and Busy Roads – Interim Guideline

To support the ISEPP, the NSW Department of Planning released the *Development in Rail Corridors and Busy Roads – Interim Guideline* (December 2008). The Guideline assists in the planning, design and assessment of developments in, or adjacent to, major transport corridors in terms of noise, vibration and air quality.

The Guideline provides general guidance for strategic planning purposes, for Councils and other government agencies or private proponents investigating possible locations for new residential and other sensitive development that require development approval. It provides guidance on site selection to reduce or avoid the need for mitigation measures specifically to new residential developments. It also provides guidance with specific mitigation measures.

5.2.1.1 Clarification of ISEPP Noise Limits

The Guideline clarifies the time period of measurement and assessment. As stated in the Guideline in Section 3.4 'What Noise and Vibration Concepts are Relevant' and Table 3.1 of Section 3.6.1, noise measurements are determined over the following relevant time periods:

- Daytime 7am-10pm $L_{Aeq(15hr)}$
- Night-time 10pm-7am $L_{Aeq(9hr)}$

L_{Aeq} is the Equivalent Continuous Noise Level and accounts for both the level of fluctuating noise and also the number of noise events over the time period. The noise criteria nominated in the ISEPP are internal noise levels with windows and doors closed and the requirements are stated in the following table.

Table 9 – ISEPP Internal Noise Criteria

Internal Space	Time Period	Noise Metric	Internal Criteria
Bedrooms	10pm to 7am	$L_{Aeq(9hrs)}$	35
Other Habitable Rooms	Any Time	$L_{Aeq(15hrs)}$ and $L_{Aeq(9hrs)}$	40

Notes: *with windows and doors closed*

The Guideline in Section 3.6.1 'Airborne Noise' states as follows;

"If internal noise levels with windows or doors open exceed the criteria by more than 10dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia."

5.2.2 Rail Vibration Guidelines

For disturbance to human occupants of buildings, the ISEPP guideline refers to the DECC's *'Assessing Vibration; a technical guideline'* (DECC, 2006), which is based on BS 6472-1992 *'Evaluation of human exposure to vibration in buildings (1-80Hz)'*. Vibration sources are defined as C*ontinuous, Impulsive or Intermittent.* Section 2 of the DECC guideline defines each type of vibration as follows:

> ***'Continuous*** *vibration continues uninterrupted for a defined period (usually throughout the day-time and/or night-time).*

Impulsive *vibration is a rapid build up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds.*

Intermittent *vibration can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude'.*

Vibration from train passbys is defined as **intermittent**.

The criteria is to be applied to a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states:

'Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472).'

Intermittent vibration is to be assessed using vibration dose values (VDVs). The VDV method is a fourth power approach which is more sensitive to peaks in the acceleration waveform and makes corrections to the criteria based on the duration of the source's operation. The VDV can be calculated using the overall weighted rms acceleration of the vibrating source in each orthogonal axis and the total period during which the vibration may occur. Weighting curves are provided in each orthogonal axis in the guideline. Preferred and maximum VDV values are defined in Table 2.4 of the guideline and are reproduced in Table 10 below.

Table 10 – Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred values	Maximum values	Preferred values	Maximum values
Critical areas[2]	0.10	0.20	0.10	0.20
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
Workshops	0.80	1.60	0.80	1.60

Notes: 1. Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am

2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source: BS 6472-1992

5.2.3 Rail Assessment

Noise and vibration impact from light rail would be addressed in detail during the Stage 2 Development Applications and design development stage of each residential component. Of note is the rail squeal identified during cornering near Darling Drive, which was observed during short-term noise monitoring. It is recommended that such noise be addressed at the source, rather than by the residential building envelope and suggest discussion with Transport NSW to establish measures available to reduce the curve squeal at the track.

5.3 SICEEP Ground Floor Retail

The concept plans indicate that the proposed ground floor occupancies of the proposed buildings in The Haymarket are to be commercial/retail use. This may include liquor licensed venues, cafes, restaurants and retail shops. As discussed in Section 3.2.2, the specific uses are not defined within this application and therefore would be subject to detailed design at a later stage of the development.

In regards to noise management, current noise policy places the onus of noise control on the noise generator, and therefore the proposed ground floor uses would need to give consideration to potential impact upon any existing and future residential premises. It is however noted that where vibrant environments are sought in the public realm, noise impact at residential premises, particularly future premises within the SICEEP, may be addressed through the design of the residential buildings. This may also be required where residential development is to be located in proximity to existing noise generating development such as the Pumphouse (adjacent Novotel) and restaurants on Harbour Street. Assessment and determination of the required noise management and mitigation methods should be determined at the detailed development application stages for each building at the Stage 2 Development Application stage.

5.4 The Theatre

The new Theatre is proposed to be located adjacent to The Haymarket, to the north of Pier Street. The Theatre has been assessed as part of SSDA1, and detailed in AECOM noise and vibration impact assessment report 60263715 dated 6 March 2013. Noise emission from The Theatre would be required to be controlled at the source and therefore is not considered a constraint to residential development within The Haymarket.

It is understood that the existing Sydney Entertainment Centre will be demolished prior to completion of any buildings within The Haymarket.

6 DEMOLITION AND CONSTRUCTION

6.1 Projected Program & Schedule

At this stage of the development the program for demolition and construction of the Haymarket is not confirmed and will be dependent upon both the approvals process and market factors. However an indicative development program is set out below, in order to provide an indication of the potential overlap in works across the Haymarket.

- Demolition Early 2014 - Mid 2014
- West Plot Mid 2014 - Late 2016
- North West Mid 2014 - Late 2016
- South West Mid 2014 - Mid 2017
- North East Mid 2016 - Late 2018
- South East Late 2017 - Late 2019
- North Late 2017 - Late 2018

The indicative program above suggests that there will be periods where more than one section of the Haymarket will be under construction, however are expected to be at different stages of development. Noise and vibration management from the site should therefore consider the cumulative impact of construction works.

6.2 Construction Noise Guideline

Construction activities related to the development of the site should be managed and assessed in accordance with the NSW *Interim Construction Noise Guideline* (*ICNG)*. This document is currently issued as an interim guideline, and is being referred to as the NSW standard policy for assessing construction noise on new projects.

The key components of the ICNG that can be incorporated into this assessment include:

1. Use of L_{Aeq} as the descriptor for measuring and assessing construction noise

In recent years NSW noise policies including the Industrial Noise Policy (INP) and the Environmental Criteria for Road Traffic Noise (ECRTN) have moved to the primary use of L_{Aeq} over any other descriptor. As an energy average, L_{Aeq} provides ease of use when measuring or calculating noise levels since a full statistical analysis is not required as when using, for example, the L_{A10} descriptor. Consistent with the latest guideline (ICNG) the use of L_{Aeq} as the key descriptor for measuring and assessing construction noise is to be used.

2. Application of feasible and reasonable noise mitigation measures

As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice, and is practical to build given the project constraints. Selecting reasonable mitigation measures from those that are feasible involves making a judgement to

determine whether the overall noise benefit outweighs the overall social, economic and environmental effects, including the cost of the measure. In other words the suitability of noise mitigation to each site needs to be considered.

3. Quantitative and qualitative assessment

The ICNG provides two methods for assessment of construction noise, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement and prediction of noise levels, and assessment against set criteria.

A qualitative assessment is recommended for small projects with a short-term duration where works are not likely to affect an individual or sensitive land use for more than three weeks in total. It focuses on minimising noise disturbance through the implementation of feasible and reasonable work practices, and community notification.

4. Management Levels

Residences

Table 11 below (reproduced from Table 2 of the ICNG) sets out the noise management levels and how they are to be applied. The rating background level (RBL) is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours).

As noted in Table 11, the proposed construction hours are modified from those set out in the ICNG. The proposed hours of 7:00am to 7:00pm Monday to Friday and 8:00am to 5:00pm Saturdays are however consistent with the standard approved construction hours for other major projects in the Sydney CBD such as Barangaroo. They have therefore been adopted as 'standard hours' in the context of the ICNG for this project.

Table 11 – Noise at Residences Using Quantitative Assessment

Time of Day	Management Level $L_{Aeq\ (15\ min)}$*	How to Apply
Proposed Standard Hours: Monday to Friday 7:00am to 7:00pm Saturdays 8:00am to 5:00pm*	Noise affected RBL + 10dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. ▪ Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. ▪ The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. ▪ Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5dB(A)	▪ A strong justification would typically be required for works outside the recommended standard hours. ▪ The proponent should apply all feasible and reasonable work practices to meet the noise affected level. ▪ Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. ▪ For guidance on negotiating agreements see section 7.2.2.

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

Commercial and Industrial Premises

The process of defining management levels for commercial and industrial premises is separated into three categories as follow;

- Industrial premises: external $L_{Aeq\ (15\ min)}$ 75 dB(A)
- Offices, retail outlets: external $L_{Aeq\ (15\ min)}$ 70 dB(A)
- Other businesses that may be very sensitive to noise, where the noise level is project specific.

The recommended 'maximum' internal noise levels in AS/NZS 2107:2000 'Acoustics – Recommended design sound levels and reverberation times for building interiors' may be referenced to assist in the determination of relevant noise levels for other noise-sensitive businesses.

6.3 Construction Noise Goals

Table 12 below sets out the construction noise goals relevant for the various receiver locations.

Table 12 – Construction Noise Targets, dB(A)

Receiver ID	Receiver Location	Standard Construction Hours*		
		Day RBL	Noise Affected	Highly Noise Affected
R1	The Peak Apartments (Market City) - 2 Quay St	55	65	75
R2	Holiday Inn Apartments – 68 Harbour St	57	67	75
R3	Southern Cross on Harbour (Seasons Darling Harbour) – 38 Harbour St	60	70	75
R4	Novotel Rockford Hotel – 17 Little Pier St	58	68	75
C1	Market City – 9-13 Hay St	-	70	75
C2	Harbour St Restaurants, btw Hay St & Goulburn St	-	70	75
C3	Pumphouse (Heritage building) – 17 Little Pier St	-	70	75
C4	The Powerhouse Museum – 500 Harris St	-	70	75
E1	UTS – Quay St (internal)	-	45	-

Note: ** Proposed standard hours are 7:00am to 7:00pm Monday to Friday and 8:00am to 5:00pm Saturday.*
Where hotel developments are typically closed windows and are mechanically ventilated, internal noise targets may be more relevant for the management of noise impact.

6.4 Construction Vibration Guidelines

6.4.1 Disturbance to Buildings Occupants

For disturbance to human occupants of buildings, reference is made to DECC's 'Assessing Vibration; a technical guideline', published in February 2006. This document provides criteria which are based on the British Standard BS 6472-1992, 'Evaluation of human exposure to vibration in buildings (1-80Hz)'. Vibration sources are defined as Continuous, Impulsive or Intermittent. Table 13 below provides a definition and examples of each type of vibration.

Table 13 – Types of Vibration

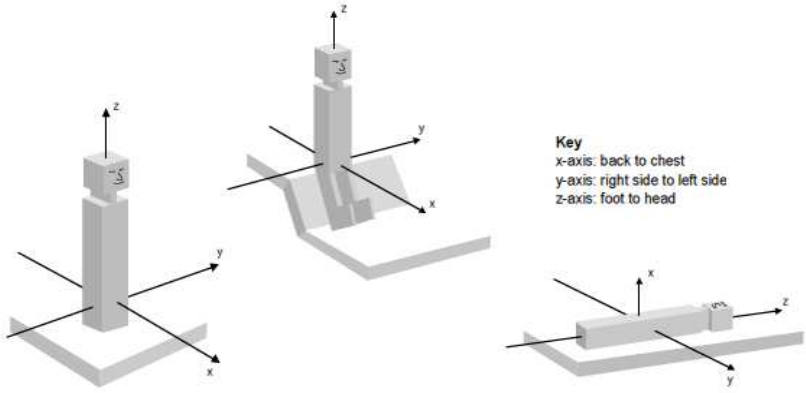
Type of Vibration	Definition	Examples
Continuous vibration	Continues uninterrupted for a defined period (usually throughout the day-time and/or night-time)	Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).
Impulsive vibration	A rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.
Intermittent vibration	Can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer, this would be assessed against impulsive vibration criteria.

Source: Assessing Vibration; a technical guideline, Dept Environment & Climate Change 2006

The criteria are to be applied to a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states: 'Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472).'

When applying the criteria, it is important to note that vibration may enter the body along different orthogonal axes, i.e. x-axis (back to chest), y-axis (right side to left side) or z-axis (foot to head). The three axes are referenced to the human body. Thus, vibration measured in the horizontal plane should be compared with x- and y-axis criteria if the concern is for people in an upright position, or with the y- and z- axis criteria if the concern is for people in the lateral position.

Figure 4 – Orthogonal Axes for Human Exposure to Vibration



Source: Assessing Vibration; a technical guideline, Dept Environment & Climate Change 2006 p4

Preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and are reproduced below. In this assessment, commercial premises are included in the 'Offices, schools, educational institutions and places of worship' category of Table 14 below.

Table 14 – Preferred and Maximum Levels for Human Comfort

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration[3] (Weighted RMS Acceleration, m/s^2, 1-80Hz)					
Critical areas[2]	Day or night time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night time	0.020	0.014	0.040	0.028
Workshops	Day- or nighttime	0.04	0.029	0.080	0.058

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Impulsive vibration[3] (Weighted RMS Acceleration, m/s^2, 1-80Hz)					
Critical areas[2]	Day or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day or night-time	0.64	0.46	1.28	0.92
Intermittent vibration[4] (Vibration Dose Values, VDV, $m/s^{1.75}$, 1-80Hz)					
Critical areas[2]	Day or night-time	0.10		0.20	
Residences	Daytime	0.20		0.40	
	Night-time	0.13		0.26	
Offices, schools, educational institutions and places of worship	Day- or night-time	0.40		1.60	
Workshops	Day or night-time	0.80		1.60	

Notes:
1. *Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am*
2. *Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992*
3. *For continuous and impulsive vibration the preferred and maximum values are weighted acceleration rms values (m/s^2)*
4. *For intermittent vibration the preferred and maximum values are vibration dose values (VDVs), based on the weighted acceleration values ($m/s^{1.75}$)*

Intermittent vibration is assessed using vibration dose values (VDVs). The VDV method is a fourth power approach which is more sensitive to peaks in the acceleration waveform and makes corrections to the criteria based on the duration of the source's operation. The VDV can be calculated using the overall weighted rms acceleration of the vibrating source in each orthogonal axis and the total period during which the vibration may occur. Weighting curves are provided in each orthogonal axis in the guideline. Preferred and maximum VDV values are defined in Table 2.4 of the guideline and are reproduced Table 15.

Table 15 – Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred Values	Maximum Values	Preferred Values	Maximum Values
Critical areas[2]	0.10	0.20	0.10	0.20
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
Workshops	0.80	1.60	0.80	1.60

Notes:
1. *Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am*
2. *Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source: BS 6472-1992*

6.4.2 Structural Damage to Buildings

Whilst criteria for the management of human exposure to vibration are set out above, the primary focus of vibration management during demolition and construction works is for the management of potential structural damage to adjacent structures. Currently there is no existing Australian Standard for assessment of structural building damage caused by vibration energy. Therefore, reference is made to both the British and German standards below which are relevant to the assessment of structural damage.

6.4.2.1 British Standard

British Standard 7385: Part 2 "Evaluation and measurement of vibration in buildings", can be used as a guide to assess the likelihood of building damage from ground vibration. BS 7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur.

BS 7385 recommends that the peak particle velocity is used to quantify vibration and specifies damage criteria for frequencies within the range 4Hz to 250Hz, which is the range usually encountered in buildings. At frequencies below 4Hz, a maximum displacement value is recommended. The levels from the standard are given below in Table 16.

Table 16 – BS 7385 Structural Damage Criteria

Group	Type of Structure	Peak Component Particle Velocity, mm/s		
		4Hz to 15Hz	15Hz to 40Hz	40Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	15 to 20	20 to 50	50

The peak vibration limits set for minimal risk of 'cosmetic' damage are: 15mm/s for un-reinforced or light framed structures, for example residential or light commercial buildings (Group 2; increasing as the frequency content of the vibration increases) and 50mm/s for reinforced or framed structures, for example industrial and heavy commercial buildings (Group 1; constant across all frequencies). 'Minor' damage is considered possible at vibration magnitudes which are twice those given and 'major' damage to a building structure may occur at levels greater than four times those values. These values relate to transient vibrations and to low rise buildings. Continuous vibration can give rise to dynamic magnifications due to resonances and may need to be reduced by up to 50%.

The levels set by this standard are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular types of buildings. Damage comprises minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls. This standard states that it considers sources of vibration including blasting, demolition, piling, ground treatments, compaction, construction equipment, tunnelling, road and rail traffic and industrial machinery.

As stated in the standard, it sets guide values for building vibration based on the lowest levels above which damage has been credibly demonstrated. That is, it gives guidance on the levels of vibration above which building structures could be damaged.

6.4.2.2 German Standard

The German standard DIN 4150 – Part 3 – "Structural vibration in buildings – Effects on Structures", also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration. This standard too, presents recommended maximum limits over a range of frequencies measured in any direction at the foundation or in the plane of the uppermost floor.

The minimum 'safe limit' of vibration at low frequencies for commercial and industrial buildings is 20mm/s. For dwellings, it is 5mm/s and for particularly sensitive structures (e.g. historical with preservation orders etc.), it is 3mm/s. These limits increase as the frequency content of the vibration increases.

The criteria are presented in Table 17 below and are generally recognised to be conservative.

Table 17 – DIN 4150-3 Structural Damage Criteria

Group	Type of Structure	Vibration Velocity, mm/s			
		At Foundation and at Frequency of			Plane of Floor Uppermost Storey
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz	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 Group 1 or 2 and have intrinsic value (e.g. buildings under a preservation order)	3	3 to 8	8 to 10	8

6.5 Construction Noise & Vibration Assessment

6.5.1 Construction Noise

Whilst the specific methodology and number of plant and equipment have not defined at this stage of project, based on the typical demolition and construction procedures and proximity of neighbouring premises, it is expected that the target levels may be exceeded during the peak demolition and potentially some construction activities.

The most sensitive premises are expected to be the UTS site to the south and hotel developments to the north east and east of the site. It is understood that the Entertainment Centre may be retained during the demolition and initial construction of the western portion of

the precinct, and therefore would provide significant acoustic shielding to the sensitive receiver locations to the northeast and east of the site. Noise and vibration managing would however be required in regard to impact upon the Entertainment Centre.

Given the proximity and potential for noise impact upon adjacent receivers, due regard to any potential methods for noise reduction should be given during the development of the detailed demolition and construction plans. In-principle noise management measures have been outlined in Section 6.6.

6.5.2 Construction Vibration

Typical vibration levels from construction equipment most likely to cause significant vibration are summarised below. The information was sourced from a variety of reference materials available in the Renzo Tonin & Associates library.

Table 18 – Typical Ground Vibration Generated by Construction Plant

Activity	Typical Ground Vibration
Excavators / Bulldozers	Typical ground vibration from excavators and bulldozers range from 1mm/s to 2mm/s at distances of approximately 5m and at distances greater than 20m, vibration levels are usually below 0.2mm/s.
Compactor	Compactors typically generate 20mm/s at distances of approximately 5m, 2mm/s at distances of 15m. At distances greater than 30m, vibration are usually below 0.3mm/s.
Vibratory rollers	Ground vibration caused by vibratory rollers can range up to 1.5mm/s at distances of 25m. The highest levels of vibration usually occur as the roller is brought to rest and the frequency of the centrifugal forces passes through resonance with the natural frequency of the roller/ground/structure. Machinery should therefore not be brought to rest when in the vicinity of susceptible buildings, especially dwellings. Higher levels could occur at closer distances, however, no damage would be expected for any building at distances greater than approximately 12m (for a medium to heavy roller).
Truck traffic	Typical vibration from heavy trucks passing over normal (smooth) road surfaces generate relatively low vibration levels in the range of 0.01 - 0.2mm/s at the footings of buildings located 10 - 20m from a roadway. Very large surface irregularities can cause levels up to five to ten times higher. In general, ground vibration from trucks is usually imperceptible in nearby buildings. The rattling of windows and other loose fittings that is sometimes reported is more likely to be caused by airborne acoustic excitation from very low frequency (infrasonic) noise radiated by truck exhausts and truck bodies. While this may cause concern to the occupants, the phenomenon is no different from the rattling caused by wind or people walking or jumping on the floor and fears of structural damage or even accelerated ageing are usually unfounded.

Based on the items above, and considering the distance to the vibration sensitive receptors, vibration generated from the construction of the residential towers is not expected to cause damage or adverse human response. On this basis, no further assessment or consideration of mitigation measures has been set out within this report.

6.6 Construction Noise & Vibration Management

Table 19 provides in-principle solutions to reduce construction noise and vibration impacts to sensitive receivers. Detailed mitigation and management strategies would be developed once demolition and construction methodologies are known and would generally be outlined in detailed noise and vibration management plans. The advice provided here is in respect of acoustics only.

Table 19 – Construction Noise and Vibration Management Options

Construction Noise and Vibration Management Options	
Source controls	
Time constraints	Limit work to the approved standard hours. Consider implementing respite periods with low noise/vibration-producing construction activities.
Scheduling	Perform noisy work during less sensitive time periods.
Equipment restrictions	Select low-noise plant and equipment. Ensure equipment has quality mufflers installed.
Emission restrictions	Establish stringent noise emission limits for specified plant and equipment. Implement noise monitoring audit program to ensure equipment remains within specified limits.
Substitute methods	Use quieter and less vibration emitting construction methods where possible. For example, if piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration reduction benefits.
Limit equipment on site	Only have necessary equipment on site.
Limit activity duration	Where possible, concentrate noisy activities at one location and move to another as quickly as possible. Any equipment not in use for extended periods during construction work should be switched off.
Equipment Location	Noisy plant and equipment should be located as far as possible from noise sensitive areas, optimising attenuation effects from topography, natural and purpose built barriers and materials stockpiles.
Site access	Vehicle movements outside construction hours, including loading and unloading operations, should be minimised and avoided where possible.
Equipment maintenance	Ensure equipment is well maintained and fitted with adequately maintained silencers which meet the design specifications.
Reduced equipment power	Use only necessary size and power.
Quieter work practices	For example, implement worksite induction training, educating staff on noise sensitive issues and the need to make as little noise as possible.
Reversing alarms	Consider alternatives, such as manually adjustable or ambient noise sensitive types ("smart" reversing alarms) and closed circuit TV systems. Alternative site management strategies can be developed, in accordance with the Occupational Health and Safety Plan, with the concurrence of the Occupational Health and Safety Officer.
Path controls	
Noise barriers	Use of solid hoardings can provide shielding to low level receivers, however can be of limited benefit for upper level receivers. Locate equipment to take advantage of the noise barriers provided by existing site features and structures.
Enclosures	Install noise-control kits for noisy mobile equipment and shrouds around stationary plant, as necessary.
Increased distance	Locate noisy plant as far away from noise-sensitive receptors as possible.

Construction Noise and Vibration Management Options	
Receptor controls	
Consultation	Community consultation, information, participation and complaint responses are essential aspects of all construction noise management programs. They typically involve: • A community information program before construction and/or high risk activities is commenced. This usually involves a leaflet distribution and direct discussions and negotiations with affected residents, explaining the type, time and duration of expected noise emissions. • The involvement of affected residents in the development of acceptable noise management strategies. • A nominated community liaison officer with a contact telephone number. • A complaints hotline. • Timely responses to complaints, providing information on planned actions and progress towards the resolution of concerns.
Noise / Vibration Monitoring	Noise and vibration compliance monitoring for all major equipment and activities on site should be undertaken.

7 CONCLUSION

Renzo Tonin & Associates have completed an assessment of noise and vibration for the Stage 1 application of The Haymarket, being part of the Sydney International Convention, Exhibition and Entertainment Precinct (SICEEP). The report responds to the Director General's Requirements (DGRs), and addresses noise and vibration in regard to the following polices and guidelines:

- NSW Industrial Noise Policy (EPA (EPA, 2000)
- Interim Construction Noise Guideline (DECC, 2009)
- Assessing Vibration: A Technical Guideline (DEC, 2006)
- Environmental Criteria for Road Traffic Noise (EPA, 1999)
- State Environmental Planning Policy – Infrastructure 2007
- Development Near Rail Corridors and Busy Road-Interim Guideline

This report has established the relevant criteria for the assessment against the policies outlined in the DGRs. Whilst at Stage 1 application phase, sufficient detail is not available to carry out a quantitative acoustic assessment of all aspects of the development, this assessment has identified the methods by which noise and vibration can be managed and mitigated in accordance with the relevant policies and guidelines. Further detailed acoustic assessment is required for each specific detailed development application at which approval is sought for specific uses. Acoustic assessment and design is also expected throughout the design development phases of the project, including the Stage 2 Development applications. These detailed assessments will quantify potential impacts and determine the specific of any noise mitigation and management measures, where they may be required.

APPENDIX A - GLOSSARY OF ACOUSTIC TERMS

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse Weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
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 Point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken 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 (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
dB(A):	A-weighted decibels. The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive 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	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{max}	The maximum sound pressure level measured over a given period.
L_{min}	The minimum sound pressure level measured over a given period.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.

L90	The 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).
Leq	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) 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	A fluctuation of air pressure which is propagated as a wave through air.
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 - SHORT TERM MONITORING

ID	Location	Date	Time	Desc	Overall dB(A)	Octave Band Centre Frequency - Hz dB(Z)									Comments
						31.5	63	125	250	500	1k	2k	4k	8k	
1	Harbour St Restaurants	6/02/2013	12:02pm - 12:17pm	L_{10}	68	75	77	71	66	65	63	60	55	39	Noise sources: traffic on Harbour St, pedestrians, mech plant, restaurants
				L_{eq}	66	72	73	68	64	64	60	57	52	53	
				L_{90}	59	66	64	63	60	57	53	48	42	53	Traffic count - 69
			2:52pm - 3:07pm	L_{10}	66	72	74	69	66	63	61	57	52	41	Noise sources: traffic on Harbour St, pedestrians, mech plant, restaurants
				L_{eq}	66	69	75	68	64	64	61	56	52	53	
				L_{90}	59	64	64	62	60	56	53	47	41	49	Traffic count - 72
		8/02/2013	10:47pm - 10:55pm	L_{10}	65	72	71	66	63	62	61	57	50	36	Noise sources: Road traffic, pedestrian activity, mech plant audible between traffic, Cold Rock. L_{90} controlled by mech plant and distant traffic.
				L_{eq}	63	69	69	65	61	61	59	55	47	45	
				L_{90}	59	65	64	62	59	57	54	49	42	48	
		9/02/2013	12:07am - 12:22am	L_{10}	64	68	69	66	63	61	60	56	49	33	Noise sources: All restaurants closed. 15-20 ppl sitting outside McDonalds. Music from Covent Garden hotel audible. L_{90} controlled by mech plant.
				L_{eq}	61	66	67	64	60	58	57	52	45	46	
				L_{90}	57	63	63	60	57	55	52	46	39	46	
2	Harbour St - Holiday Inn	6/02/2013	12:23pm - 12:38pm	L_{10}	70	73	75	72	68	66	65	62	56	32	Noise sources: Traffic, pedestrians, distant mech plant. Vehicle count - 88
				L_{eq}	67	70	74	69	66	64	62	59	54	45	
				L_{90}	59	66	65	62	60	56	53	48	41	52	
			2:28pm - 2:44pm	L_{10}	68	76	74	69	66	64	64	59	54	34	Noise sources: Traffic, pedestrians, distant mech plant. Vehicle count - 76
				L_{eq}	65	73	71	67	64	61	61	57	53	51	
				L_{90}	57	65	65	62	59	55	52	47	39	56	
		8/02/2013	11:55pm - 12:10am	L_{10}	66	70	73	69	64	62	62	58	50	32	Noise sources: L_{90} controlled by mech plant from SEC. Local traffic on Harbour St, dist traffic on Goulbourn St. Pedestrian activity. ~15 patrons outside JB's bar - generally inaudible above pedestrians.
				L_{eq}	64	68	71	67	61	60	60	58	52	37	
				L_{90}	57	63	63	61	58	55	52	46	39	39	
		9/02/2013	12:34am - 12:49am	L_{10}	67	68	74	68	64	63	63	59	52	29	Noise sources: Road traffic on Harbour St & distant traffic on Goulburn St and pedestrians.
				L_{eq}	65	66	74	67	64	62	60	56	51	40	
				L_{90}	56	62	62	59	57	54	51	46	38	38	

ID	Location	Date	Time	Desc	Overall dB(A)	Octave Band Centre Frequency - Hz dB(Z)									Comments
						31.5	63	125	250	500	1k	2k	4k	8k	
3	Harbour St - Harbour Plaza	6/02/2013 6/02/2013	12:51pm - 01:06pm	L_{10}	72	80	78	74	69	68	67	63	59	35	Noise sources: Road traffic on Harbour St and Goulburn St. Traffic queuing at intersection.
				L_{eq}	69	78	75	71	67	65	64	60	56	44	
				L_{90}	62	69	69	64	62	59	57	52	47	49	Vehicle count - 80
			2:11pm - 2:27pm	L_{10}	69	77	76	71	68	65	64	59	54	41	Noise sources: Road traffic on Harbour St and Goulburn St. Traffic queuing at intersection.
				L_{eq}	66	74	73	71	67	63	61	57	52	48	
				L_{90}	62	70	68	64	62	59	57	52	46	52	Vehicle count - 96
		8/02/2013	10:58pm - 11:13pm	L_{10}	66	78	76	71	66	64	61	57	52	37	Noise sources: L_{90} controlled by mech plant and traffic idling at intersection. Distant traffic, pedestrians. Crowd departing SEC after 11pm.
				L_{eq}	64	75	73	69	64	62	59	55	49	43	
				L_{90}	61	69	68	64	61	58	55	51	44	46	
		9/02/2013	12:11am - 12:27am	L_{10}	67	75	73	70	65	63	62	58	52	36	Noise sources: L_{90} controlled by mech plant and traffic idling at intersection. Distant traffic, pedestrians.
				L_{eq}	64	71	71	69	63	60	59	55	49	41	
				L_{90}	59	64	64	61	58	55	54	49	42	41	
4	Novotel	6/02/2013	1:08pm - 1:23pm	L_{10}	63	74	73	68	64	60	57	54	52	30	Noise sources: Road traffic on Harbour St, and Goulburn St. L_{90} controlled by distant traffic and mech plant. Insects intermittent.
				L_{eq}	61	71	70	67	62	58	55	51	47	34	
				L_{90}	58	66	66	62	59	56	52	48	41	36	
			1:24pm - 1:40pm	L_{10}	63	73	72	67	63	60	58	56	50	29	Noise sources: Road traffic on Harbour St, and Goulburn St. L_{90} controlled by distant traffic and mech plant. Insects intermittent.
				L_{eq}	61	71	70	65	62	58	56	53	47	43	
				L_{90}	58	66	65	61	59	56	52	48	42	45	
		8/02/2013	11:37pm - 11:53pm	L_{10}	62	73	71	67	62	59	57	54	48	29	Noise sources: L_{90} controlled by mech plant and dist traffic. SEC crowds dispersed. Typical pedestrian activity.
				L_{eq}	60	70	69	64	60	57	55	52	45	44	
				L_{90}	58	67	65	61	58	55	52	48	41	47	
		9/02/2013	12:31am - 12:48am	L_{10}	59	68	70	65	60	56	54	51	45	33	Noise sources: L_{90} controlled by mech plant from SEC and above Pumphouse/Novotel. Pumphouse closed.
				L_{eq}	58	66	67	62	58	55	52	49	42	42	
				L_{90}	55	63	63	58	56	53	50	45	38	46	

ID	Location	Date	Time	Desc	Overall dB(A)	Octave Band Centre Frequency - Hz dB(Z)									Comments
						31.5	63	125	250	500	1k	2k	4k	8k	
5	Pumphouse	6/02/2013	12:54pm -1:09pm	L_{10}	63	71	72	69	64	60	58	53	50	30	Noise sources: L_{90} controlled by fountain located under Pier St overpass. Mech plant from Novotel, traffic on Goulburn St and Harbour St. Patron noise from Pumphouse indistinguishable from pedestrians.
				L_{eq}	61	69	70	66	62	59	56	51	48	38	
				L_{90}	59	65	66	62	60	56	53	48	42	41	
			1:29pm - 1:44pm	L_{10}	63	72	72	68	64	61	58	54	50	26	
				L_{eq}	62	69	70	66	62	59	56	52	48	41	
				L_{90}	60	66	66	62	61	57	54	49	44	38	
		8/02/2013	10:42pm - 10:57pm	L_{10}	67	71	72	74	69	64	62	58	54	25	Noise sources: L_{A0} controlled by music playing from Pumphouse (doors open) and mech plant from SEC and Novotel. No patrons visible in Pumphouse. Fountain not operating. Pedestrians. Light traffic on overpass.
				L_{eq}	65	70	70	71	67	62	61	56	51	40	
				L_{90}	63	66	67	66	63	59	56	52	47	36	
		8/02/2013	11:21pm - 11:36pm	L_{10}	66	75	72	78	66	64	61	56	50	31	Noise sources: Pumphouse closed, but music still playing, controlling L_{90}. Higher pedestrian activity due to patrons departing SEC event. Fountain off.
				L_{eq}	65	73	70	75	65	62	59	54	49	39	
				L_{90}	62	71	67	67	62	59	55	50	43	36	
		9/02/2013	12:50am - 1:05am	L_{10}	60	66	68	64	62	58	56	51	44	39	Noise sources: BG controlled by mech plant from SEC and Pumphouse/Novotel. Pumphouse closed.
				L_{eq}	59	64	66	62	60	57	54	49	41	53	
				L_{90}	57	62	62	58	58	55	51	45	37	53	
6	Darling Dr	6/02/2013	12:25pm - 12:40pm	L_{10}	68	70	71	65	63	63	65	60	53	41	Noise sources: Traffic on Darling Drive. Dist traffic on Pier St. Two light-rail pass-bys (corner squeal). Dist mech plant from direction of SEC. Traffic count – 120
				L_{eq}	64	68	68	62	59	59	61	56	49	53	
				L_{90}	53	63	61	56	53	50	49	43	35	49	
			2:15pm - 2:30pm	L_{10}	70	71	72	66	63	64	67	62	54	36	Noise sources: Traffic on Darling Drive. Dist traffic on Goulburn St. Two light-rail pass-bys (corner squeal). Dist mech plant from direction of SEC. Traffic count – 140
				L_{eq}	65	68	70	63	60	60	62	57	50	45	
				L_{90}	53	64	62	56	52	50	49	44	37	48	

ID	Location	Date	Time	Desc	Overall dB(A)	Octave Band Centre Frequency - Hz dB(Z)									Comments
						31.5	63	125	250	500	1k	2k	4k	8k	
		8/02/2013	11:03pm - 11:18pm	L_{10}	68	75	71	64	61	62	66	61	53	33	Noise sources: L_{90} controlled by passing traffic on Darling Drive. Three light-rail pass-bys (corner squeal). 11.10pm increase of cars departing carpark (end of event)
				L_{eq}	64	72	69	63	59	60	61	57	49	46	
				L_{90}	55	65	63	56	52	51	51	46	40	46	
		9/02/2013	12:54am - 1:09am	L_{10}	63	65	66	60	57	58	60	55	48	32	Noise sources: Road traffic, distant mech plant. One light-rail pass-by.
				L_{eq}	60	63	64	63	55	54	57	52	44	45	
				L_{90}	50	59	59	53	50	47	46	40	34	52	
7	UTS	6/02/2013	12:01pm -12:16pm	L_{10}	62	69	72	66	63	60	56	52	46	34	Noise sources: Two tram pass-bys (corner squeal, impulsive at expansion joints in concrete). Distant mech plant and traffic from CBD. Traffic, incl. trucks on Harbour St.
				L_{eq}	61	70	70	65	61	59	57	52	48	51	
				L_{90}	55	63	63	60	56	53	50	44	37	56	
			2:38pm - 2:53pm	L_{10}	62	70	72	68	63	60	57	53	45	32	Noise sources: Three tram pass-bys (corner squeal, impulsive at expansion joints in concrete). Distant mech plant and traffic from CBD. Traffic, incl. trucks on Harbour St.
				L_{eq}	61	69	70	65	61	59	56	52	48	37	
				L_{90}	55	64	63	61	57	53	49	43	36	39	
		8/02/2013	11:48pm - 12:03pm	L_{10}	59	73	71	65	61	57	55	49	43	29	Noise sources: Road traffic on Darling Drive. L_{90} controlled by distant traffic and mech plant from CBD. Two light-rail pass-bys.
				L_{eq}	62	74	71	64	61	58	59	51	47	40	
				L_{90}	55	66	63	60	56	52	49	43	36	38	