ACOUSTICS AND AIR

BARANGAROO CENTRAL

WATERFRONT PROMENADE AND INTERIM PUBLIC DOMAIN OPERATIONAL NOISE MANAGEMENT PLAN

REPORT NO. 12228-O
VERSION F

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PREPARED FOR

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This firm is a member firm of the Association of Australian Acoustical Consultants and the work here reported has been carried out in accordance with the terms of that membership.

Celebrating 50 Years in 2012

Wilkinson Murray is an independent firm established 50 years ago originally as Carr & Wilkinson. In 1976 Barry Murray joined founding partner Roger Wilkinson and the firm adopted the name which remains today. From a successful operation in Australia, Wilkinson Murray expanded its reach into Asia by opening a Hong Kong office early in 2006. 2010 saw the introduction of our Queensland office and 2011 the introduction of our Orange office to service a growing client base in these regions. From these offices, Wilkinson Murray services the entire Asia-Pacific region.

TABLE OF CONTENTS

GLOSSARY OF ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

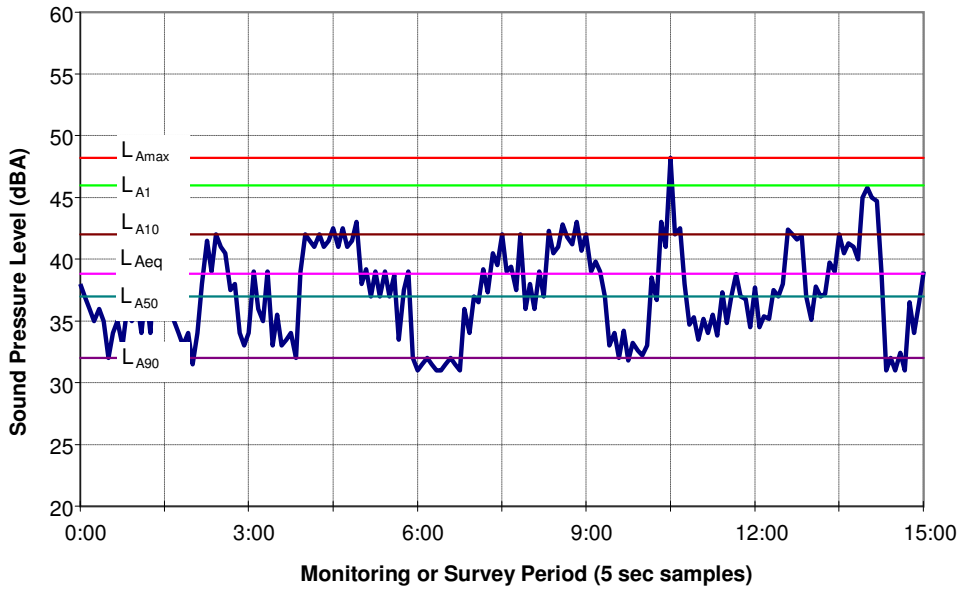
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10^{th} percentile (lowest 10^{th} percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

Typical Graph of Sound Pressure Level vs Time



1 INTRODUCTION

This Operational Noise Management Plan (ONMP) has been prepared to address and manage potential noise emissions from major events associated within the Barangaroo Central Waterfront Promenade and Interim Public Domain Site.

The ONMP has been prepared in accordance with the recommendations of the Environmental Protection Authority's (EPA) Noise Guide for Local Government – with reference Part 3 Noise management principles."

The plan references the previous noise and vibration assessment prepared by Wilkinson Murray being Barangaroo Central Waterfront Promenade and Interim Public Domain - Construction & Operational Noise & Vibration Management Assessment Report No. 12228 Version E dated October 2012.

The noise management plan predicts the levels of noise at the surrounding residential areas. This plan sets the noise limits at the various events.

The extent of this Noise Management Plan is as follows:

- A description of the site and the activities to be undertaken;
- Details of the existing acoustic environment and predicted noise levels of the site activities;
- Noise objectives, controls and noise management practices to be implemented to manage the site activities to minimise the impact on the acoustic amenity of surrounding residences; and ;
- Procedures for addressing noise complaints and issues and methods that will be undertaken to resolve noise issues.

The parameter of operation of the Central Barangaroo site's operation will be set by the EPA. Consultation with the EPA may result in set conditions similar to ones presented in the Noise Guide for Local Government to manage events, reference;

- http://www.environment.nsw.gov.au/resources/noise/10799Part3nglg.pdf

Wilkinson Murray has conducted the operational assessments for all development associated with the Barangaroo South site along with an assessment of construction noise associated with the Headland Park Site. This assessment of noise is consistent with these assessments and, where appropriate, methodologies and established noise criteria are also consistent with these assessments.

2 PROJECT DESCRIPTION

2.1 Site Context

The public domain in Barangaroo Central will be the connector between Headland Park and the urban precinct of Barangaroo South, and will contain elements common to both of these areas. It will extend the Headland Park Promenade along the harbour to Barangaroo South as well as providing significant spaces for public recreation and leisure, and for major events.

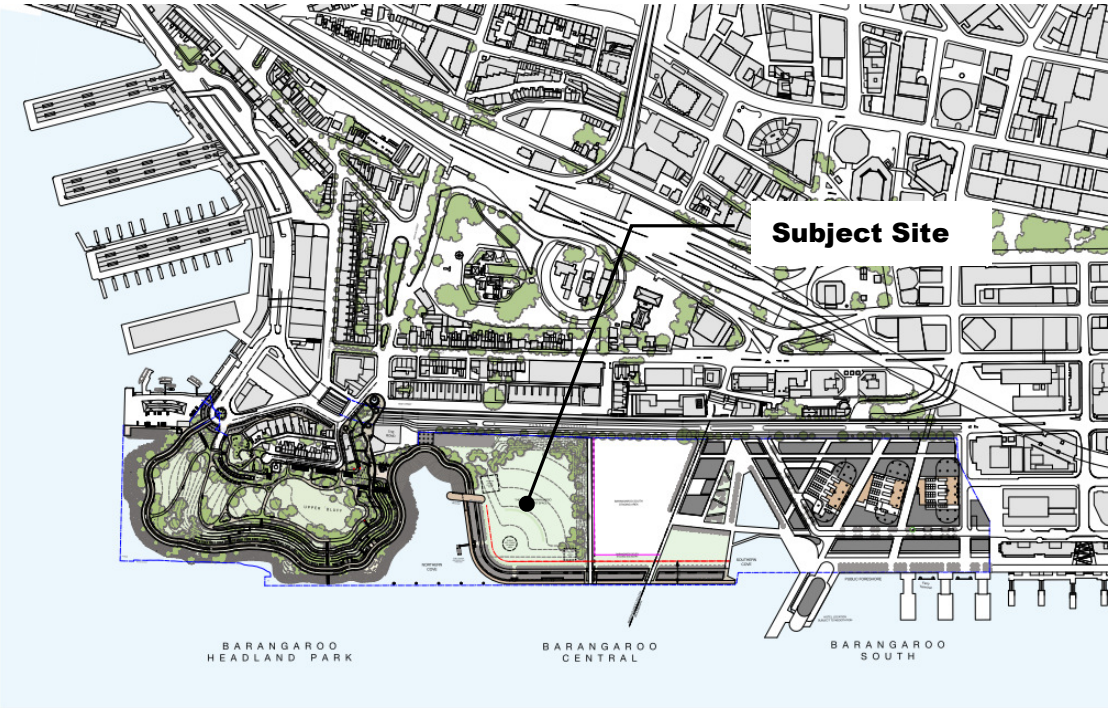
The Barangaroo Central Waterfront Promenade and Interim Public Domain is the first stage in the development of the Barangaroo Central site and is scheduled to be completed in 2015.

2.2 Location & Layout

The Barangaroo Central Waterfront Promenade and Interim Public Domain is located on the Barangaroo Central site, and is bounded by the Northern Cove and Headland Park to the north, the harbour to the west, Hickson Road to the east, and the Lend Lease Temporary Construction Staging Area to the south.. This is illustrated as below.

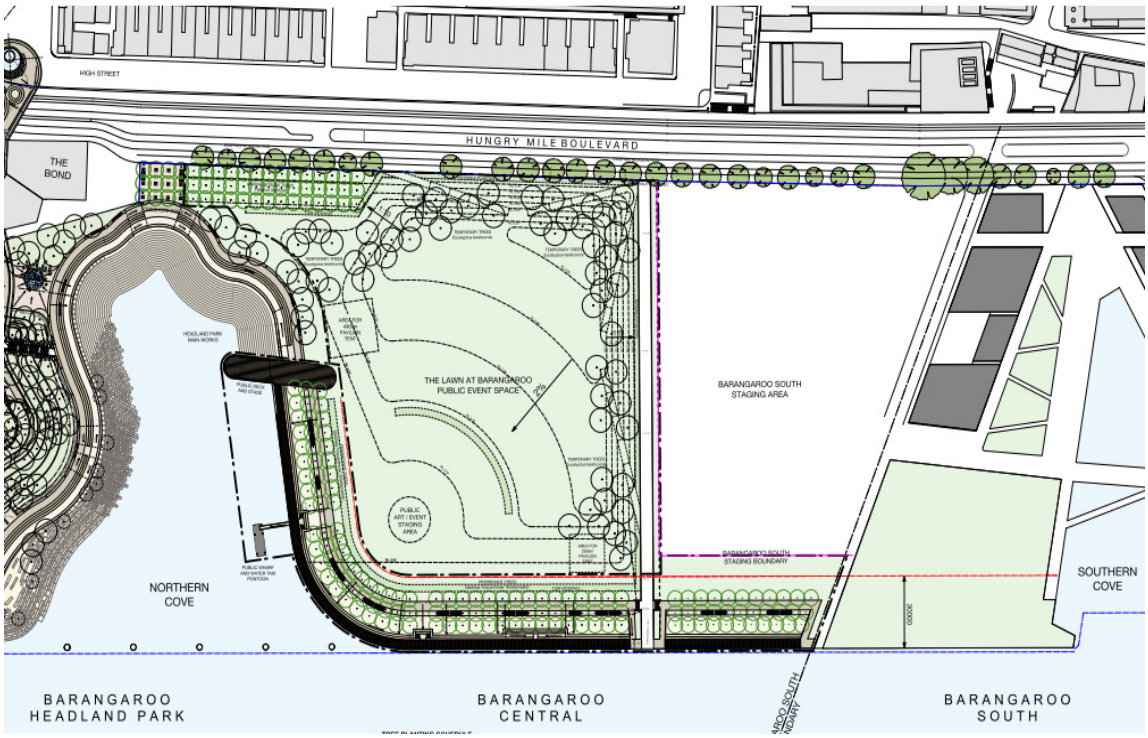
The locational context of the site is shown in Figure 2-1.

Figure 2-1 Barangaroo Site



The Barangaroo Central Waterfront Promenade and Interim Public Domain comprises two areas, the Barangaroo Central Waterfront Promenade (the "Promenade") and the Barangaroo Central Interim Public Domain. Figure 2-2 shows the subject development.

Figure 2-2 Location of Barangaroo Central Waterfront Promenade and Interim Public Domain



The **Barangaroo Central Waterfront Promenade** covers the zone from the harbour edge approximately 30m into the site, and extends along the full length of the Barangaroo Central site from the eastern side of the public deck in the Northern Cove to the Barangaroo South boundary

The Barangaroo Central Waterfront Promenade will integrate with and continue the foreshore Promenade from Headland Park to Barangaroo South, whilst acknowledging the character of each precinct.

The Barangaroo Central Interim Public Domain covers the remainder of the site.

2.3 Proposed Operations

The Barangaroo Delivery Authority (BDA) has engaged Event & Sports Projects Australia Pty Ltd (ESPA) to prepare a Plan of Management for Events to be included as part of the Development Application – Barangaroo Central Waterfront Promenade and Interim Public Domain Works.

BDA is proposing for major public and special events for up to 15,000 patrons to be held on the Barangaroo Central open space area. BDA has previously engaged Mr & Mrs Fish in May 2012 to prepare the Barangaroo Central Interim Public Domain Events Brief which described the typologies of proposed events to be held in the Interim Public Domain.

Typical noise emission levels associated with events on site that are considered to be acoustically significant are detailed in Table 2-2.

Table 2-2 Noise Source $L_{Aeq(15\ minute)}$ Sound Levels – dBA

Noise Source	Sound Power Level	Typical Sound Level at Audience or Patrons
Speaker Towers (Music)	130	90
Speaker Towers (Speech)	120	80
Crowd Noise (Concert)	115	80
Crowd Noise (Fair)	105	65

2.4 Ambient Noise Levels and Surrounding Receivers

Residential and commercial receivers surrounding the site, potentially affected by operational event noise from Central Barangaroo have been identified. These are detailed in Table 2-3 below.

Table 2-3 Surrounding Receivers

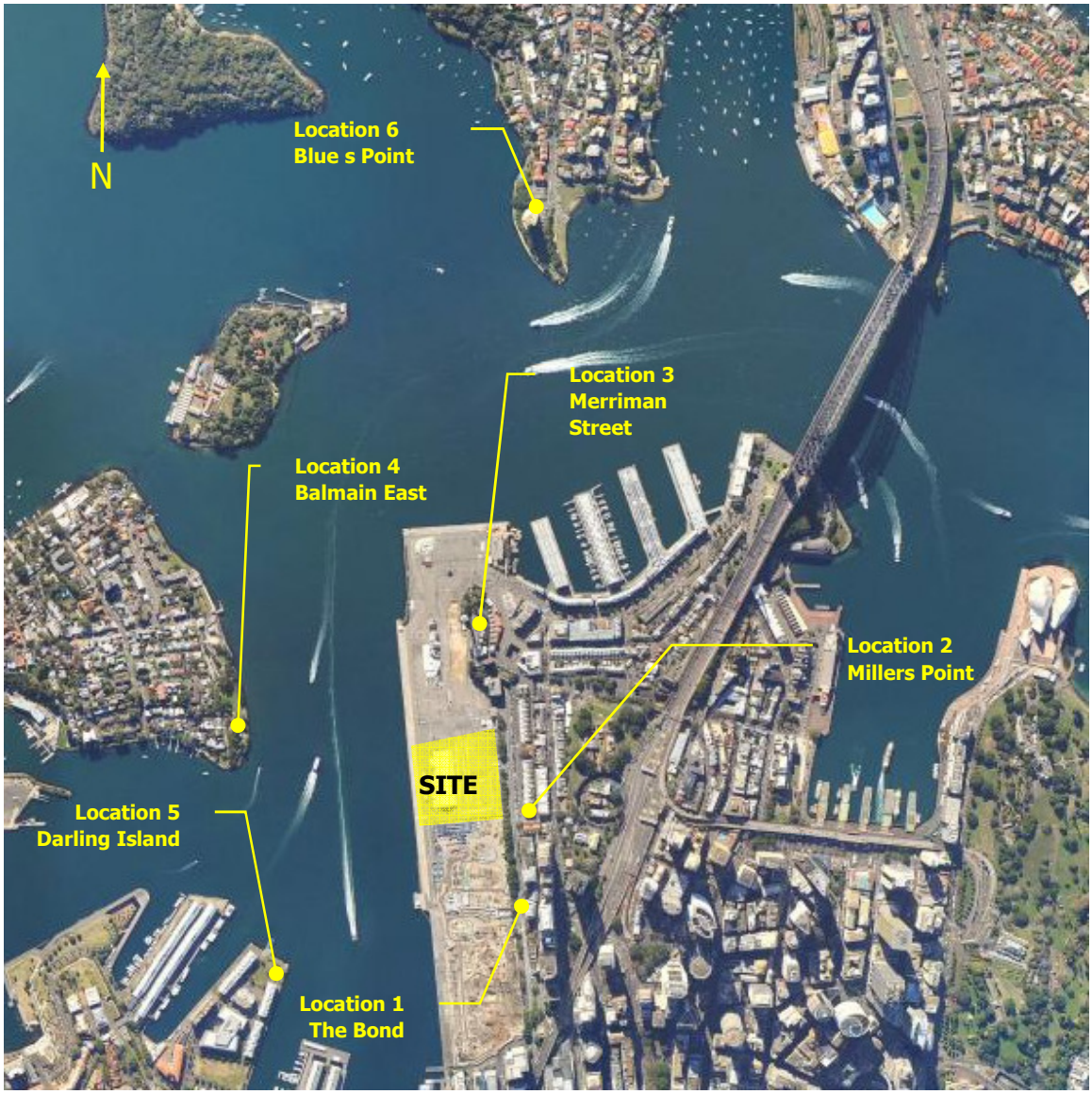
Receivers	Type	Comments
Hickson Road, Millers Point	School / Commercial	Billabond Child Care Centre, Lend Lease offices,
High Street, Millers Point	Commercial	KU Lance Preschool & Children's Centre
Munn Street	Commercial	Universal Music Studio
Hickson Road, Millers Point	Residential	Multi-storey residential building
High Street, Millers Point	Residential	Terrace residences
Merriman Street, Millers Point	Residential	Double storey unit blocks and single storey houses
Dalgety Road, Merriman Street	Residential	Double storey community housing
Edward Street, Balmain East	Residential	Waterfront properties along Balmain peninsula
Northern end of Darling Island Road & Wharf Crescent, Darling Island	Residential	Multi-storey apartments
Blues Point Tower, McMahons Point	Residential	Multi-storey apartments

In order to quantify the existing noise environment, long-term ambient noise levels were monitored at several locations surrounding the site. Table 2-4 presents measured noise levels at these sites.

Table 2-4 Summary of Measured Noise Levels - dBA

Location	RBL (dBA)			$L_{Aeq,period}$ (dBA)		
	Daytime 7-6pm	Evening 6-10pm	Night 10pm-7am	Daytime 7-6pm	Evening 6-10pm	Night 10pm-7am
Hickson Road,	53	53	49	62	61	57
Millers Point	47	44	41	58	55	51
Merriman Street	46	44	40	58	55	50
Balmain East	49	45	40	67	51	47
Darling Island	47	44	39	54	49	46
McMahons Point	48	46	39	58	53	49

Figure 2-1 Aerial showing Noise Monitoring Locations



2.5 Noise Predictions

A noise model has been developed using the computer program, CadnaA. This model takes into account noise generated at the source, attenuation with distance and any shielding provided in the noise path.

Noise emission scenarios have been established in order to help simplify the assessment of the various events involved at each of the sites. The noise models for each site have concentrated on the noisier events as follows:

- Scenario A Concerts with music and crowds of up to 15,000 persons
- Scenario B Speaking events (amplified) and crowds of up to 12,000 persons.
- Scenario C Live events with crowds of up to 15,000 persons.
- Scenario D Fairs with crowds of up to 10,000 persons.

It is noted that the above Scenarios A and B reflect popular concerts and do not include heavy Rock type music. **Table 2-5** presents predicted noise levels at surrounding receivers compared with the NGLG intrusive noise goals for these receivers**.**

Table 2-5 Predicted L_{Aeq} Noise Levels from Operation at Residences

Receiver	Predict Noise Level – dBA				Intrusive Noise Goal Day/Evening Night
	Scenario A	Scenario B	Scenario C	Scenario D	
Hickson Road Residences	67	54	45	39	58/58/54
High Street Residences	77	63	55	49	52/49/46
Merriman Street Residences	71	55	50	44	51/49/45
Balmain East Residences	66	50	38	32	54/50/45
Darling Island Residences	60	46	37	31	52/49/44
Blues Point Tower Residences	56	37	33	27	53/51/44

Greatest potential impact is likely to occur at residences to the east of the site i.e. High Street Residences. Therefore management of noise at this location will address noise management at all other locations.

3 NOISE MANAGEMENT

Due to the close proximity of the city receivers surrounding the Central Barangaroo site and the relatively high level of the predicted noise levels, implementation of noise control and management procedures are required to reduce the emergence of predicted noise levels above the intrusive noise goals. However it is not expected that the intrusive noise goals can be achieved at nearby residences and receivers around the Central Barangaroo site.

Accordingly a noise management plan should be developed so that noise emissions from large events. The following sections detail indicative measures that could be adopted to minimise the impact of noise at surrounding receivers. A review of similar outdoor entertainment precincts has been conducted to develop the following recommended noise limits.

3.1 Event Categories

For the purpose of managing noise emissions through this Noise Management Plan, major events will fall into one of four (4) categories. The criteria used to classify an event into a particular category are outlined in Table 3.1.

Table 3.1: Classification Table –Event Categories

Category 1	Attendance up to 15,000 patrons Usually a "one off" event and unlikely to recur in the short to medium term Use of high output amplified sound system
Category 2	Attendance up to 12,000 patrons, usually a "one off" event and unlikely to recur in the short term Use of high output amplified sound system
Category3	Attendance up to 15,000 patrons. Associated with Live events Use of some amplified sound system for broadcast of events of a big screen such as: Football, Olympics, Tennis etc
Category 4	Attendance up to 10,000 patrons. Typically a fair or community event Use of localised low output amplified sound system for announcements or for live intimate entertainment. Community events Private Functions

3.2 Timing of Events

The time of staging events is a key determinant of the actual or perceived degree of noise impact from major events on residents and workers, as background noise levels and domestic/ workplace needs and expectations for quiet enjoyment vary greatly across a typical 24 hour period. Based on environment protection standards there are three (3) relatively distinct event staging time periods from a noise management perspective;

a) 7am to 5pm (day)

b) 5pm to 11pm (evening)

c) 11pm to 7am (night)

The timing of on event in itself does not dictate whether an event requires noise monitoring or controls. However, consideration should be given to Category 1 and Category 2 events where feasible these events should be concluded by 11pm on any given night of the week.

Where Category 1, 2 & 3 events involve the use of amplified sound systems, the commencement of the amplified sound cannot occur before 10am on any given morning of the week.

Category 4 events should not be restricted to time limits.

3.3 Events Requiring Noise Monitoring and Controls

The categorisation and timing of an event determines whether noise monitoring and/or controls are required for the event. This approach and an explanation are also outlined below.

Category 1 Events

All Category 1 events require noise monitoring and controls. The nature of these controls and monitoring is discussed in section 3.4.1

Category 2 Events

All Category 2 events also require noise monitoring and controls. The nature of these controls and monitoring is discussed in section 3.4.1

Category 3 Events

Some Category 3 events also require noise monitoring and controls. The nature of these controls and monitoring is discussed in section 3.4.1

Category 4 Events

Category 4 events are not subject to noise monitoring or standard controls except for where specific and legitimate compliant is received.

3.4 Noise Limits and Controls

Suggested noise limits for each of the four (4) categories of events described in Table 3-2. These limits have been determined using noise assessment of the site and a review of Limits that have been set in other precincts around Sydney. The limits recognise the fact that the "noisy" events occur will occur infrequently.

The noise limits are expressed across two main measurements, to reflect intrusive (using L_{Amax} criteria) and amenity (using L_{Aeq} criteria) noise impacts. In addition, limits are also set for low frequency noise to minimise noise impacts;

- **L_{Amax}** The A-weighted maximum sound pressure level measured over a sample period, measured on fast response, during the sample period (average over 5 minutes).
- $L_{Aeq, 15mins}$ The $L_{Aeq,15mins}$ level is the equivalent continuous noise level.
- L_{Cmax} low frequency noise (C-weighted maximum sound pressure level measured over a sample period)

The following Table 3-2 presents recommended noise limits for various events categories are defined in previous sections. The feasibility of these limits should be confirmed at test events and in consultation with the EPA.

Table 3.2: Proposed Noise and Operational Limits

Category /Description	Limits Controls
1 - Musical concerts using sound amplification equipment with crowd capacity up to 15,000.	Maximum of 6 concerts per year. A series of musical concerts may be held over a maximum of 4 consecutive days. Each concert must be held between 10 am and 11 pm only. Rehearsals for each concert audible beyond the park boundary must not exceed 4 hours and must be held between 10 am and 10 pm. Sound tests for each concert audible beyond the park boundary must be conducted on 1 day only, not exceed 1 hour and be held between 10 am and 8 pm. $L_{Aeq(T)}$ must not exceed 70 dB(A). $L_{A\ max}$ must not exceed 80 dB(A). $L_{C\ max}$ must not exceed 100 dB(C). An exceedence of these noise limits during a single 5-minute period during the first 15 minutes of the performance of each new separate band or act will not be taken to be a breach.
2 – Speech Events using sound amplification equipment with crowd capacity greater than 10,000.	A-weighted sound pressure level ($_{LA10.T}$) must not exceed 10 dB(A) above ambient background level (LA90) between 10 am and 11 pm, and 5 dB(A) above ambient background level (L_{A90}.) at other times.
3 –Crowds up to 15,000 with medium level amplification	A-weighted sound pressure level ($_{LA10.T}$) must not exceed 10 dB(A) above ambient background level (LA90) between 10 am and 11 pm, and 5 dB(A) above ambient background level (L_{A90}.) at other times.
4 –Crowds up to 10,000 low level amplification	A-weighted sound pressure level ($_{LAeq.T}$) must not exceed 5 dB(A) above ambient background level (L_{A90}) between 10 am and 11 pm, and ambient background level (L_{A90}.) at other times.

It should be noted that the limits noise above are to be applied to controllable noise sources being sound amplification equipment. These limits are not intended to control crowd noise, where the control of noise from this source is a more indirect function of crowd management procedures.

3.5 Noise Mitigation Techniques

Amplified sound associated with large events should only be permitted in the day and evening periods. Outside those times, the PA system should only be used as a last resort for announcements related to emergencies or crowd control.

- All sound systems should include a limiter/compressor so music can be locked below a desired threshold noise level if required. The setting of the limiter should be determined during sound checks in consultation with the Acoustic Consultant.
- The design of the sound system should take into consideration the noise requirements of this Plan. Speakers should be orientated towards the audience so that noise "spill" is minimised. The use of noise cancelling "sub" arrays should be considered in the design and layout of the sound system.
- Sound level meters should be set up at each sound desk to monitor levels and ensure that they do not depart from the appropriate levels recommended for compliance at sensitive receivers.
- When notified of an acceptable level by the acoustic supervisor, the production manager shall ensure that the correspondent noise level measured by the desk sound level meter is clearly advertised at the sound desk.
- Production managers and sound engineers (day events, night rehearsals) as well as site managers (night time installation and decommissioning works) should be briefed on the importance of reducing noise levels as requested by the acoustic consultant. The event organisers are responsible for briefing the managers prior to the event. Briefing should include awareness of noise issues, clear outline of responsibilities, acoustic consultant contact information, procedures to implement in order to quickly reduce noise levels, and procedures to implement in order to maintain appropriate noise levels.
- The event organisers are responsible for ensuring that the various production managers have rehearsed the process of quickly reducing noise levels.
- Teams should be used to assist people in arriving to/leaving sites quietly.
- Installation and decommissioning works should be undertaken during the day when possible. Such works should only take place at night as a last resort.
- If installation and decommissioning works need to be carried out at night then:
    - Mechanical plant and vehicles should only be operating when needed.
    - Mechanical plant should be placed as far as possible and possibly shielded from the closest receiver.
    - Noisier works should be carried out as early as possible in the night in order to reduce noise impact.
    - Management measures shall be implemented in order to ensure that the noisy

works do not occur simultaneously.

3.6 Temporary Generators

Temporary Plant, such as mobile generators should be planned and managed to address potential noise emissions. The following measures should be adopted as part of each event management plan.

- Generators should be located in areas away from the audience and residences so as to take into account any noise shielding provided by topography or site structures.
- All generators should be silenced.
- Where units exceed a noise level of 85 dBA at 1 meter specialist review will be required which may require localised acoustic treatment to be provided. The need for such treatment should be determined on a case by case basis.

3.7 Compliance Noise Monitoring

This section summarises likely requirements for noise management during large events.

For those events requiring noise monitoring, categories 1 and 2, it is the responsibility of the promoter to ensure an accredited noise consultant is engaged to conduct all noise measurements. The promoter must also ensure;

a) Noise monitoring is carried out across the whole event period as well as any related sound tests or rehearsal periods (where noise is being emitted).

b) Noise monitoring measures noise emissions at four locations as a minimum being:

- 1 High Street Residences
- 2 Merriman Street Residences
- 3 Darling Island Residences
- 4 Balmain East Residence.

Figure 3-1 Recommended Monitoring Locations

* Monitoring can be attended or unattended. It is noted that there are permanent noise monitoring stations at locations 1, 3 and 4 which are associated with the South Barangaroo development. It may be feasible to utilise these sites for monitoring purposes

- When measuring L_{Aeq} levels associated with an event at affected residences over any 15 minute period and with a sound level meter set to fast response, levels must comply with either the noise limits set in the Plan or the noise predictions.
- Noise monitoring should be conducted at least once at each of the identified noise sensitive receivers around the Barangaroo site shortly after the start of high-noise-generating events.
- In addition to the noise monitoring locations described in (b), a noise monitor should be located at the event mixing console throughout the entire event period as well as any sound test or rehearsal period.
- It is important that, throughout the entire event and any sound test or rehearsal period, there is a communication link between the noise monitoring personnel and the controller of the noise (i.e. mixing desk console operator).
- The noise measuring equipment required for collecting data relating to the Noise Management Plan is a Type 1 Sound Level Meter or equivalent, and must be capable of measuring L_{Amax}, L_{Aeq} and L_{Cmax}.
- When conducting noise readings at residences the reading must be taken within 1.5m of the facade of the residential building most exposed to the event noise.

- In the case of attended monitoring, where the direct measurement of L_{Aeq} from the event noise is not possible, the average maximum noise level from the event, $L_{Amax\ average}$, is a suitable approximation. The use of this or any other measurement method should be noted and justified in the monitoring report.

3.8 Monitoring Reports

Following the completion of the event a written report will be provided to BDA by the operator within five working days of the event's completion. The following information is to be provided;

a) Compliance or non-compliance with the noise limits relevant to the event

b) The number, frequency, location and actual noise level of any non-compliance during the event period;

c) Any mitigation action that was undertaken during the event period.

In addition to the above preliminary information, the operator will submit a written report detailing the effectiveness of the event within one month of the completion of the event. The report should include, as a minimum, the following information;

(ii) Details of the type of equipment used for noise measurements

(iii) Times, location of all attended and unattended noise measurement carried out.

(iv) All recorded noise measurements.

(v) Highlight of any noise non-compliance.

(vi) Any recommended measures that have been identified that can be adopted in future events to reduce noise emissions at surrounding receivers.

3.9 Community Consultation

All identified noise sensitive receivers should be notified at of events in advance. Notification must be made through:

- Provision of advance information to the local community, by way of routine event promotional activities, about the range of events planned for Central Barangaroo;
- Notices in buildings and letter drop. In the case of an apartment building, the body corporate should also be notified.
- Notification should provide information regarding the event schedule and potential noise impact.
- Close consultation and communication with all the identified receivers is to be maintained during the weeks preceding the event and during the entire event.
- Establish a 24/7 phone "hotline" for any event noise related issue.

3.10 Complaints Handling

The operator is required to respond to complaints. In the case where complaints are received

on the day/night of the event itself via the Event Noise Hotline, the response should be immediate. Any complaint received in the days after the event are to respond to in a timely manner. The complaints procedure should include.

- A 24 hour complaints handling hotline should be established.
- Letter drops and notices to all identified sensitive receivers should include the complaints hotline number.
- During night time activities, the complaints hotline number should be advertised.
- Complaints should be investigated and recorded in a register of compliants.
- All investigated issue should be reported to the complainant.

3.11 Record Keeping

The operator is to establish and maintain a system of records which provides full documentation of all noise monitoring activities, complaint handling and responses to non-conformances.

The operator will establish and maintain procedures for the collection, indexing, filing, storage and maintenance of the records. Archived records will be kept until the completion of the project. Reports will be made available to the EPA if requested.

3.12 Review of Noise Management Plan

BDA will regularly review and update the Noise Management Plan taking into account:

- complaints on noise emanating from open air concerts and other events on site;
- results of the community consultation; and
- Recommendations from the EPA, Sydney City Council and results of event monitoring by operators acoustical consultants engaged in monitoring of noise during the events.