

Infrastructure New South Wales

Walsh Bay Arts Precinct

SSD 16_7689 SEARs - Noise Impact
Assessment

Rev E | 13 February 2017

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Executive Summary

This report has been produced in response to the Secretary's Environmental Assessment Requirements (SEARs) of the State Significant Development Application SSD 16_7689 relating to the Walsh Bay Arts Precinct – Stage 2, and responds to issues raised in submissions received during the exhibition of the Stage 2 SSDA.

This report addresses Key Issues required for a SSD and specifically responds to the SSD 7689 Key Issue 9 (noise and vibration). Reference is made to construction noise which is one of the topics in Key Issue 17 (Environmental and Construction Management Plan). In responding to these issues, reference has been made to the Conditions of Consent, particularly numbers A13 (relating to Operational Event Noise Management Plan) and B16 (outputs from previous studies into noise at the site).

This report sets out the criteria that relate to noise and vibration from the development affecting the environment both during construction and in operation.

For completeness, this report includes, as appendixes, detailed assessments of the acoustic issues associated with construction of the project and the use of the outdoor areas of the precinct for events.

Conclusion

This report demonstrates that the issues in the SEARs and submissions that relate to noise and vibration can be appropriately resolved. In particular:

- Criteria based on site measurements have been developed for noise from plant affecting the environment. These criteria comply with the *NSW Industrial Noise Policy (EPA 2000)*.
- Noise during construction will be assessed based on the requirements set out in the *Interim Construction Noise Guideline 2009 (EPA)*. The control of noise and vibration during construction will be a strict requirement for the future contractor. The requirements to achieve acceptable construction noise and vibration levels onto the existing development are likely to be more onerous than those to achieve acceptable conditions at the nearest noise sensitive receivers. Most of the construction work will take place within the existing building envelope although there is some necessary external works.
- Preliminary modelling demonstrates that noise from outside events can be effectively controlled. Included within the Event Noise Management Plan (separate document) are recommendations for protocols to manage noise as well as proposed noise limits for different types of activity.

1 Introduction

This report describes the outcome of a detailed investigation into the environmental noise and vibration issues associated with the proposed development of the Walsh Bay Arts Precinct. It includes information presented previously in the Noise Impact Assessment put on public exhibition but, following comments received, has been expanded to include further specific details relating to construction noise and operational noise.

Alongside the Arts Precinct project, there are plans for major modifications to take place inside the Sydney Theatre Company (STC) facilities. To limit the disruption, it is likely that the works would be done at the same time as the main Arts Precinct project. Although these are subject to a separate planning application, the potential cumulative impacts from these works for STC have been assessed herein.

A glossary of the acoustic terminology used in this report has been included as Appendix D to this document.

1.1 The Site and surrounds

The Walsh Bay Arts Precinct (WBAP) (the “site”) generally comprises Pier 2/3, Pier 4/5 and its shore sheds which make up Wharf 4/5, as well as the adjoining waterway. The site has a street frontage to Hickson Road. The site is shown in Figures 1 and 2. The site is part of the Walsh Bay area which is located adjacent to Sydney Harbour within the suburb of Dawes Point. The site is located within the City of Sydney Local Government Area.

Walsh Bay is strategically located to the north of Sydney’s CBD in the vicinity of major tourist destinations including the Sydney Harbour Bridge, the historic areas of Millers Point and The Rocks, Circular Quay and the Sydney Opera House. The Barangaroo redevelopment precinct is located immediately to the south-west.

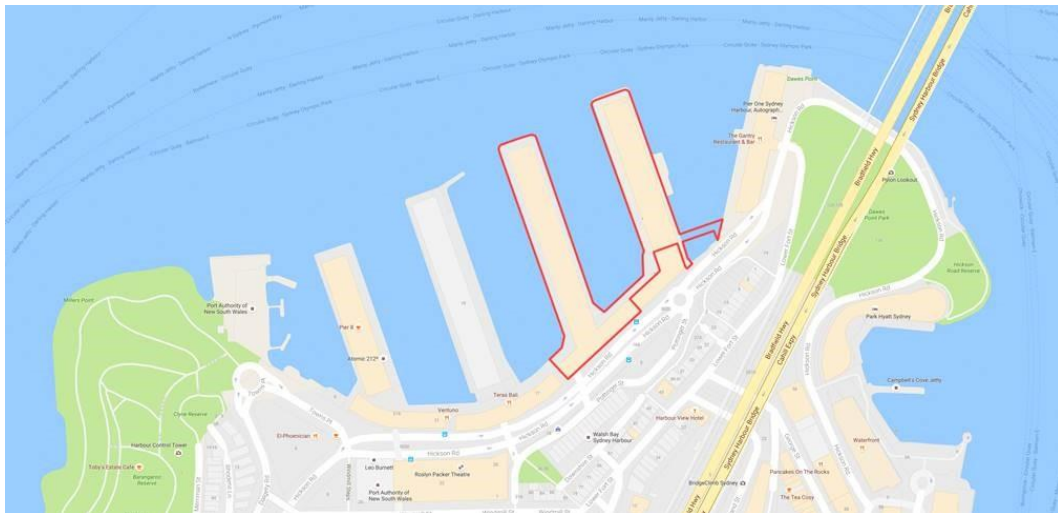


Figure 1: Site Location

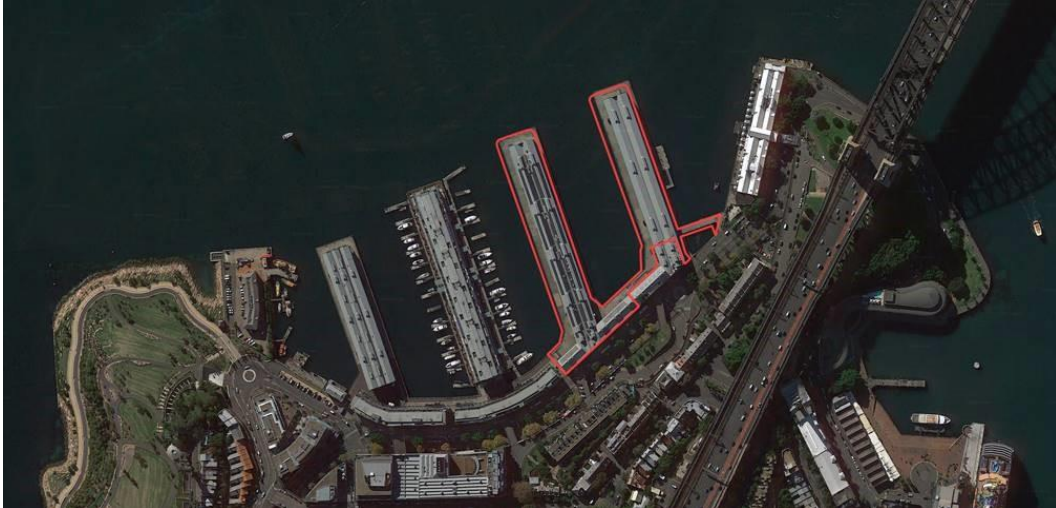


Figure 2: Aerial view

Pier 2/3 is legally described as Lot 11 in DP 1138931 and Wharf 4/5 is legally described as Lot 65 in DP 1048377. The total area for these lots is 18,090sqm.

The land owner of the site is the Roads and Maritime Services (RMS). Both Pier 2/3 and Wharf 4/5 are occupied under various lease arrangements with Arts NSW, Department of Justice, primarily for arts and cultural uses.

The area of water that the project proposes to build over is also owned by RMS. Its land title description is Lot 12 in DP 1138931.

Walsh Bay comprises ten berths constructed between 1908 and 1922 for international and interstate shipping. These are collectively known as the Walsh Bay Wharves. The Walsh Bay Wharves Precinct is listed as an item on the State Heritage Register.

The Walsh Bay Wharves comprise the following:

- Pier One which contains the Sebel Pier One Sydney Hotel;
- Pier 2/3 the last remaining undeveloped pier (has previously received approval for cultural uses, temporary arts events and some commercial events);
- Wharf 4/5 which is occupied by the Sydney Theatre Company (STC), the Australian Theatre for Youth Program (ATYP), Sydney Dance Company (SDC), Bangarra Dance Theatre and the choirs comprising Gondwana, the Song Company and Sydney Philharmonia;
- Pier 6/7 which has been redeveloped for residential apartments and associated boat marina;
- Pier 8/9 which has been redeveloped for office uses; and,
- Shore sheds aligning Hickson Road which contain a range of commercial activities, including restaurants, bars, shops and offices.

1.2 The Project

The approved Stage 1 development application comprised:

- A new waterfront public square between Pier 2/3 and Wharf 4/5;
- A series of new stairs and balconies on Pier 2/3 and Wharf 4/5 and modification to the roof of Pier 2/3;
- The inclusion of new tenancy spaces in Pier 2/3 and Wharf 4/5 for arts and cultural activities; and,
- The use of the precinct for arts festivals, events and pop-ups and associated uses, including restaurants, cafes and bars.

The WBAP Stage 2 State Significant Development Application seeks consent for construction works for the above to realise the WBAP project, as well as the proposed external alterations and additions to all of Wharf 4/5. It also seeks consent for new commercial and event uses in the precinct. Key aspects of the proposed development are outlined below:

Early works

- Early construction works comprising infrastructure upgrades, demolition, hazmat removal and sub structure works.

Pier 2/3

- Internal alterations and reconfiguration to provide for the following:
 - Performance venues;
 - Rehearsal rooms, production workshops, back of house facilities and offices;
 - Function spaces, bars, cafes and foyer spaces extending onto external gantry platforms (balconies) providing breakout space for internal foyers and allowing views of outdoor performances;
 - Mezzanine spaces for offices and back of house facilities;
 - Upgrades to meet compliance with current BCA, DDA and fire codes;
 - New lifts and stairs;
 - Creation of new commercial tenancies and public toilets;
 - Removal of some storey posts and beams to facilitate internal reconfiguration and new uses; and
 - Retention of a large proportion of the ground floor in its existing 'raw' heritage state for events and festivals including Sydney Writers' Festival and Biennale including venue and commercial hire.
- External alterations and additions comprising:

- New balconies and external stairs for fire egress;
- New external lift for access;
- Installation of glazing in existing cargo sliding door openings and other solid panels on the eastern, western and northern elevations to allow for views into and out of the building;
- Roof penetrations within the central valley at the southern and northern end to accommodate new performance spaces and associated structural modifications including truss strengthening;
- Installation of ESD elements, such as photovoltaic panels and seawater heat exchange systems; and
- Raising of the external floor level on the eastern side by introducing a new raised deck and continuous set of stairs beyond the existing column line.

Wharf 4/5

- Internal alterations and reconfiguration to the Bangarra Dance Theatre (BDT) tenancy to provide for the following:
 - Upgrade of the main rehearsal and performance spaces;
 - Upgraded foyer and exhibition space along the eastern frontage;
 - Improved office space at mezzanine level including a new lift and stairs;
 - Provision of a function space at ground level of the northern end of wharf with associated kitchen facilities; and
 - New entrance and new glazing in bays of sliding cargo doors, opening up the foyer and main studio to the Pier 4 apron.
- Minor internal alterations and additions to the SDC tenancy comprising:
 - Reducing the existing workshop space to create a fifth dance studio; and
 - Upgrading office and reception areas.
- External alterations and additions to SDC tenancy comprising:
 - Raising of the timber wharf deck adjoining the SDC café and opening of the facade with new glazing to activate the waterfront square.
- Creation of new commercial tenancies and public toilets;
- External fabric alterations around the Sydney Theatre Company (STC) tenancy comprising:
 - Improved street entry at Hickson Road involving relocation of the stairs to allow for an improved landing and point of arrival to the STC;

- New ‘gantry’ balconies, stairs and lifts mid-wharf and at the end of the wharf to provide for improved accessibility and compliance with fire engineering solutions;
- Minor amendments to the existing façade to accommodate new entries and exits along the wharf;
- Roof penetrations within the central valley at two locations to accommodate theatre and workshop spaces and associated structural modifications including truss strengthening; and
- Reinstallation of existing photovoltaic panels where applicable.

Wharf 4/5 Shore Sheds

- Internal alterations to reconfigure the choir spaces, including provision of a mezzanine for choir administration;
- Creation of new commercial tenancies at ground and mezzanine levels; and
- Provision of office space at ground level.

Public Domain

- Construction of a new waterfront square comprising a deck on piled structure;
- Shaded informal performance space on piled structure; and
- Changes to existing levels and steps down to facilitate access between the existing apron and new waterfront square.

New Uses

- Use of the precinct for arts festivals, events and pop ups as well as a range of activating uses such as retail, restaurants, cafes and bars.
- Events as per table below extracted from SSSA 6096 conditions:

Events

The precise nature of the events to take place at the precinct are not known at this stage but are limited by the Stage 1 DA and amendments to the Stage 2 DA for events held within public domain including the Water front Square and include the following:

Major Events

- up to 7,500¹ people moving through the site at any one time
- max 4 times per year
- must not occur over more than one day
- must not occur before 7 am or after midnight on any day, except New Year's Eve (when the use may occur until 2 am the following day.)
- music to be ceased by 11 pm in all cases (with the exception of New Year's Eve)
- set-up/dismantle time for the use must not start earlier than 6 am, or end later than 1 am, on any day, except New Year's Eve when dismantle may occur until 2 am the following day
- clean up time for the use must end no later than 2 hours after the use was to stop occurring or may be undertaken the following day

Arts and Cultural Festivals

- up to 5,000 people moving through the site at any one time
- can occur over consecutive days up to 90 days
- max 6 times per year
- use must not occur before 7 am or after 12 midnight on any day , including set up/dismantle and clean up time)
- music to be ceased by 11 pm in all cases

Community Events

- up to 5,000 people
- Up to 150 community events held in a year
- can occur over consecutive days up to 35 days
- use must not occur before 7 am or after midnight on any day, including set up/dismantle time and clean up
- music to cease by 11 pm in all cases
- use of localised low output amplified sound system for announcements or for live intimate entertainment only

Private Events

- up to 1,000 people
- Up to 50 private events held in a year

¹ Safety and pedestrian studies have shown that events with this number of attendees are not practicable. The external largest event is expected to be around 5000 visitors with no more than 1500 people in the waterfront square.

- use must not occur before 7 am or after midnight, including set up/dismantle and clean up time, and up to 3 consecutive days in duration
- music to cease by 11 pm in all cases
- private event should not restrict or impede public
- access to public outdoor areas
- use of localised low output amplified sound system for live intimate entertainment only

Nature of Events

The principles for a curatorial framework for events have been developed that provides less emphasis on “traditional “programmed events such as concerts and large festivals and focus on low impact, intimate entertainment and passive and immersive activation to guide the development of events held within the Waterfront Square.

Events, and in particular category 2 and 3 events have been chosen that intentionally provide niche and focused activations and involve smaller interactions held over longer periods to reduce the impact on neighbouring business and residents.

For example Art and About (Category 3 Event), the Biennale (Category 2 Event), and Artist in Residence (Category 3 Event) events will have minor impacts on the precinct. They have long run consecutive durations but provide low impact daily visitation that support the activation goals of the arts precinct.

It is reasonable to expect that all events may require the use of low output amplified sound for announcements, entertainment and/or feature intimate music.

Given the nature of the events and the intended audience, it is expected that most would take place primarily outside normal ‘office hours’, although some setup would take place during the normal working day.

2 Issues Addressed

This report addresses the following Key Issues:

- Assess construction noise and vibration impacts. The assessment must consider cumulative noise and vibration impacts from all concurrent construction activities;
- assess operational noise from the use of the buildings and the public domain, associated events and any food and drink premises;
- assess operational vibration from the use of the premises;
- outlines measures to minimise and mitigate potential noise and vibration impacts within the precinct and to surrounding occupiers of land

Noise from external events are discussed in detail in a separate document².

Reference has also been made to the Stage 1 DA conditions of consent for SSD 6069³, in particular:

- Condition A13 relating to the Operational Event Noise Management Plan (see reference ² below).
- Condition B16 relating to the demonstration of how the recommendations of the Noise Impact Assessment prepared by WSP (dated June 2014) have been implemented.

² Walsh Bay Arts Precinct – Operational Event Noise Management Plan, by Arup, dated 10 Nov 2016

³ Development Consent for Application SSD 6069 to Arts NSW dated 21 May 2015.

3 Relevant Policies and Guidelines

- NSW Industrial Noise Policy (EPA)
- Interim Construction Noise Guideline 2009 (EPA)
- Assessing Vibration: a technical guideline

Issues associated with air quality and odour are not considered in this report.

4 Existing Environment

The NSW Industrial Noise Policy (INP)⁴ sets out a methodology to derive appropriate criteria for noise from plant affecting the environment. This is based on the levels of existing noise around the site which in turn are derived from an extensive survey of existing noise levels, details of which are given below. The derivation of the noise criteria from this data is given in Section 5.1.

The environment is affected by a number of significant noise sources, which give rise to relatively high short term noise levels. Unusually for a central urban site, there is very little direct road traffic noise affecting the environs. The main noise sources are:

- Marine traffic (noise from boat engines and occasional horns)
- Rail traffic on the Sydney Harbour Bridge
- Regular civilian helicopter traffic
- Occasional military helicopter traffic
- Distant aircraft noise
- General activity noise from users of the existing facilities.

Most of the above sources are intermittent in nature and variable in level.

The reactivation of the precinct will inevitably lead to an increase in general occupational noise levels as a result of the increased transient population of the precinct from visitors. However, no significant changes are expected as a result of noise from plant or from road traffic. The results of the noise surveys presented in Appendix A this report represent the minimum likely noise levels at site and in this regard can be considered 'worst case'.

4.1 Description of Site

4.2 Key receptors

The key receptors are shown in Figure 3 and Figure 4 below.

⁴ NSW Industrial Noise Policy. Environment Protection Authority. January 2000



Figure 3: Key Noise Receptors (Image modified from previous WSP report)

Residential receivers are referenced as R1, R2 etc and commercial receivers shown as C1, C2, C3 etc.



Figure 4: Noise Receptors to the North of the Development (Image taken from WSP report)

4.3 Measurement of existing noise levels

The background noise levels have been determined previously by WSP⁵ and submitted as part of the Stage 1 SSDA. The results of the measurements are summarised below with the full report included as Appendix A1 of this report. Whilst the data is two years old, it has been shown to be representative of the existing noise climate through validation by Arup using attended and unattended noise measurements at various locations at site over recent months.

Also included in Appendix A (subsection A2) are details of some additional noise measurements conducted by Arup which assess noise levels local to the Shore Sheds between Pier 2/3 and Wharf 4/5 (location C3 on Figure 3).

The noise measurement locations are shown in Figure 3 and Figure 4 above.

⁵ Noise and Vibration Impact Report, WSP, 24 June 2014

5 Acoustic Criteria

5.1 NSW Industrial Noise Policy (INP)

This section outlines applicable external noise limiting criteria. Noise criteria are provided to maintain on site acoustic amenity and avoid adverse acoustic impacts to the surrounding environment.

The INP covers noise emissions from the proposed operation of a facility and from other plant and equipment affecting the proposed facility. In line with the stage 1 SSDA, the INP criteria are to be used for assessing the internal operational noise breakout from daily operations and use. Noise from traffic movement on a site (i.e. not on public roads) is assessed as being operational noise under the INP.

The objective of the INP is to protect sensitive receivers, such as residences, from noise generated by commercial, industrial or trade premises. In this context, ‘industrial’ refers to the source of the noise (e.g. plant) rather than the nature of the premises.

Noise limits are set based on land use in the area and existing background noise levels. Compliance is achieved if the adjusted L_{Aeq} noise level at any sensitive receivers affected by noise from the facility is below the noise limit. The adjusted L_{Aeq} is determined by applying corrections for such noise characteristics as duration, intermittency, tonality, and impulsiveness.

The assessment of noise emission under the INP is based on the calculation of a noise limit at a receiver position, taking into account the land-use in the surrounding area and the existing background noise level.

The INP separates the 24 hour day into three different time periods – day, evening and night. These time periods are detailed below in Table 1.

Table 1: Standard INP time periods

Period	Day of Week	Time period
Day	Monday-Saturday	7:00 am-6:00 pm
	Sunday, Public Holidays	8:00 am-6:00 pm
Evening	Monday-Sunday	6:00 pm -10:00 pm
Night	Monday-Saturday	10:00 pm -7:00 am
	Sunday, Public Holidays	10:00 pm -8:00 am

The INP states that background noise levels should be determined over the “days and times of operation of the project”. When setting criteria, only the measured data from the hours of operation of the project should be included.

The INP provides guidance on acceptable noise levels from the introduction of new industrial noise sources to an area. The assessment procedure for industrial noise sources has two components:

- Controlling intrusive noise impacts in the short term for residences; and

- Protecting noise level amenity for particular land uses such as residences, recreation areas and commercial offices etc.

Both of these components result in noise criteria that should not be exceeded in order to avoid any adverse noise impacts on the affected areas. Both criteria have been taken into account when assessing the noise impact of building services noise source(s) associated with the project. Where the intrusiveness and the amenity criterion differ, the most stringent of the noise criteria has been adopted as the 'project-specific' noise criterion.

The Project Specific Noise Emission Criteria derived from the noise measurements by WSP and Arup (see Table 2), are given below in Table 2. An additional receiver has been added (C3) which has been added to the assessment in December 2016.

Table 2: Summary of Project Specific Noise Criteria (free-field noise criteria to be met at boundary of receiver)

Location	Time Period	Project Specific Noise Criteria (L _{Aeq} 15min)
Receiver R1: Residential Apartments	Day (7:00 – 18:00)	57
	Evening (18:00 – 22:00)	52
	Night (22:00 – 7:00)	44
Receiver R2: Terraced houses	Day (7:00 – 18:00)	57
	Evening (18:00 – 22:00)	52
	Night (22:00 – 7:00)	51
Receiver R3: The Sebel Hotel	Day (7:00 – 18:00)	57
	Evening (18:00 – 22:00)	52
	Night (22:00 – 7:00)	51
Receiver R4: McMahons Point	Day (7:00 – 18:00)	54
	Evening (18:00 – 22:00)	47
	Night (22:00 – 7:00)	42
Receiver R5: McMahons Point	Day (7:00 – 18:00)	54
	Evening (18:00 – 22:00)	47
	Night (22:00 – 7:00)	42
Receiver C1: Café Restaurants (applicable only when in use)	Day (7:00 – 18:00)	65
	Evening (18:00 – 22:00)	60
	Night (22:00 – 7:00)	58
Receiver C2: Shops and Cafes (applicable only when in use)	Day (7:00 – 18:00)	62
	Evening (18:00 – 22:00)	60
	Night (22:00 – 7:00)	58
Receiver C3: Shops and Cafes and Offices (applicable only when in use)	Day (7:00 – 18:00)	55
	Evening (18:00 – 22:00)	54
	Night (22:00 – 7:00)	44

The building services (mechanical plant) noise mitigation requirements to meet these criteria are discussed in Section 6.3.

The INP also allows increases to the environmental noise limits for events of short durations where no more than one event occurs in any 24 hour period. This is to allow for short and intermittent operation of equipment during testing and/or emergencies such as stair pressurisation fans. The same approach could potentially also be applied to noise from occasional operational events and would need to be coordinated through the Precinct Manager. However this approach, with its associated relaxed criteria, has not been factored in to the noise assessment described in this report.

The allowances are summarised in Table 3.

Duration of Noise (one event in any 24 hour period)	Increase in acceptable noise level at receptor, dB(A)	
	Daytime and Evening (7am-10pm)	Night 10pm-7am
1-2.5 hours	2	Nil
15 minutes to 1 hour	5	Nil
6 minutes to 15 minutes	7	2
1.5 minutes to 6 minutes	15	5
less than 1.5 minutes	20	10

Table 3: Adjustments to Environmental Noise Limits for Duration

For the purposes of design, it is assumed that smoke exhaust fan tests will fall in the 15 minutes to 1 hour band during the daytime, and thus attract an allowable increase of 5 dB(A) to the limiting noise criteria for typical building daytime operation.

The scheduled testing of smoke exhaust fans will also be limited to occur on Saturdays during the daytime hours to avoid disruption to occupants within the building.

5.2 Limits on noise local to the development

As well as controlling noise affecting nearby residences and the nearby recreation spaces, it is intended to control noise local to the development in order to protect amenity of the outdoor areas and the existing local commercial and retail tenancies.

5.3 Event Noise

Event noise is discussed in detail in the Event Noise Management Plan (ENMP – included as Appendix C of this document). Criteria are proposed for the different types of events defined in Condition A7 of SSD 6069, reflecting their nature and frequency. For Major Events and Arts and Cultural Events, an absolute criterion is proposed based on common practice in Sydney. The more frequent events (i.e. Community and Private Events) have a more-onerous criterion that has been derived in relation to the existing background noise level.

The current proposals are for no overall site licensing for the public domain but to allow each tenancy to obtain their own licences under specific conditions. This would allow more flexibility to tailor noise criteria to the nature and size of the event.

Liquor & Gaming NSW has a set of default noise clauses for licensed premises which they often apply to license approvals in the absence of other site specific noise criteria. For consistency in noise policy, it is recommended that the noise criteria proposed in this report (i.e. the final SSD consent conditions relating to noise) are used for all future liquor license approvals for precinct events, instead of the default Liquor & Gaming NSW noise clauses. There is a precedent for this approach being adopted by Liquor & Gaming NSW at other large precinct developments such as Barangaroo that have site-wide noise management policies.

The types of events are split into the following categories:

- Category 1 – Major Events
- Category 2 – Arts and Cultural Festivals
- Category 3 – Community
- Category 4 - Private Events

The types of events envisaged are described below along with a summary of the noise criteria for reference.

5.3.1 Nature of Events

The principles for a curatorial framework for events have been developed that provides less emphasis on “traditional” programmed events such as concerts and large festivals. Instead, there is a focus on low impact, intimate entertainment and passive and immersive activation to guide the development of events held within the Waterfront Square.

Events, and in particular Category 2 and 3 events have been chosen that intentionally provide niche and focused activations and involve smaller interactions held over longer periods to reduce the impact on neighbouring business and residents.

For example Art and About (Category 3 Event), the Biennale (Category 2 Event), and Artist in Residence (Category 3 Event) events will have minor impacts on the precinct. They have long run consecutive durations but provide low impact daily visitation that support the activation goals of the arts precinct.

It is reasonable to expect that all events may require the use of low output amplified sound for announcements, entertainment and/or feature intimate music.

Given the nature of the events and the intended audience, it is expected that most would take place primarily outside normal ‘office hours’, although some setup would take place during the normal working day.

More detail regarding the timing and nature of events is given in the Event Noise and Vibration Management Plan (Appendix C).

5.3.2 Category 1 - Major events (up to 4 times per year)

The noise limits in Table 4 are proposed for Major Events. They cover noise from setup and take down as well as noise generated by the event itself.

Included in the table are suggested noise limits for 0000h to 0200h. This would only apply for New Years Eve.

Table 4: Noise Criteria for Major Events (free-field noise criteria to be met at any residential boundary)

Activity	Early Morning (0700h to 1000h)	Daytime (1000 to 2200h)	Late Evening (2200h to 2400h ⁶)	Night – New Years Eve only (0000 to 0200h)
Setup / takedown	$L_{Aeq,15m} < 55$	$L_{Aeq,15m} < 65$	$L_{Aeq,15m} < 55$	$L_{Aeq,15m} < 50$
Sound Check	None allowed	$L_{Aeq,15m} < 65$ $L_{Ceq,15m} < 80$	$L_{Aeq,15m} < 55$ $L_{Ceq,15m} < 70$	None allowed
Event	None allowed	$L_{Aeq,15m} < 65$ $L_{Ceq,15m} < 80$	$L_{Aeq,15m} < 55$ $L_{Ceq,15m} < 70$	$L_{Aeq,15m} < 50$ $L_{Ceq,15m} < 65$

5.3.3 Category 2 - Arts and cultural festivals

As these events are more frequent than the Major Events, and last for longer, a lower noise criterion will need to be adopted. These are given below in Table 5.

Table 5: Noise Criteria for Arts and Culture Festivals (free-field noise criteria to be met at any residential boundary)

Activity	Early Morning (0700h to 1000h)	Daytime (1000 to 2200h)	Late Evening (2200h to 2300h)
Setup / takedown	$L_{Aeq,15m} < 50$	$L_{Aeq,15m} < 60$	$L_{Aeq,15m} < 50$
Sound Check	None allowed	$L_{Aeq,15m} < 60$ $L_{Ceq,15m} < 75$	$L_{Aeq,15m} < 50$ $L_{Ceq,15m} < 65$
Event	None allowed	$L_{Aeq,15m} < 60$ $L_{Ceq,15m} < 75$	$L_{Aeq,15m} < 50$ $L_{Ceq,15m} < 65$

The above criteria apply for any one single day during the duration of a multi-day event. For the rest of the days of the event, the Category 3 event noise criteria apply.

5.3.4 Category 3 and 4 - Community and private events

Noise from these type of events would have to comply with the normal expectations for environmental noise emissions. The noise criteria in the INP have been applied to this source to be consistent with the previous DA submissions for this project.

The relevant INP requirements are given in Table 2 above.

⁶ Events to finish at 2300h except on New Year's Eve

5.4 Construction Noise

The requirements given in the “**Interim Construction Noise Guideline**⁷” (ICNG) will apply (this is also in accordance with the relevant policies as listed in the SEARs). This defines noise management levels and work periods based on the Rating Background Level (RBL) as defined in the NSW Industrial Noise Policy.

Table 6: Management Levels at residences during intended working hours

Location	Time Period	RBL	Noise Management Level, L_{Aeq} 15minute	
			Noise affected	Highly noise affected
Receiver R1: Residential Apartments	Day (7:00 – 18:00)	52	62	75
Receiver R2: Terraced houses	Day (7:00 – 18:00)	60	70	75
Receiver R3: The Seibel Hotel	Day (7:00 – 18:00)	60	70	75
Receiver R4: McMahons Point	Day (7:00 – 18:00)	49	59	75
Receiver R5: McMahons Point	Day (7:00 – 18:00)	49	59	75
Receiver C1: Café Restaurants	Day (7:00 – 18:00)	60	70	-
Receiver C2: Shops and Cafes	Day (7:00 – 18:00)	60	70	-
Receiver C3: Shops, Cafes, Offices	Day (7:00 – 18:00)	50	70	-

In cases where construction noise exceeds the Noise Management Levels during standard hours, all “feasible and reasonable” mitigation levels will be implemented in accordance with the requirements of the ICNG to reduce the noise levels.

⁷ Interim Construction Noise Guideline, Department of Environment & Climate Change, NSW, July 2009

6 Noise Impacts to Community

6.1 Additive effects of other developments at Walsh Bay

The Sydney Theatre Company (STC) have plans for an upgrade to their facilities which is likely to take place at the same time as the works covered by this report. The potential additive effect of noise from the STC development (construction noise and operation noise) is assessed in this application.

In practice, the event noise from STC will be minimal because of the very high standards of sound insulation provided within the building envelope of the STC facilities. This is necessary to control both noise intrusion and noise breakout and for adherence to any existing noise management plan. This is discussed in more detail below (see section 7).

For plant noise, a factor of 5 dB will be included in the plant noise assessments to account for a potential additive effect from STC plant noise where relevant (see 6.3 below).

The implications of the STC works on construction noise are noted in the Construction Noise and Vibration Management Plan.

6.2 Modelling of noise

Noise from operation and construction has been modelled using SoundPlan 7.4. The model has included the terrain and taken into account the screening afforded by the existing buildings and the acoustical properties of water.

The modelling has been used to assess operational noise (from internal and external events) and noise from ventilation plant.

Screen shots of the acoustic model are shown below. The residential receiver locations can be seen as small yellow dots on the façade of the key buildings.

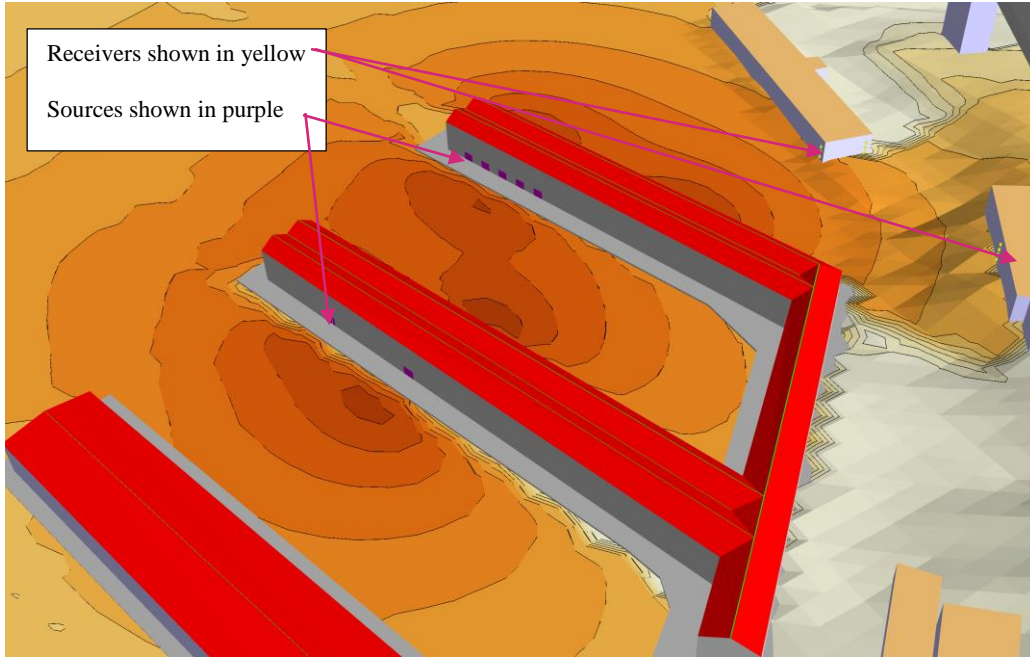


Figure 5: Screenshot of acoustic model showing nearby residential receivers

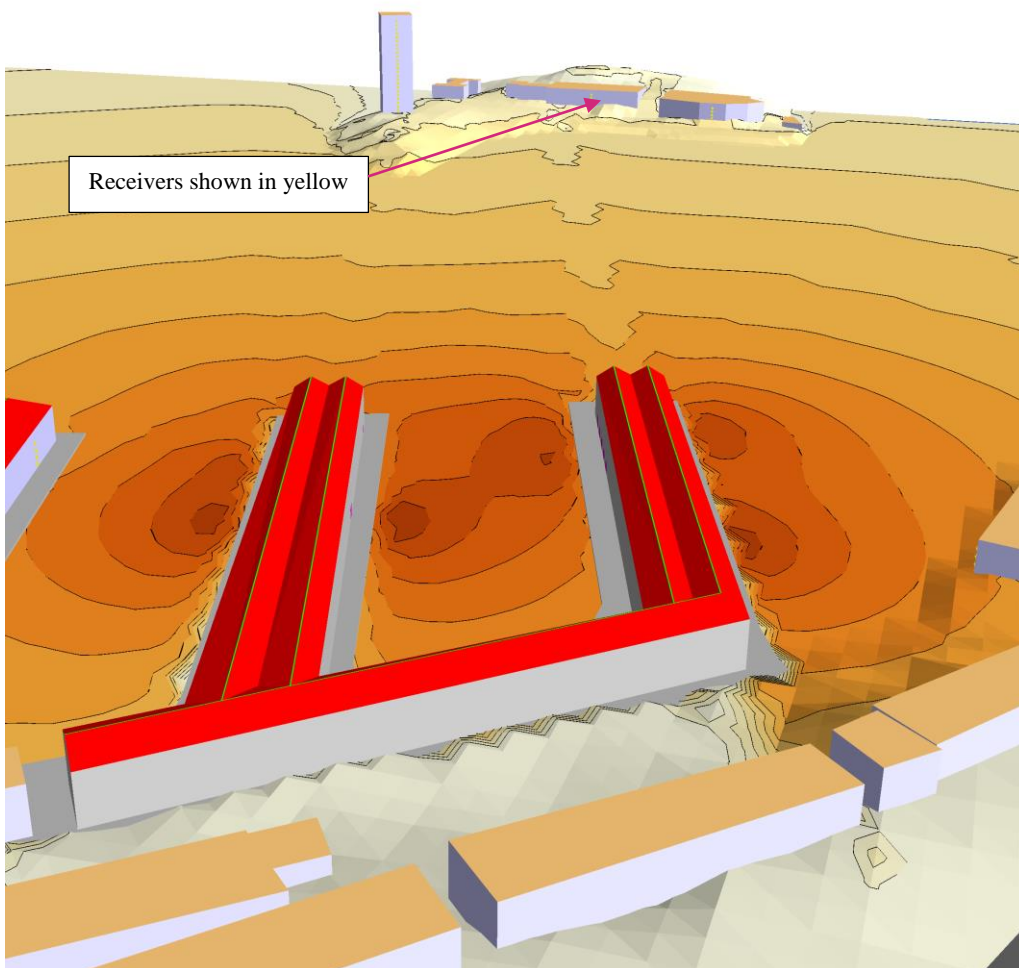


Figure 6: Screenshot of acoustic model showing distant residential receivers

6.3 Mechanical plant noise

Total plant noise (including STC) will be limited to the criteria listed in Section 5.1 (Table 2). Currently an allowance of 5 dB will be included for the potential additive effects of the STC plant at relevant receivers along with appropriate engineering margins.

At this stage in the project, details of the plant selections are not known. During the detailed design process, appropriate noise and vibration control treatments will be specified to ensure that the noise limits are maintained. These will be selected based on the actual duties of the selected plant as well as their location and orientation.

Calculations based on preliminary plant selections show that acceptable noise levels can be achieved. Most of the plant is serving low-noise internal areas and this requires the selection of inherently quiet plant.

The noise control treatments are likely to include:

- Specification of maximum sound power levels for all items of plant as part of the project documentation
- Rectangular and circular attenuators to control fan noise
- Acoustic louvres to control noise from plantroom ventilation openings
- Vibration isolators to reduce vibration input to the building structure
- Acoustic screens around any external plant
- Incorporation of sound absorptive treatments in plantroom spaces where needed
- Kitchen exhausts with discharge attenuators (treated against kitchen grease)

It is expected that the project will make use of seawater cooling. This is intrinsically quieter than many of the alternatives (i.e. cooling towers or air cooled condensers). The seawater cooling plant will be enclosed in a plantroom.

Current plant proposals do not include generator sets, thereby further lowering the potential for noise impacts.

6.4 Construction noise and vibration

Construction noise and vibration is considered in detail in the Construction Noise and Vibration Management Plan set out in detail in Appendix B.

The control of noise affecting the community will be given a high priority and form a critical part of the eventual Contractor's scope of work. There will be a specific requirement for the Contractor to prepare a detailed Construction Noise and Vibration Management Plan as part of their appointment.

6.5 Outdoor Event Noise

Calculation models have shown that the criteria proposed for noise from events are achievable at the residential receivers with event noise set at realistic levels.

Events held in the Waterfront Square may impact on the nearby commercial receivers in the shore sheds that overlook the area and also the various arts venues within the precinct. The management of the WBAP will have a central role in managing the events to ensure that existing and future tenancies are not unduly impacted.

Noise from outdoor events is discussed in the Event Noise Management Plan which is provided in Appendix C.

6.6 Breakout of internal event noise

6.6.1 General

The project is cognisant of the potential for noise from internal activities to affect the nearby residences, particularly from events taking place in the spaces which are required to be naturally ventilated.

As the envelope of the facilities is largely being left 'as is' because of the heritage constraints, the noise breakout from activities will need to be managed by the operators of the various tenancies. Most of these are existing tenants and have developed appropriate protocols to manage noise to avoid complaints. These protocols have been working successfully for several years and it is considered reasonable to conclude that they will do so in the future.

It is worth noting that some of the spaces in the development, particularly those for the Australian Chamber Orchestra (ACO) and Australian Theatre for Young People (ATYP) and Sydney Theatre Company (STC) are very well insulated acoustically to control noise intrusion and will therefore be effectively insulated against noise breakout. These acoustically insulated spaces are discussed below (6.6.2.)

Some of the other facilities will be naturally ventilated or mixed mode operation where doors might be left open in the warmer months to allow for cooling and air movement. Noise from these facilities is discussed in 6.6.3.

6.6.2 Acoustically Insulated Spaces

Noise breakout from these sealed and fully air conditioned spaces is not significant relative to that from the naturally ventilated spaces. Tenants in these naturally ventilated spaces include Bangarra Dance, Sydney Dance Company, Bell Shakespeare and the choirs who will be based in the precinct.

The level of noise breakout for the STC facilities is shown below in terms of the expected maximum sound pressure level at 1 m from the facade. These assessments are based on an assumed worst-case noise level in the performance venues of 94 dBL_{Aeq} and similar levels in the ACO and ATYP spaces.

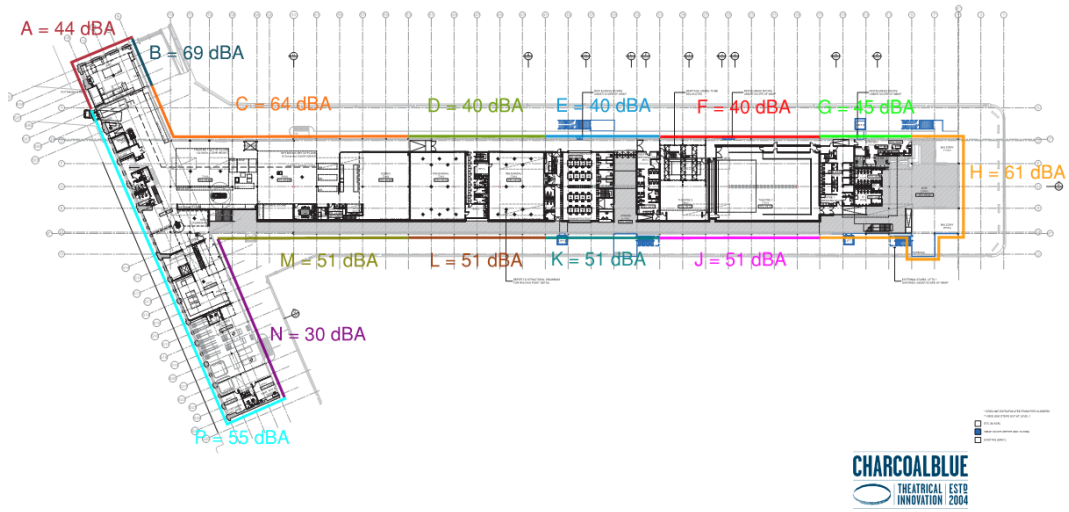


Figure 7: Sound Pressure Level at 1m from facade of STC facilities (image courtesy of Charcoal Blue)

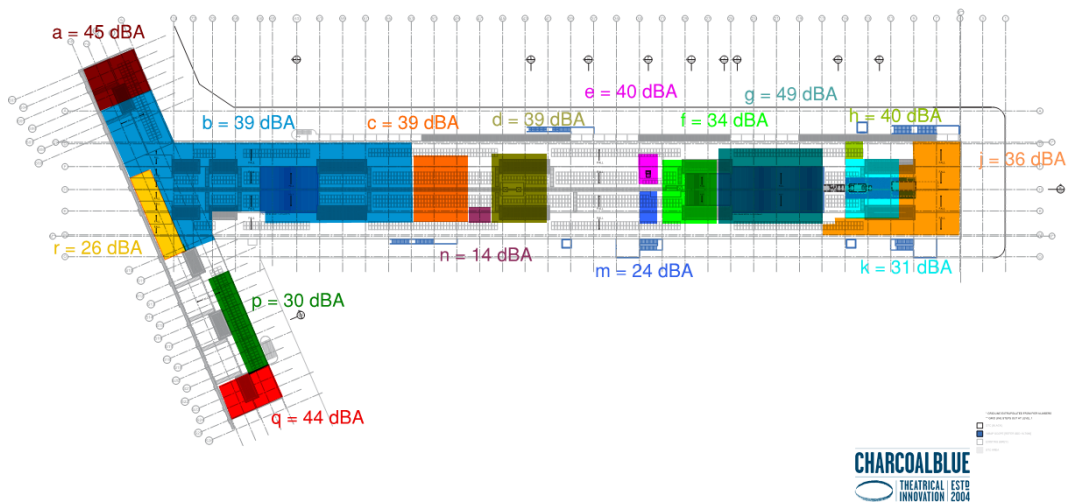


Figure 8: Sound Pressure Level at 1m from roof of STC facilities (image courtesy of Charcoal Blue)

The layout of the Pier 2/3 acoustically insulated spaces in the upper floors and roof are shown below along with the estimated sound pressure levels at the façade / roof. Note that the key acoustically sensitive spaces (ACO and ATYP) are set in from the façade which helps to reduce the levels of noise breakout.

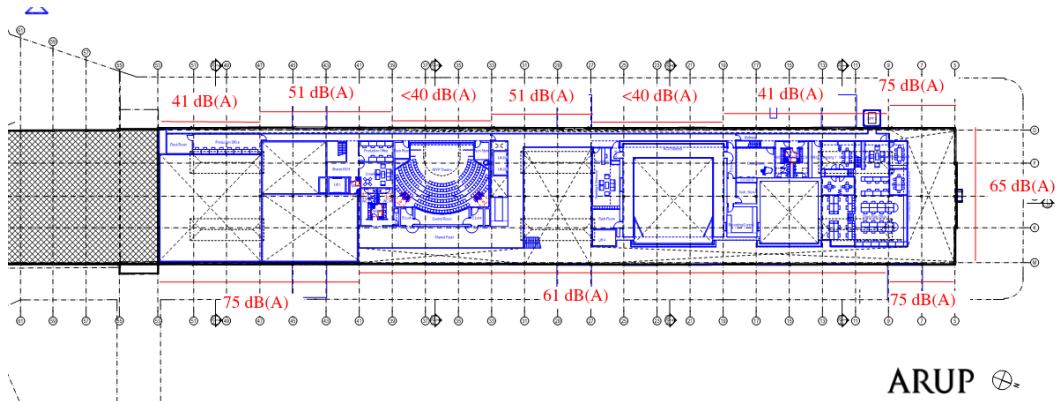


Figure 9: Estimated sound pressure levels at 1 m from upper facade of Pier 2/3

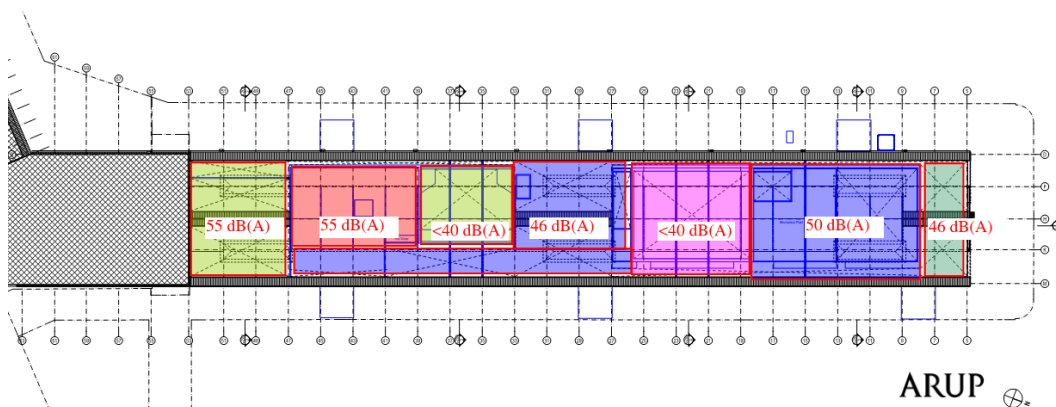


Figure 10: Estimated sound pressure levels at 1 m from external roof of Pier 2/3

As can be seen from the above, breakout noise levels even local to the façade and roof of the acoustically insulated spaces are significantly below the NSW INP targets for noise to atmosphere.

6.6.3 Calculations of noise from Natural Ventilation Openings

Noise breakout has been assessed through acoustic modelling of the naturally-ventilated spaces. This is made using ‘worst case’ assumptions, in particular:

- All natural ventilation openings are in an *open* configuration
- All the noisy internal activities happen concurrently

The following noise spectra have been used in the assessment. These are based on measurements undertaken by Arup for similar uses and represent the most pessimistic (i.e. noisiest) of a range of events.

Table 7: Operational Noise Assumptions

Source	dB(A)	Sound Pressure Level (dB re 10 ⁻⁶ Pa L _{eq}) Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
Loud cocktail party	85	86	86	87	83	80	74	67	60
Loud applause	85	57	65	72	76	82	81	72	62
Amplified foreground music	90	90	90	87	78	82	86	83	77

The calculations have used the above noise levels and applied them to the natural ventilation openings and, based on the areas of these openings, the sound power radiated to atmosphere then calculated and fed into the noise map.

The limited internal sound insulation *within* the piers means that is not possible to have amplified music at a 'concert' level (i.e. ~105 dB(A) within the venue) as this would disturb adjoining tenants, as well as resulting in excessive noise leaving the development. The need to control noise will be part of the agreements with hirers of the function spaces.

These assumptions have been used as follows in the calculations:

Table 8: Assumed activities in typical naturally ventilated spaces

Source	Location	Noise spectrum
Bell Shakespeare Rehearsal	Ground floor Pier 2/3	Loud applause / Loud cocktail party
Function One (event space)	Ground floor Pier 2/3	Loud cocktail party
SDC Studio 5	Ground floor Pier 4/5	Amplified foreground music
Bell Shakespeare small rehearsal room	1 st floor Pier 2/3	Loud applause
Bell Shakespeare large rehearsal room	1 st floor Pier 2/3	Loud applause
Commercial 6 (event space)	1 st floor Pier 2/3	Loud cocktail party

The assumptions above are in line with (but not identical to) those used in the WSP Noise Impact Assessment.

The assessment has been based on the combined operation of the internal spaces. The noise breakout from *external* events in the waterfront plaza have been assessed separately in the Event Noise Management Plan. In practice, it is unlikely that there would be a cumulative noise impact on the community from both external *and* internal events concurrently. This is because such events would interfere with each other and would therefore have to be programmed such that there is no mutual disruption.

6.6.4 Modelling results

The results of the modelling are shown below as noise contours in dBL_{Aeq} units for comparison with the INP criteria in Table 2.

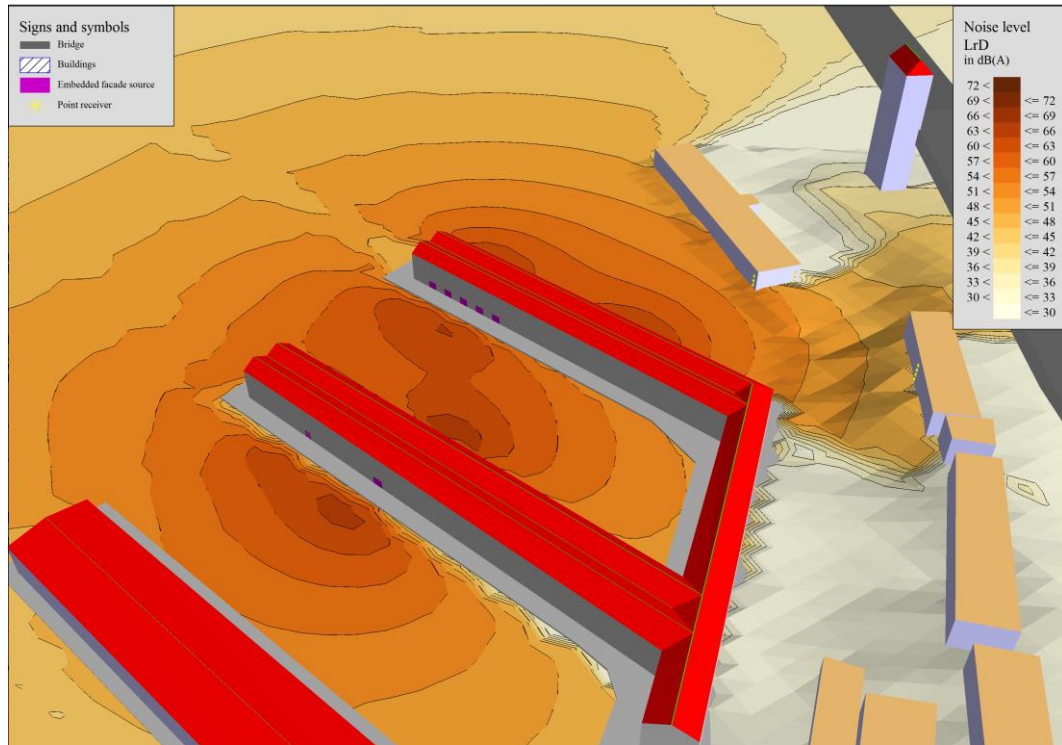


Figure 11: Noise Level Predictions from Internal Events (L_{Aeq}) showing local receivers

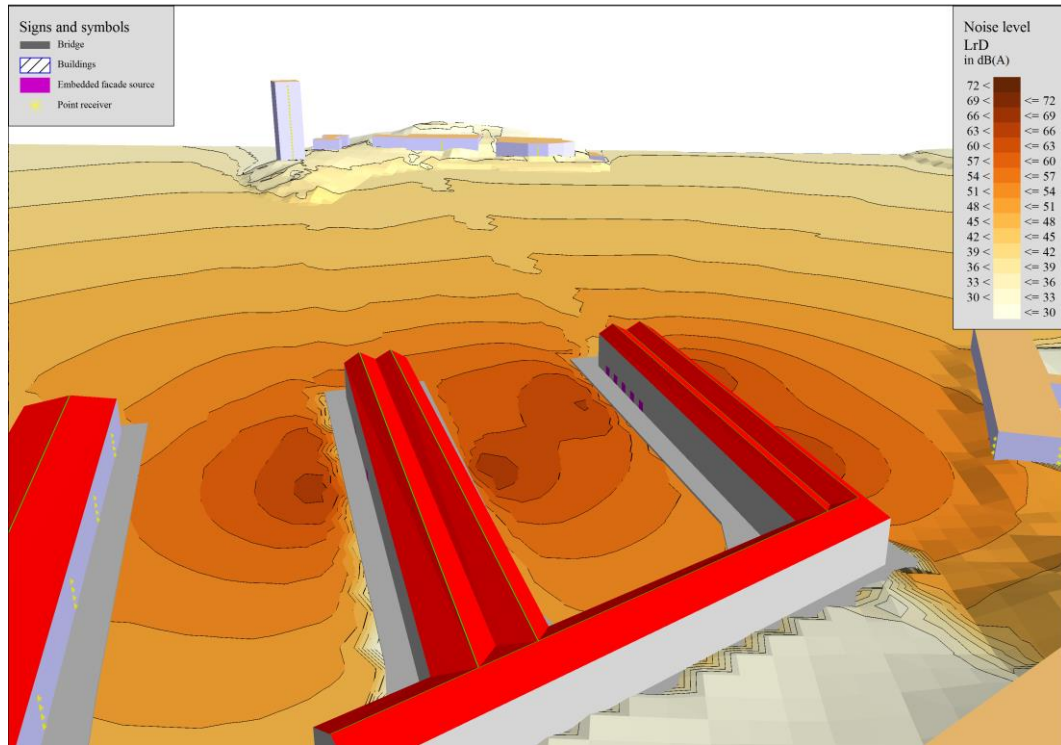


Figure 12: Noise Level Predictions from Internal Events (L_{Aeq}) showing northern receivers

The calculations show that noise levels are compliant with the proposed criteria during the daytime but with the possibility of a nominal 2 dB exceedance of the evening time noise criteria, based on the worst case assumptions noted above.

The worst affected residential units are in Pier 6/7 (location R1) and it is possible for the evening time noise criteria to be exceeded from loud events in Pier 4/5 and for the Pier 1 hotel (location R3) to be possibly affected by noise in Pier 2/3. Some control on noise levels within the spaces is therefore necessary.

Noise at the northern receivers from events within the units is not expected to exceed the proposed evening time criteria. The results are summarised below in Table 9.

The results are broadly consistent with the findings of the previous EIA study (from stage 1 SSDA).

Table 9: Results of noise breakout calculations (refer to Figure 3 for details of the receivers)

Location	Predicted Noise Level $dBL_{Aeq,15min}$	Target (evening time period) $dBL_{Aeq,15min}$	Assessment
R1	54	52	Slight exceedance with worst case assumptions
R2	48	52	Acceptable with worst case assumptions
R3	53	52	Acceptable with worst case assumptions
R4	37	47	Acceptable with worst case assumptions

Location	Predicted Noise Level dBL _{Aeq,15min}	Target (evening time period) dBL _{Aeq,15min}	Assessment
R5	37	47	Acceptable with worst case assumptions
C3	54	54	Acceptable with worst case assumptions

6.6.5 Recommendations

Significant exceedances may occur during the night time period when the limits are more onerous than evening time, so it is recommended that the doors be closed after 2200 h for venues in use with significant noise generation. Closing the doors would be expected to reduce noise levels by at least 10 dB and lead to compliance with the night time noise limits. The heritage nature of the doors means that it would not be practicable to seal the doors to obtain very high levels of sound insulation.

6.7 Other noise issues

6.7.1 Loading and Unloading

The noise from unloading and waste removal has been estimated from Arup data, as shown in Table 10.

Table 10: Data used for assessment of delivery noise

Noise Source	Noise level measured at 10 m, L _{Aeq} dB(A)
Heavy Rigid Vehicle (HRV), 14.5 Tonne (TARE) waste removal truck driving forward at low speed	64
Heavy Rigid Vehicle (HRV), 14.5 Tonne (TARE) waste removal truck reversing at low speed with reversing beepers active	67
Heavy Rigid Vehicle (HRV), 14.5 Tonne (TARE) waste removal truck lifting and compacting operations	67
8 Tonne (TARE) Truck (low speed)	63
1 – 5 Tonne (TARE) Truck (low speed)	57
Loading dock activities – Use of pallet jack	69

Calculations using these data show that noise from loading/unloading can be kept to within acceptable noise levels (as defined in the INP) to allow for daytime and evening loading and unloading activities (0700 h to 2200 h).

6.7.2 Set-building work

The Bell Shakespeare and ATYP tenancy will include some set building facilities. Noise from this activity has been measured by Arup in a theatre set workshop.

The measurements covered all the major noise-generating power tools although these items would not be expected to operate continually or concurrently.

A summary of the noise measurements is provided in Table 11 below.

Table 11: Summary of set workshop building activity noise levels

Activity	Octave Band Centre Frequency, Hz									
	dB(A)	63	125	250	500	1k	2k	4k	8k	
Unknown saw type (dremel-like) @ 2m	L _{max}	96	66	72	83	94	91	89	86	77
Unknown saw type (dremel-like) @2m	L ₁₀	91	60	63	80	88	83	85	83	75
Carba-Tec Thicknesser	L _{max}	104	74	78	85	90	97	99	99	87
Carba-Tec Thicknesser	L ₁₀	100	70	74	82	87	87	92	97	83
Band saw @ 2m (sawing timber)	L _{max}	101	77	80	86	90	91	92	95	96
Band saw @ 2m (sawing timber)	L ₁₀	97	66	61	63	74	81	88	93	93
Table saw @ 2m	L _{max}	95	78	81	85	89	92	87	84	77
Table saw @ 2m	L ₁₀	89	75	77	76	82	84	83	80	76
Table saw @ 2m	L _{max}	91	74	77	70	77	82	86	84	81
Table saw @ 2m	L ₁₀	88	73	76	67	72	79	82	83	80
Nail gun @ 2m	L _{max}	92	75	81	85	86	86	86	84	84
Nail gun @ 2m	L ₁₀	84	72	76	77	78	77	78	77	76
Angle grinder @ 2m	L _{max}	91	70	72	70	76	80	84	87	86
Angle grinder @ 2m	L ₁₀	86	67	68	66	71	77	80	81	80
Band saw @ 2m (sawing aluminium)	L _{max}	109	77	77	81	86	86	97	103	108
Band saw @ 2m (sawing aluminium)	L ₁₀	100	66	68	75	83	84	91	96	95

The noise levels measured in Table 11 will assist in the building façade and internal wall/floor partition design to ensure noise break-out is controlled to meet noise limits at the nearest sensitive receiver locations. The theatre tenants will be required to keep doors and windows shut to protect the local environment when particularly noisy work is being undertaken.

As there are regular set-building activities currently undertaken at the precinct, without noise issues, it is reasonable to assume that this can continue, especially given the additional distances involved.

6.8 Operational Vibration Impacts

The intended use of the precinct is not expected to result in any significant vibration. All plant will need to be carefully vibration isolated to control structure-borne noise. The overall sensitivity of the development itself to noise and vibration (because of the arts uses) will mean that there will be tight control of any future vibration generating activities.

6.9 Operational Traffic Noise

6.9.1 Outside Precinct

The project is not expected to generate sufficient additional traffic to result in a significant impact from road traffic noise. For reference, the traffic volume would have to double for there to be barely perceptible increase in noise levels.

6.9.2 Within Precinct

There will be a requirement for delivery vehicles to use specific routes for gaining access to the precinct, for both safety and noise mitigation reasons.

There will be a system for vehicles to flow through the Public Domain without needing to reverse (thus avoiding noise from reversing alarms). Vehicles moving along the piers will be required to turn only at the ends of the piers or within their tenancies and not allowed to drive in reverse at any other location. Again, this will avoid the need for reversing alarms outside noise sensitive premises.

7 Cumulative Impacts

As noted above, it is likely that the STC project will be undertaken at the same time as the main WBAP works. There is therefore potential for noise and vibration generated during the STC construction and operational stages to add to the impacts from the WBAP project, given that generally the same noise receivers will be affected.

Although the projects are separate and have their own design teams, there has been close liaison to ensure that the cumulative environmental noise and vibration impacts from both projects remains within acceptable limits.

7.1 Construction Noise

The noisiest construction activities are associated with the construction of the Waterfront Square and the piling for that area. As noted in the Construction Noise and Vibration Management Plan (Appendix B), particularly quiet piling techniques will be used and projections based on typical plant of the type proposed show that noise levels will be below the Noise Management levels specified in the NSW Interim Construction Noise Guidelines at the worst affected receiver. The best practical means will be used to minimise noise from construction work.

Almost all of the work for the STC upgrade will be done internally. Calculations show that this will not add significantly to the overall construction noise levels within the precinct associated with the WBAP works.

7.2 Operational Noise

A major part of the upgrades to STC are the works to reduce the level of external noise intrusion that would otherwise affect performances. The upgrades to the walls and roof (which are similar to those that are proposed for the new ACO and ATYP facilities) will greatly reduce noise breakout as well as noise intrusion.

Calculations show that the breakout from performances and rehearsals in the STC facilities would not have any significant impact on noise sensitive receivers within the precinct or further away (see 6.6.2). There is therefore no additive impact from the STC events to the overall cumulative event noise breakout levels.

The detailed design of the mechanical plant is at an early stage and specific plant selections have not yet been made. As with the works to the building envelope, the project requires very low plant noise levels and so intrinsically quiet plant will be used. Targets for plant noise for each of the projects have taken account of the potential for there to be additive impacts and the noise criteria set accordingly. Noise control equipment will be specified for the plant to enable the total noise levels from *all* normally operating equipment to meet the target noise levels set out in this report.

8 Conclusion

This report has addressed the SSD 16_7689 SEARs Key Issues relating to noise and vibration from construction works (Appendix B), day to day operation and noise from outdoor events (Appendix C).

Reference has been made to relevant NSW and Australian guidance as well as international experience in arts facility design from within Arup.

Noise from construction is not expected to be a significant issue for the nearby residential and commercial properties. A majority of the construction work will take place internally and the Contractor will be required to manage noise. No percussive piling is proposed.

The analysis has shown that there is a possibility of excessive noise from the naturally ventilated performance and event venues when windows / shutters are open. These ventilation openings should be kept shut after 2200h for venues in use with significant noise generation to control this. The levels of noise in the large Function Space in Pier 2/3 will need to be controlled to protect the nearby performance venues (particularly the ACO), as well as residential property and the local environment.

Acoustic modelling using realistic noise levels for the type of outdoor events that are planned shows that acceptable noise levels can be achieved at the nearby residential receivers during events. Noise control protocols are included in the Event Noise Management Plan.

It is recognised that there is potential for outdoor event noise to impact on commercial and retail tenants within the WBAP. A key role of the central management of the precinct will be to manage disturbance from specific events as they effect these local non-residential receivers. Most events are expected to take place out of normal office hours and therefore are unlikely to impact on office users.

The development will be provided with seawater cooling which avoids the need for cooling towers or condenser plant. Space is being allowed for noise control to the internal plant to ensure that any noise radiation to the atmosphere from the plant does not exceed the criteria.

A combined noise model is being used to assess the cumulative total noise from the project, including the noise from the STC works. At this stage of the project, allowances are being made for the cumulative noise by including an overall 5 dB safety factor for each element. As more detail becomes available, the model will be updated to show the detailed requirements for noise control based on specific octave band noise data.

On the basis of the noise and vibration measurements made on site and the information currently available for the development, Arup see no impediment to approval.

Appendix A

Noise Survey from Stage 1 DA

A1 Noise Data from Stage 1 DA

2. Site and Project Description

At a glance

This section outlines the Site and Project Description.

2.1 Background

Arts NSW is proposing to develop a new arts precinct at Walsh Bay which will expand and strengthen the existing cluster of cultural institutions and attractions along Sydney's "Arts and Cultural Ribbon". The arts precinct includes Wharf 4/5, Pier 2/3 and Sydney Theatre. The concept provides for an integrated performing arts and cultural precinct within an enhanced public domain at Walsh Bay. It is envisaged that the arts and cultural program within the Walsh Bay Arts Precinct (WBAP) will complement the other cultural initiatives in surrounding areas, including those proposed at nearby Barangaroo (currently under development).

In 2011/12 Arts NSW engaged the NSW Government Architect to prepare a master plan for the precinct. The master plan proposed:

- The transformation of Pier 2/3 to accommodate the Australian Chamber Orchestra, Bell Shakespeare and Australian Theatre for Young People
- The retention of a large "raw" space in Pier 2/3 for events, festivals and functions
- A major upgrade of ground floor facilities at Wharf 4/5, allowing Bangarra to confirm its place as the premier Indigenous performing arts company and maximise new tourist and engagement opportunities
- The expansion of creative and commercial activities along the shore sheds offering cafes, restaurants, retail and commercial activities to further enhance the visitor experience
- A new north facing waterfront square supported with new boardwalks which will significantly increase public open space and create a central platform for activity, collaborative outdoor performances, events, festivals and public art.

2.2 The Site and Surrounds

The WBAP site is part of the Walsh Bay area which is located adjacent to Sydney Harbour within the suburb of Dawes Point. Walsh Bay is strategically located to the north of Sydney's CBD in the vicinity of major tourist destinations including the Sydney Harbour Bridge, the historic areas of Millers Point and The Rocks, Circular Quay and the Sydney Opera House. The Barangaroo redevelopment precinct is located immediately to the south-west and McMahon's Point lies directly on the opposite side of the harbor to the north.

The location of the WBAP site is shown in Figures 1 and 2 overleaf.

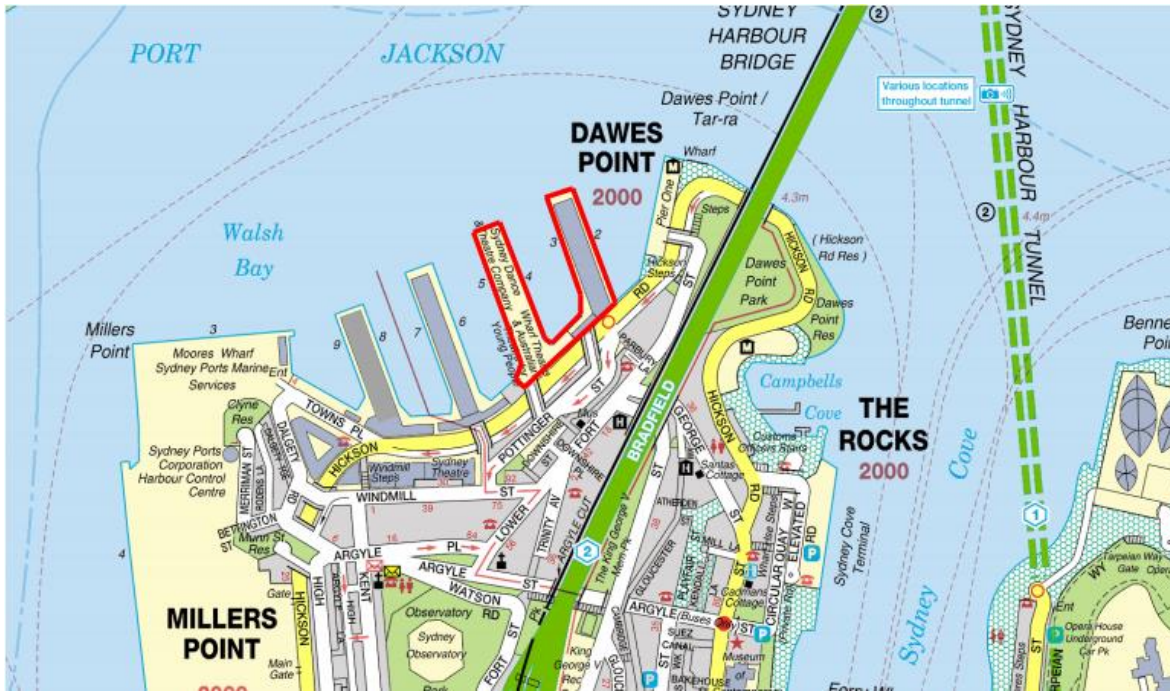


Figure 1 - Site Location (Source: UBD Digital Edition 2004)



Figure 2 - WBAP site (Source: Google Maps)

Walsh Bay comprises ten berths constructed between 1908 and 1922 for international and inter-state shipping. These are collectively known as the Walsh Bay Wharves. The Walsh Bay Wharves Precinct is listed as an item on the State Heritage Register. Much of Walsh Bay

(excluding Wharf 4/5 and Pier 2/3) was redeveloped between 1997 and 2004 by the NSW Government in partnership with the Walsh Bay Partnership (Mirvac and Transfield). The Walsh Bay Wharves comprise the following:

- Pier One which contains the Sebel Pier One Sydney Hotel
- Pier 2/3 is the last remaining undeveloped pier. It has approval for cultural uses, temporary arts events and some commercial events.
- Wharf 4/5 which is occupied by the Sydney Theatre Company, Australian Theatre for Young People, Bangarra Dance Theatre and other arts organisations.
- Pier 6/7 which has been redeveloped for residential apartments and associated boat marina
- Pier 8/9 which has been redeveloped for office uses
- Shore Sheds which contain a range of commercial activities, including restaurants, bars, shops and offices.

The Sydney Theatre is within the WBAP however it is not part of the proposed redevelopment. Given the significant difference in grade between Walsh Bay and Millers Point, there are a number of bridges over Hickson Road which provide pedestrian access between the site and Millers Point. The bridge linking Pottinger Street and Wharf 4/5 is also used for vehicular parking. To the south-west of the wharves is Hickson Road, which provides the major vehicular access to the site. Hickson Road links the site to Barangaroo to the south-west and Circular Quay and The Rocks to the north-east. Other roads providing access to the site include Pottinger Street which provides access to Millers Point, and Towns Place which also provides access to Millers Point via Dalgety Road and Argyle Street.

The Barangaroo redevelopment project to the south of Walsh Bay comprises three redevelopment areas – the Headland Park, Central Barangaroo and Barangaroo South. The Headland Park is to be located adjacent to the Walsh Bay Precinct and is currently under construction. The park is being built up to reflect a similar landform to other headlands around Sydney Harbour. It is proposed that a 300 space car park and an as yet undefined cultural facility will be located inside the headland. Master planning for Central Barangaroo is currently underway with the intention that it will be the cultural and civic focal point for recreation, events and entertainment. Barangaroo South is being developed as a major commercial and mixed use centre.

2.2.1 Pier 2/3

Pier 2/3 is a finger wharf comprising two storeys (and associated shore sheds) and was constructed between 1912 and 1921. It is Sydney's last wharf structure in its original state. Much of it is an empty shell however it does contain some commercial uses. There is a 99 year lease between the Maritime Authority of NSW (now Roads and Maritime Services) and Communities NSW (which now rests with Arts NSW, Department of Trade and Investment) for the finger wharf, the portion of open air wharf apron, the pedestrian link bridge and the wharf substructure. The granting of this lease, amongst other things, allows Pier 2/3 to be used for arts, cultural and creative purposes. The City of Sydney has granted consent for Pier 2/3 to be used as a cultural facility for a range of uses such as rehearsals, exhibitions, workshops, filming and events, including the Sydney Writers' Festival and the Biennale of Sydney. The consent was granted on 21 September 2011 and is for a period of 3 years.

2.2.2 Wharf 4/5

Wharf 4/5 is a four storey timber building which was built around 1917 and used as a steamship berthing and cargo storage facility until the mid-1970s. The Wharf has been progressively upgraded and adaptively reused since the early 1980s. Ten arts and cultural organisations use the facility which comprises a range of performance venues, rehearsal and workshop spaces, a recording studio, café/restaurants and office accommodation.

Wharf 4/5 is recognised as a highly successful adaptive reuse of an important heritage item. Its redevelopment 30 years ago was the subject of numerous architectural and design awards. However, many of its spaces are not fit for purpose and use of the space is not optimised.

2.3 Site Ownership

The land is legally described as follows:

- Pier 2/3 - Lot 11 DP 1138931
- Pier 2/3 Shore Sheds – Lot 24 DP 1071597
- Wharf 4/5 - Lot 65 in DP 1048377

The land owner of the WBAP site is the Roads and Maritime Services (RMS). Both Pier 2/3 and Wharf 4/5 are occupied under various lease arrangements with Arts NSW, Department of Trade and Investment, primarily for arts and cultural uses. The area of water that the project proposes to build over, with walkways and the bridge, is also owned by RMS. Its land title description is Lot 12 in DP 1138931.

2.4 The Project

The Concept Design more than doubles the arts and cultural offerings at Walsh Bay, with new and upgraded production, rehearsal, studio and performance venues. It remains a working arts precinct, with complimentary commercial opportunities

Following the Master Plan, the Concept Design has responded to stakeholder feedback and greater design investigation, resulting in a more resolved concept, with the following key differences from the Master Plan:

- Floating pontoons and connecting bridge have been removed;
- Heritage impacts have been interrogated and minimised;
- Internal planning has been further articulated to meet arts tenants requirements; and
- A stage area canopy has been introduced into the waterfront square.

The main features of the development of Pier 2/3 include:

- New homes for Bell Shakespeare, Australian Chamber Orchestra and the Australian Theatre for Young People, including office accommodation, rehearsal space and performance spaces; and
- Retention of raw heritage space for a range of events and functions, with some improved ancillary facilities.

The proposed refurbishment of Wharf 4/5 ground floor includes:

- Upgraded facilities for Bangarra Dance Theatre and Sydney Dance Company (Sydney Theatre Company facilities are not included in this proposed development)

- Several arts organisations - Accessible Arts, Regional Arts, and the choirs are to relocate from this building

The proposed modifications to Wharf 4/5 Shore Sheds include the provision of upgraded choirs office accommodation and rehearsal space, and new commercial spaces.

The Waterfront Square has been further developed from the public domain proposed in the Master Plan to include a central square for events, festivals, markets and public art. As noted above, the pontoons and bridges have been removed and a shade structure/canopy has been introduced over the notional stage area of the Waterfront Square.

3. Site analysis

At a glance

This section outlines the primary noise & vibration sources impacting the site, and establishes all surrounding noise and vibration sensitive receptors. This section also details the noise survey that has been undertaken and quantifies the existing ambient noise levels on site and at the noise sensitive receivers.

3.1 Key Noise & Vibration Site Analysis

3.1.1 Primary Noise & Vibration Sources

The site is subject to the following existing noise sources:

- Road and rail traffic from Sydney Harbour Bridge
- Marine activity on Sydney Harbour
- Low levels of air traffic noise from aircraft using Sydney Airport
- Occasional but regular light aircraft (Helicopter) noise.
- Existing restaurants & bars
- Existing noise generation from Pier 2/3 tenancies.

3.1.1 Surrounding Noise and Vibration Sensitive Receivers

The site has nearby residential and commercial areas. The closest residential properties are on Pier 6/7 and across Hickson Road sitting approximately 9m higher than the Piers. The closest commercial properties are local stores and cafés across Hickson Road, on street level. To the east, at Pier 1, a hotel with restaurants/cafes sits along the waterfront.

The following table and figure identify the most effected noise sensitive receivers for use throughout the assessments. These will be referenced throughout.

Table 1- Nearby noise sensitive receivers

Receiver	Building	Closest distance from site façade (horizontal)
R1	Residential Apartments	80m
R2	Residential Terrace houses	50m
R3	Residential Hotel – The Seibel Pier One	67m
R4	Residential Apartments – McMahons Point	540m
R5	Residential – McMahons Point	624m
C1	Commercial premises – Café Restaurants	67m
C2	Commercial Premises – Shops and cafes	25m



Figure 3 - Surrounding Noise Sensitive Receptors. Background image courtesy of Google Maps 2014

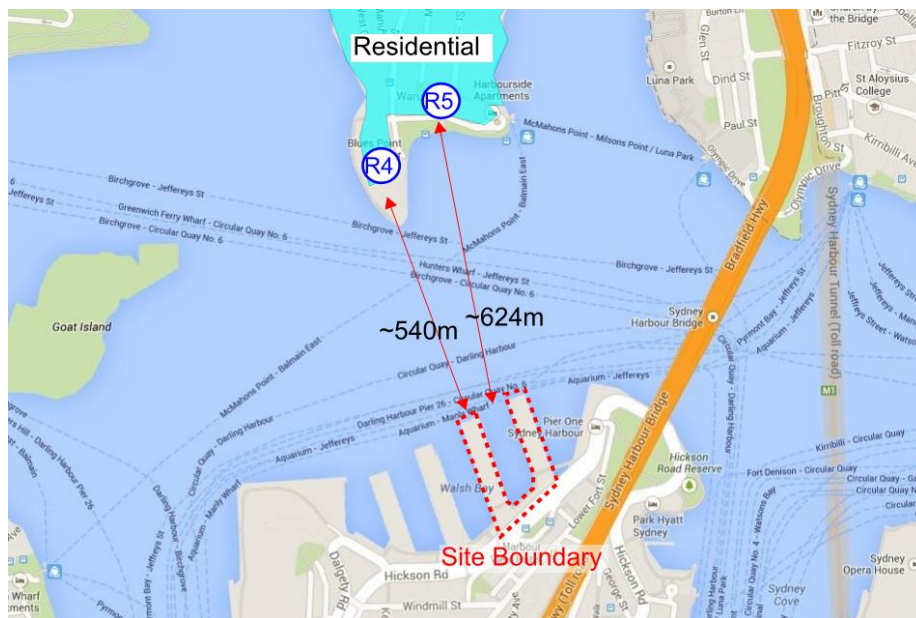


Figure 4 – Surrounding Noise Sensitive Receptors Mc Mahons Point. Background image courtesy of Google Maps 2014

3.3 Existing Prevailing Noise Environment

The existing noise environment has been to and from the site have been determined using site measurements and predictive methods. These methods and results are detailed within the following sections.

3.3.1 Ambient Noise Survey Methodology

Noise measurements have been undertaken around the site to benchmark the prevailing noise environment surrounding the site. Long term noise logging was undertaken taken over 7 days at Walsh Bay from 5/11/2013 - 11/11/2013 and at McMahons Point from 14/03/2014 – 19/03/2014. All logging time periods included typical weekday and weekend periods. Spot measurements were also taken at various locations around the site to inform and calibrate predictions and noise modelling.

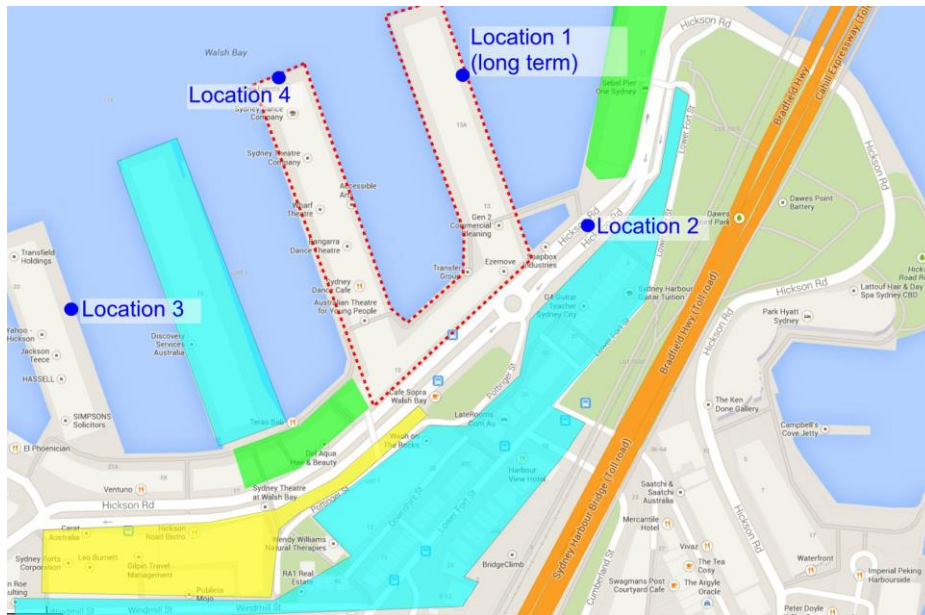


Figure 5 - Noise measurement locations. Background image courtesy of Google Maps 2014

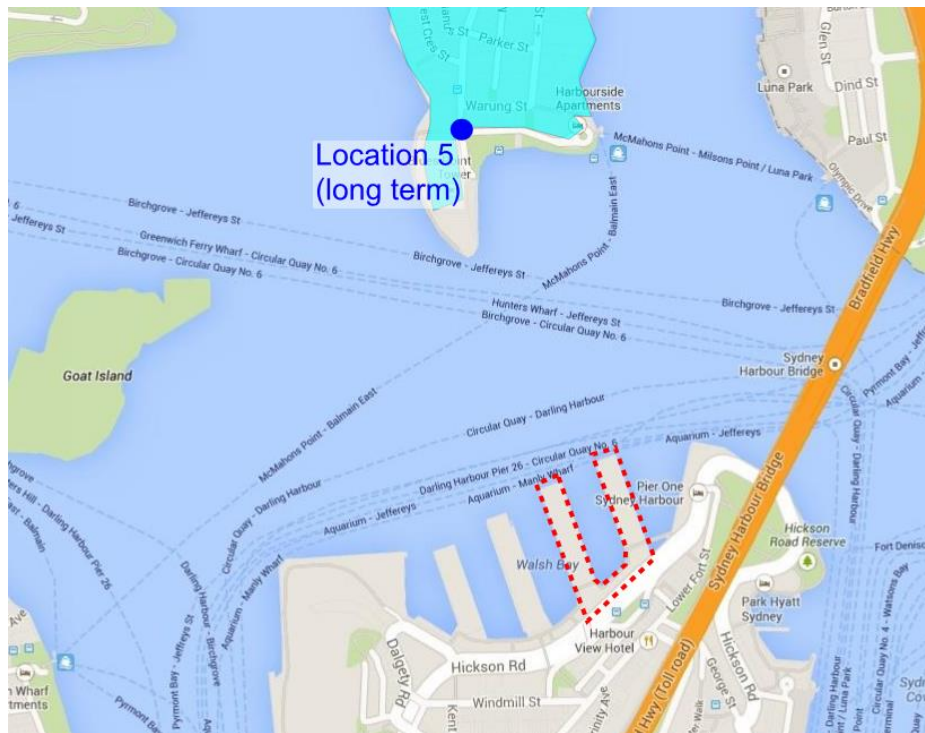


Figure 6 - Noise measurement locations McMahon's Point. Background image courtesy of Google Maps 2014

The measurements made during this visit were conducted in accordance with Australia Standard AS1055 “Acoustics-Description and Measurement of Environmental Noise”.

The equipment used during the survey is as follows:

Table 2 - Equipment used

Equipment Description	Manufacturer & Type No.	Serial No.	Calibration Due Date
Sound Level Meter*	Norsonic – Nor140	1404791	21/10/2014

Equipment Description	Manufacturer & Type No.	Serial No.	Calibration Due Date
Microphone	Norsonic - 1227	14105	21/10/2014
Preamplifier	Norsonic – 1209	14105	21/10/2014
Sound Level Meter*	NTI XL2	05718	01/10/2014
Microphone	M2210	2408	01/10/2014
Calibrator	Pulsar Model 105	55041	21/10/2014

* Class 1 sound level meter as described by IEC 61672-01:2002

Meteorological conditions for the duration of the noise survey were conducive to the measurement of environmental noise, being predominantly dry and with little wind.

The sound level meter was fitted with a windshield during the survey and was calibrated prior to, and on completion of the survey with the associated acoustic calibrator listed above. No significant calibration drift occurred (i.e. less than 0.5 dBA).

All measurements were taken at a height of 1.5m in the free field. Spot measurements were taken for 15 minute durations to mirror the assessment parameters discussed in the later section of this report.

All spot measurements (locations 2, 3 and 4) were undertaken multiple times throughout the daytime period on a 15-minute duration measurement in order to obtain an accurate measurement of the prevailing noise environment at the relevant locations. These measurements were time-synchronised to the long-term measurement at position 1; such that the prevailing noise levels all locations around the precinct could be accurately interpolated.

3.3.2 Noise survey results

The logging measurements over a seven day period are graphed below. All measurement levels are summarised in Table 3 below and broken into the relevant periods for the INP2000 assessment:

- Day time 0700hrs – 1800hrs
- Evening 1800hrs – 2200hrs
- Night time 2200hrs – 0700hrs

Table 3 – Long-Term Measurement results

	Measurement duration	Background noise dB $L_{A90,15,min}$			Ambient noise, dB $L_{Aeq,15min}$		
		Day	Eve	Night	Day	Eve	Night
Location 1	Long Term	59	54	52	63	58	57
Location 5	Long Term	49	50	42	57	56	51

Table 4 – Spot-Measurement results

	Measurement time period, T	Background noise dB $L_{A90,T}$	Ambient noise, dB $L_{Aeq,T}$
		Day	Day
Location 2	15 minutes	60	67

	Measurement time period, T	Background noise dB	Ambient noise, dB
		$L_{A90,T}$	$L_{Aeq,T}$
		Day	Day
Location 3	15 minutes	52	55
Location 4	15 minutes	54	58

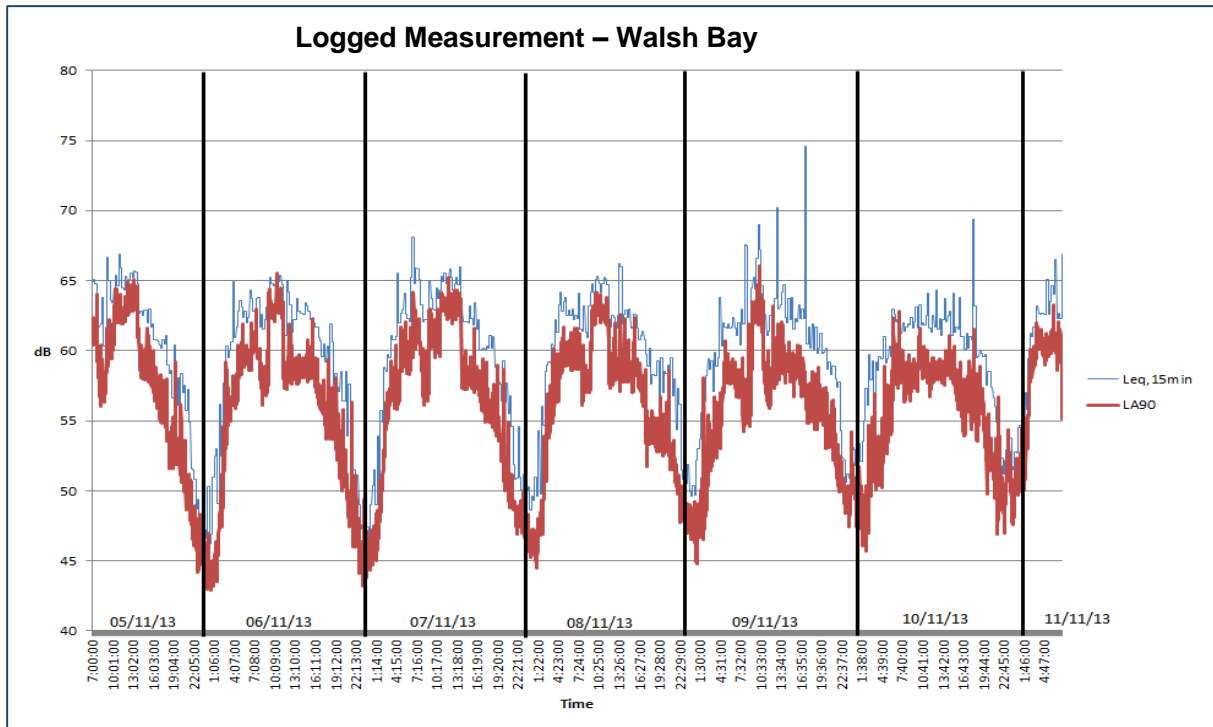


Figure 7 - Noise logging results (Location 1)

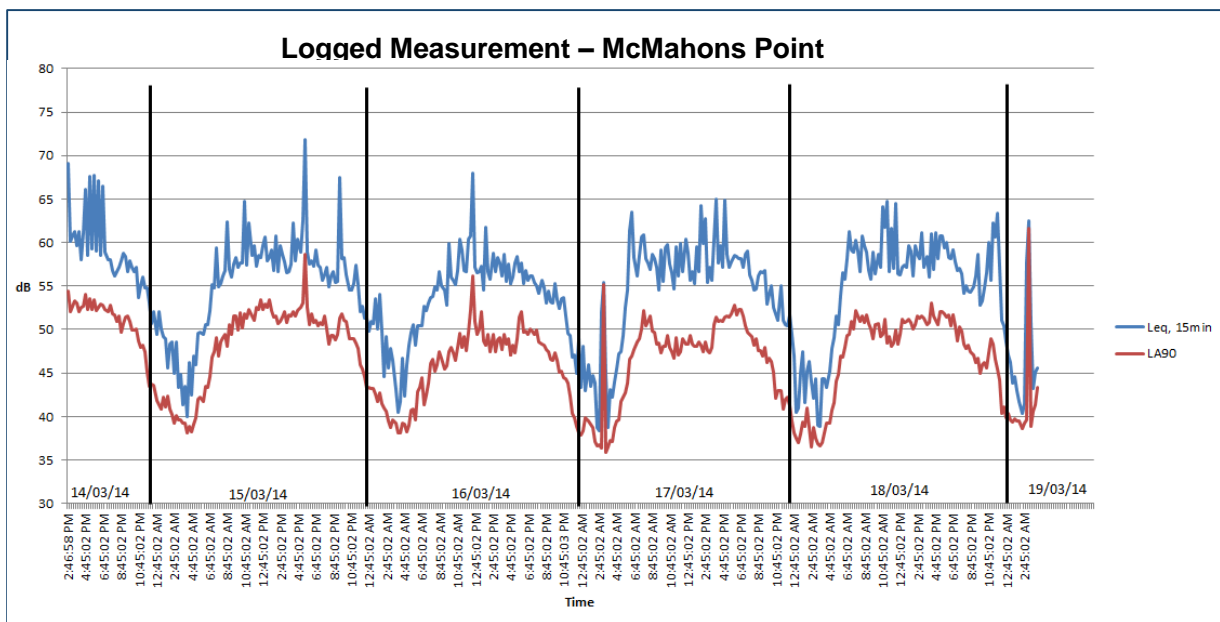


Figure 8 - Noise Logging Results (Location 5)

3.3.3 Establishing Existing Noise Levels at Noise Sensitive Receivers

Access was not available to undertake long-term noise measurements at the exact location of a number of the noise-sensitive locations identified. As such, the noise levels at these locations have been calculated based on the time-synchronised spot measurements and long-term logged noise data. This calculation was undertaken using an acoustic computer modelling program (see Section 6.1.1), which was calibrated to the measurement results obtained. As such, the noise levels presented at all noise sensitive receptors can be considered an accurate representation of the prevailing noise levels at these locations.

A predictive assessment has also been undertaken to determine the existing noise generated by Pier 2/3 activities, based on measured source noise levels for these activities. This has been completed through the use of a computer model using dedicated software (Cadna/A). This modelling process is fully detailed within Section 6.1.1.

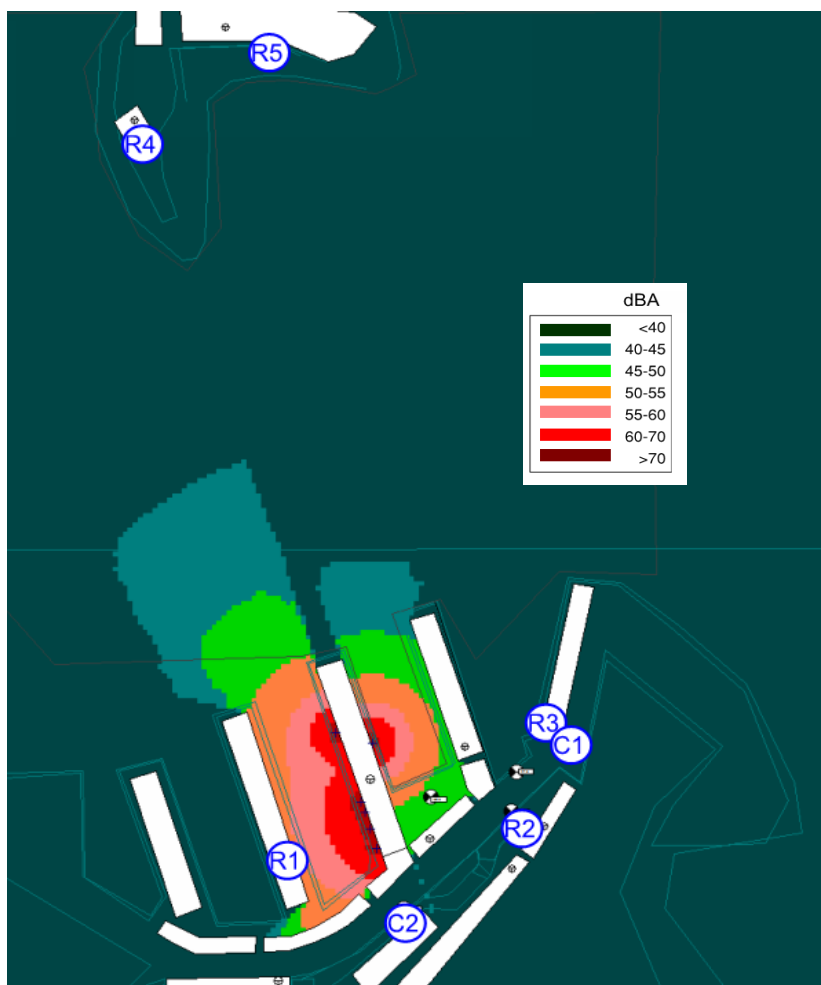


Figure 9 - Existing activity noise levels generated in Pier 2/3 on surrounding receptors

3.3.4 Existing Prevailing Noise Levels - Results

Table 5 below outlines the existing noise levels measured and predicted at each of the identified noise sensitive receivers.

Background noise and ambient noise levels are taken from the measurements of the existing environment.

Activity noise levels have been taken directly from the noise model described in Section 3.3.2 and represent only noise from activities within the existing cultural institutions.

Table 5 - Receiver noise levels based on measurements

Receiver	Background noise, dB LA90,15min			Ambient noise, dB LAeq,15min			Existing activity noise level*, dB LAeq
	Day	Eve	Night	Day	Eve	Night	
R1	52	47	45	55	50	49	56
R2	60	55	53	67	62	61	30
R3	60	55	53	67	62	61	29
R4	49	50	42	57	56	51	35
R5	49	50	42	57	56	51	28
C1	60	55	53	67	62	61	29
C2	60	55	53	67	62	61	33

* For time periods when Pier 2/3 is in use

A2 Noise Data from recent surveys

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Job number

248995

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File reference

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Date

11 January 2017

Subject Additional Noise Monitoring

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1 Introduction

This document presents the methodology and results of the additional noise monitoring carried out in the vicinity of Walsh Bay Wharf 2/3 as part of the Walsh Bay Arts Precinct Project to characterize the noise environment on site.

2 Noise Survey

An unattended noise monitoring device was installed onsite from 16 to 23 December, 2016 at the location shown in Figure 1.

Noise measurements were extracted in 15-minute intervals, with a ‘fast’ time weighting for broadband L_{Aeq} , L_{A10} and L_{A90} statistical parameters. This equipment measured continuous noise data for 7 days.

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2.1 Measurement Location

Figure 1 shows the location where the noise monitor was installed. The location was chosen as representative of the current conditions at the project site, and of the nearest potentially affected receivers. This location was secure and did not obstruct normal traffic (pedestrian and occasional vehicle movements) around the wharf. Being located above local ground level, the noise levels measured may be slightly lower than would otherwise be the case for a meter located at ground level.

The main sources of noise identified were rail and roads noise from the Harbour Bridge and marine activity in the harbour. No mechanical services plant noise was significantly affecting the noise environment at the measurement location.



Figure 1: Noise monitoring location

2.2 Equipment

Equipment used to measure the baseline noise levels is detailed in Table 1. All equipment was checked for calibration before and after measurements with no significant drift in calibration being observed. All equipment held a current NATA calibration certificate at the time of the survey.

Table 1: Noise Survey Equipment

Equipment manufacturer and type	Description of Equipment	Serial No.
Ngara™ Real Time Sound Acquisition System	Sound logging meter	8780E5
Brüel and Kjær 4231	Sound level meter calibrator	2445716

Figure 2 shows views of the noise monitoring equipment at the survey location.

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Figure 2: Noise logger at location, on staircase looking north (left) and at ground level looking south-east (right)

2.3 Results

A summary of measured unattended noise levels is provided in Table 2. Results are presented for the day, evening and night-time periods as defined in the NSW Industrial Noise Policy.

Table 2: Summary of measured noise levels for the measurement period

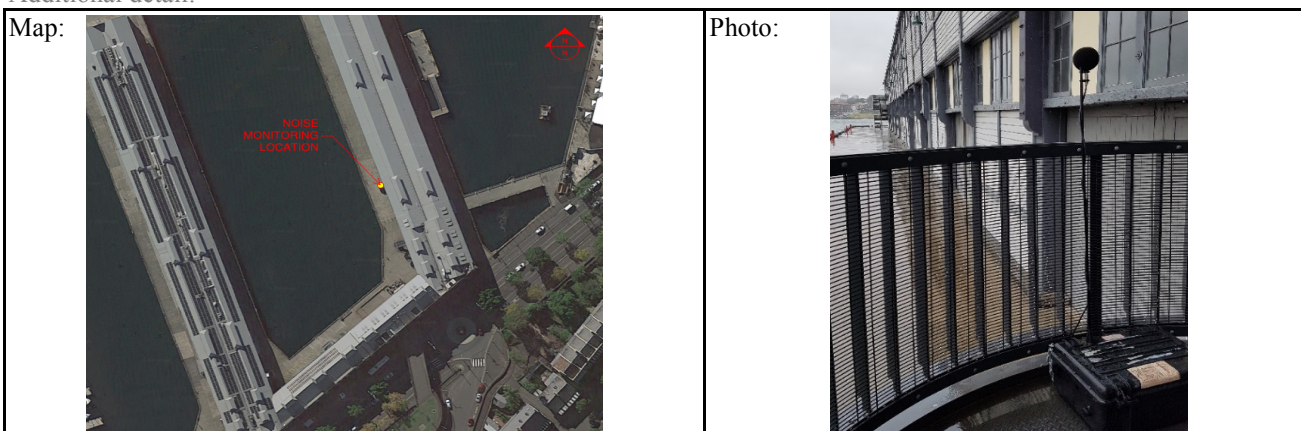
Location	Time Period	Rating Background Level (RBL) – dB(A)	L _{Aeq} (period), dB
Walsh Bay Wharf 2/3	Day (7:00 – 18:00)	50	56
	Evening (18:00 – 22:00)	49	55
	Night (22:00 – 7:00)	39	50

Detailed results are presented as attachments to this note. The shaded areas on the graphs indicate times when the data may have been influenced by weather (wind or rain).

It should be noted that normally noise measurements are conducted during normal school term time (because of the increased road traffic noise from the school trips). These measurements were taken during school holidays and as such are ‘worst case’ (ie quieter).

Walsh Bay Wharf 2/3 (Free Field)

Additional detail:



Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

Date	L _{A90} Background noise levels ⁴			L _{Aeq} Ambient noise levels		
	Day ¹	Evening ²	Night ³	Day ¹	Evening ²	Night ³
Friday-16-December-2016		54	42		59	52
Saturday-17-December-2016	48	50		57	54	
Sunday-18-December-2016	48	48	39	56	54	50
Monday-19-December-2016	50	48	39	57	54	50
Tuesday-20-December-2016	50	50	42	57	54	49
Wednesday-21-December-2016	50	49	39	55	56	49
Thursday-22-December-2016	50	49	39	56	55	49
Friday-23-December-2016						
Representative Weekday⁵	50	49	39	56	56	50
Representative Weekend⁵	48	49	39	57	54	50
Representative Week⁵	50	49	39	56	55	50

Notes:

- Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
- Evening is 6:00pm to 10:00pm
- Night is the remaining periods
- Assessment Background Level (ABL) for individual days
- Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

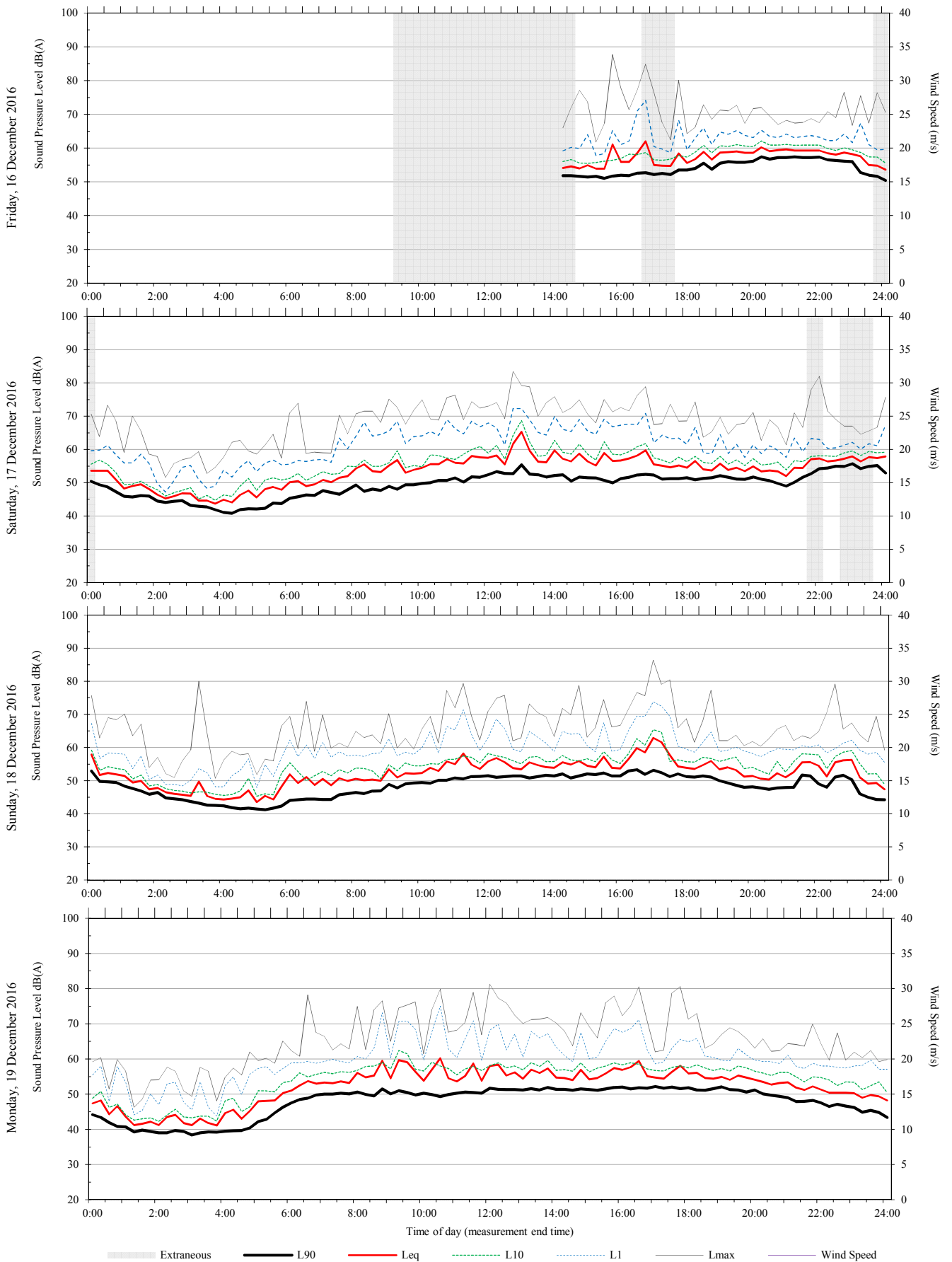
Road / Rail noise monitoring results

Date	L _{Aeq} Noise levels		L _{Aeq 1hr} Noise levels (upper 10th percentile)	
	Day ¹	Night ²	Day	Night
Friday-16-December-2016	58	52	60	58
Saturday-17-December-2016	57	51	58	58
Sunday-18-December-2016	55	50	58	55
Monday-19-December-2016	56	50	57	57
Tuesday-20-December-2016	56	49	58	51
Wednesday-21-December-2016	56	49	58	53
Thursday-22-December-2016	56	49	57	52
Friday-23-December-2016	58		61	
Representative Weekday³	57	50	59	55
Representative Weekend³	56	50	58	57
Representative Week³	57	50	59	56

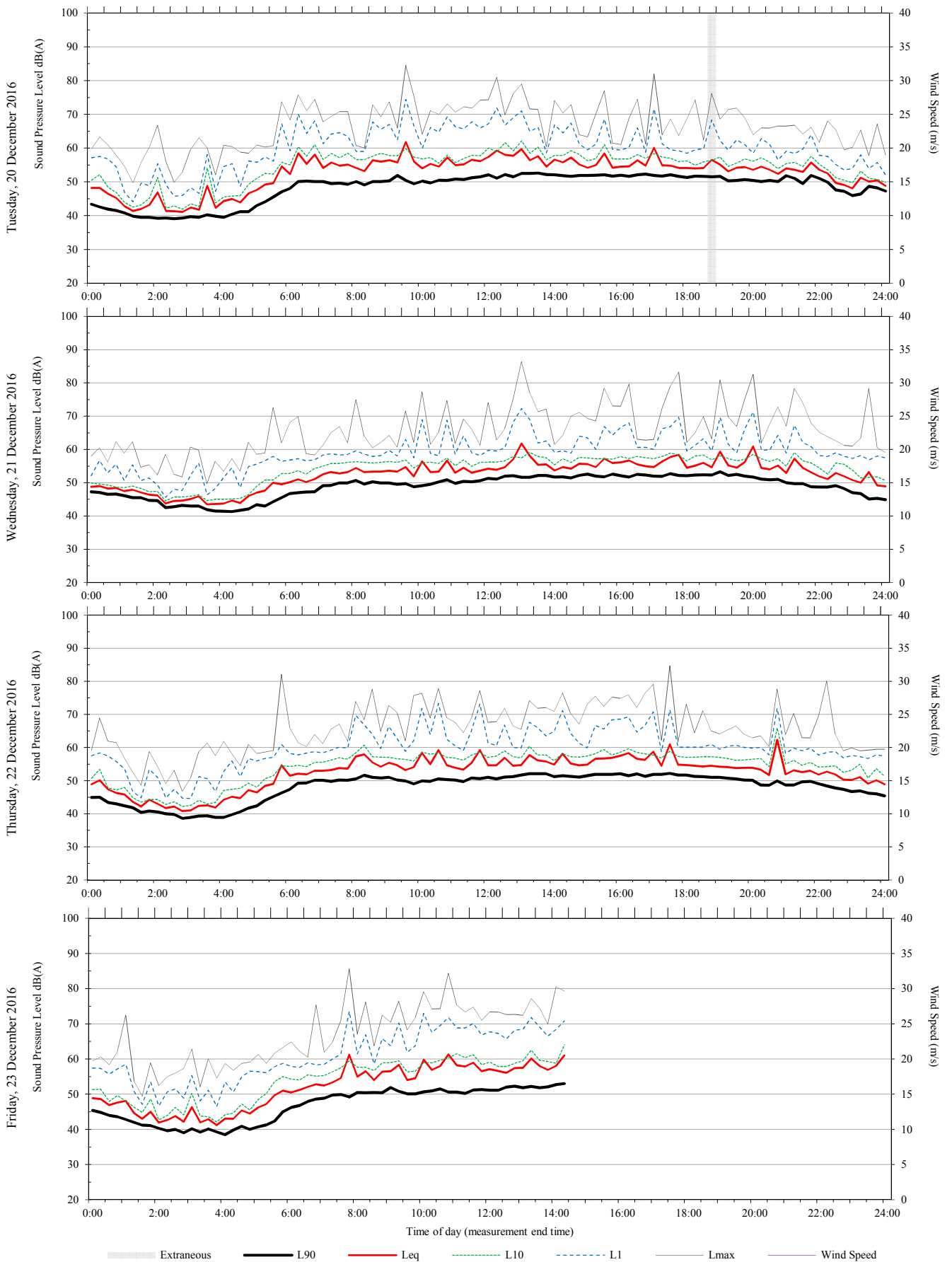
Notes:

- Day is 7:00am to 10:00pm
- Night is 10:00pm to 7:00am
- Logarithmic average of daily L_{Aeq}

Unattended monitoring: Walsh Bay Wharf 2/3 (Free Field)



Unattended monitoring: Walsh Bay Wharf 2/3 (Free Field)



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DOCUMENT CHECKING (not mandatory for File Note)

	Prepared by	Checked by	Approved by
Name	Daniel Jimenez	Nick Boulter	Nick Boulter
Signature			

Appendix B

Construction Noise and Vibration Management Plan

B1 Construction Noise Criteria

The possible impact of the noise and vibration that will be generated by the project construction is recognised. As noted below, noise and vibration will be critical for the existing uses and in some cases, noise control treatments necessary to achieve appropriate noise levels at the existing facilities will help to reduce noise affecting the nearest residential and commercial properties.

The control of noise affecting the nearby commercial tenancies and the wider community will be given a high priority and form a critical part of the eventual Contractor's scope of work.

The requirements given in the "Interim Construction Noise Guideline⁸" (ICNG) will apply. For residential receivers this defines noise management levels and work periods based on the Rating Background Level (RBL) as defined in the NSW Industrial Noise Policy, in the case of commercial receivers an absolute 'noise affected' noise management level is provided within the ICNG. Refer to Appendix A of this report for the site noise measurement details.

The work would be undertaken during normal working hours as set out in the ICNG, although there may be very occasional activities (eg delivery of large items) that will have to take place outside these.

Table 12: Management Levels at receivers during normal working hours

Location	RBL Time Period	RBL	Noise Management Level, $L_{Aeq\ 15\text{minute}}$	
			Noise affected	Highly noise affected
Receiver R1: Residential Apartments	Day (7:00 – 18:00)	52	62	75
Receiver R2: Terraced houses	Day (7:00 – 18:00)	60	70	75
Receiver R3: The Seibel Hotel	Day (7:00 – 18:00)	60	70	75
Receiver R4: McMahons Point	Day (7:00 – 18:00)	49	59	75
Receiver R5: McMahons Point	Day (7:00 – 18:00)	49	59	75
Receiver C1: Café Restaurants	Day (7:00 – 18:00)	60	70	-
Receiver C2: Shops and Cafes	Day (7:00 – 18:00)	60	70	-
Receiver C3: Shops, Cafes, Offices	Day (7:00 – 18:00)	50	70	-

⁸ Interim Construction Noise Guideline, Department of Environment & Climate Change, NSW, July 2009

B2 Construction Noise

B2.1 Overview

The actual construction noise levels will depend on the equipment and processes finally selected for the works. This will be assessed again in detail at a later stage as the construction methodology and specific plant are identified by the Contractor that will undertake the actual work. This will be a requirement placed on the eventual contractor. At this stage, an assessment has been made on the basis of estimated plant selections, as detailed below.

Much of the work will be done within the WBAP buildings and will therefore be attenuated by the existing building envelope. Indeed a primary aim of some of the refurbishments is to improve the sound insulation of the building envelope to reduce noise intrusion (and hence noise breakout). The heritage nature of the development means that many of the existing elements are being retained and the works will primarily involve the construction of new internal partitions and modifications to the roof.

Part of the project also involves the creation of a new Waterfront Square between Piers 2/3 and Wharf 4/5.

More details of the construction process is given in the Environmental Construction Site Management Plan (ECSMP).

B2.2 Waterfront Square

B2.2.1 Works

There will be some piling work required to create the new waterfront square between the two piers. In order to minimise noise levels, this will utilise screw piling rather than the more common percussive piling. The equipment used for this will be selected to be as quiet as is reasonably practicable.

There would also be some pouring of concrete to create the new waterfront square. This would involve concrete trucks delivering concrete in Hickson Road and then a concrete pump (also in Hickson Road) and pipeline being used to transfer the concrete onto the formwork for the new wharf areas. This process is estimated to take one to two days.

The intent is to construct the waterfront square at an early stage and then use it as a storage space. The deliveries for the waterfront square will be made by sea which will help to reduce the noise from vehicle movements within the precinct. The key activities and timings are shown below:

- Installation of between 55 and 85 no. screw piles (subject to final design) – estimated 30 days
- Precast structure - Headstock, Girder and Decking - 30 days
- Concrete topping slab on sections of deck – 1 to 2 days

There will be landscaping/floor finishes etc. but this will not be carried out until the end of the project and will be relatively quiet using mostly hand tools.

In addition to the piling rig, the following plant will be required to complete the construction:

- Construction Barge with crane and excavator
- Dumb Barge
- Tugboat for barge movements
- 2 work boats

The impact of the above on traffic in the harbour is expected to be minimal with only two movements per day by the barge.

B2.2.2 Noise Data

Table 13 below shows the estimated noise levels for the types of plant to be used for the project. Noise levels for the types of equipment have been taken from BS 5228-1:2009⁹ and AS 2436-2010¹⁰.

The data for screw piles is based on hydraulic jacking piles from BS 5228 which shows sound pressure levels of typically 63 to 68 dBL_{Aeq} at 10 m. This is consistent with the noise levels quoted by the supplier of the piling equipment of 50 dBL_{Aeq} at 50 m.

The type of rig envisaged is shown in Figure 13.



Figure 13: Piling rig used for inserting screwed piles

⁹ British Standard BS5228-1: 2009 + A1 :2014 *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise*

¹⁰ Australian Standard AS2436 (2010) *Guide to noise and vibration control on construction, demolition and maintenance sites*

For reference, information has also been provided in Table 13 for the noise generated by the impulsive piling which is more commonly used (but will *not* be used at Walsh Bay). As can be seen, screw piling is more than 20 dB quieter than the more traditional impulsive piling.

A concrete pump would be typically 75 to 78 dBL_{Aeq} at 10m and, as noted above, would be located in Hickson Road.

The crane and excavator would only be used intermittently.

Table 13: Plant Noise Data for Construction Equipment

Item	Sound Pressure Level at 10 m (dBL _{Aeq, 15min})
Screw piling (based on data hydraulic jacking of sheet piles)	63 to 68 dBL _{Aeq}
[impulsive piles – for reference only]	[87 to 99 dBL _{Aeq}]
Concrete pump	75 to 80 dBL _{Aeq}
Concrete vibratory pokers	69 to 78 dBL _{Aeq}
Small crane	75 to 80 dBL _{Aeq}
Small loader/excavator	75 to 80 dBL _{Aeq}
Barge with crane (when crane is being used)	70 to 80 dBL _{Aeq}

B2.2.3 Noise levels at Commercial Receivers

The nearest receivers adjoin the waterfront square (see location C3 on Figure 3). These receivers, which include restaurants / café with outdoor dining and offices, are close to the works. Piling would be as close as 8 m to the outdoor area as shown in Figure 14 below. At this worst case location, noise levels from the piling activities could be up to 70 dB(A). However, as can also be seen in Figure 14, activities would generally take place at much further distances.

be just ‘noise affected’. However, the concreting work is not extensive and is programmed to be completed within one day.

Concrete vibratory pokers have a typical noise level of 69 to 78 dBL_{Aeq} at 10m. As noted above, noise from this activity would be audible within the wharf area. The screening by the shore sheds will significantly reduce noise from this at the nearest residential property.

B2.3 Other External Construction Works

There will be some construction work externally for the erection of new lifts and new stairs. Neither of these activities are expected to involve the generation of high noise levels.

B2.4 Internal works

There will be little, if any, breaking out of concrete, although some new concrete will be poured over the existing timber floors within the buildings. This is needed to improve sound insulation.

B2.5 Deliveries and removal of materials

There will be a number of vehicles needed to deliver and remove equipment / debris from the site. It is estimated that there would be up to 40 vehicles per day during the demolition stage of the project and up to 80 vehicles per day during the construction process (ie 7 vehicles per hour).

This number of vehicles is unlikely to have any significant noise impact on Hickson Road.

B2.6 Construction vibration

No significant issues are expected with construction vibration affecting residential or commercial properties or the users of the existing venues at site. As noted above, no percussive piling is envisaged.

B2.7 Works for Sydney Theatre Company

There is potentially some work for Sydney Theatre Company (STC) taking place at the same time as the works for the rest of WBAP. This work is effectively ‘fit out’ and is primarily taking place internally within the existing STC facilities. The potential STC works would take place from January 2018 to July 2019.

There will be some additional deliveries associated with their works but these are not expected to result in a significant increase in traffic noise within Hickson Road.

A major part of the STC work is the installation of noise sound insulating provisions for the envelope of the building. This will help reduce any noise

breakout from the internal construction works such that there would be a minimal additional external noise from the STC works.

The STC50 works would include:

- A mobile barge crane will be used at a location where necessary to remove and install plant and other materials associated with the development. The worst case location within line of sight of residential receivers (location R1) has been assumed.
- Trucks will be used to remove demolition and construction waste from the site, using the ramp on at the Pottinger Street level for access. Truck movements will be restricted to daytime periods only.
- Some vehicle movements will take place on the side of the Wharf building furthest from other neighbouring wharf residences.
- Much of the construction work will be done internally and will therefore be screened by the existing building envelope. The heritage nature of the development means that many of the existing elements are being retained and the works will primarily involve the construction of new internal partitions and modifications to the roof.
- No piling works are anticipated in this contract.
- Site offices will be accommodated within the existing building structure.
- There will be some concrete removal work required, involving 3 tonne excavators and pulverisers. The equipment used for this will be selected to be as quiet as is reasonably practicable.
- Some remedial works to the heritage façade will be carried out using hand tools.

Demolition and constructions works will be limited to daytime hours only.

The calculations show that operation of the barge-mounted crane may result in the noise criteria being exceeded at the residential apartments at R1 (Wharf 6/7). This would occur when the crane is located on the west side of wharf or is in direct line of sight to R1.

B3 Assessment of Noise Levels

B3.1 Effect on the existing commercial premises

The construction of the waterfront square will have the biggest potential noise impact on the commercial receivers around the precinct but levels are not expected to exceed the Noise Management Levels. The construction of the waterfront square will be a relatively quick process. One of the noisiest operations – the concreting of the upper surface of the waterfront square deck is only expected to take one day.

Based on the information available on the types of equipment likely to be used, it is expected that the piling noise levels will be below the noise management levels at the commercial receivers around the waterfront square.

Short term events such as the use of concrete pokers will increase noise levels during the concreting of the deck but this is only expected to take one day. There may be some tile cutting as part of the final finishing of the waterfront square. Any such work should be done behind a temporary screen to minimise noise levels.

Notwithstanding the above, it is recommended that rigorous procedures be included in the contractor's Construction Management Plan to carefully manage noise generation (see Section B4 below).

B3.2 Effect on the existing residential / hotel premises

The perimeter of the Walsh Bay precinct will act as an effective noise barrier to contain most of the construction noise. The noise from the majority of the works will be internal and expected to have negligible noise impact. Construction of the waterfront square may occasionally be audible but is not expected to exceed the appropriate Noise Management Levels.

The noise mitigation measures outlined in Section B4 of this report will also serve to reduce noise impact on the residences and hotel accommodation.

At location R1 where construction noise could slightly exceeds the Noise Management Level during standard hours due to operation of the barge crane (assuming a line of sight to R1), all "feasible and reasonable" mitigation levels will be implemented in accordance with the requirements of the Interim Construction Noise Guideline to reduce the noise levels.

B3.3 Effect on the existing internal spaces

Much of the construction work will be done internally and will involve the construction of primarily dry partitions. This will avoid the need to use heavy tools to create openings in walls for services etc.

There will be some concreting for flooring in some areas (primarily to improve the internal sound insulation) and the installation of linings on the inside of the building to provide additional sound insulation against external sources.

These works are not expected to create significant noise levels outside the building and thus there would be minimal impact on nearby buildings within the precinct and externally.

The current intent is for most of the users of the refurbished / re-provisioned spaces to move out during construction which will avoid issues with noise transfer between internal spaces associated with internal construction activities.

B4 Proposed Construction Noise and Vibration Management

The contractor will have a key role in managing the noise and vibration levels during the works so as to reduce noise and vibration as far as is reasonably practicable. This will include:

B4.1 Noise and Vibration Management Plan

The contractor will be required to prepare a noise management and vibration plan as soon as they are appointed. This will specify the actual plant to be used and will include updated estimates of the likely levels of noise and the scheduling of activities.

B4.2 Staffing

- Appointing a named member of the site staff who will act as the Responsible Person with respect to noise and vibration.
- Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise.
- Ensuring good work practices are adopted to avoid issues such as noise from dropped items, noise from communication radios is kept as low as is practicable.
- Avoid the use of radios or stereos outdoors.
- Avoid shouting, and minimise talking loudly and slamming vehicle doors.

B4.3 Plant and Equipment

- Low noise screw piling systems to be used.
- Moor the work barge so that the power plant is kept as far away from the noise sensitive receivers as possible.
- Ensure that the fixed power plant on the work barge is fitted with effective residential-grade silencers and is well maintained and that all doors/hatches are shut whenever the plant is in use
- Turn off all vehicles, plant and equipment when not in use.
- Tile cutting to be done behind an acoustic screen.
- Ensuring that the Responsible Person checks the conditions of the powered equipment used on site daily to ensure plant is properly maintained and that noise is kept as low as practicable

B4.4 Scheduling

- Ensuring that the Responsible Person controls the working hours on site to ensure that work is only done during the acceptable periods as defined in the

ICNG (7am to 6pm on weekdays and 8am to 1pm on Saturdays. No work on Sundays or public holidays).

B4.5 Noise Logging

- A noise logger will be installed and maintained which can be interrogated remotely by precinct management staff as well as the Contractor. The logger will also be required to automatically send a text message to the Responsible Person on site once the 'warning' threshold (5 dB below the noise management threshold set out in Table 12 above) has been breached.
- The Precinct Management representative will also be copied in with the warning texts.
- The data from the noise logger will be used to inform the Contractor on the noise levels being generated so that particularly noisy activities can be identified and practicable options investigated to reduce noise levels further.

B4.6 Community Liaison

- Ensure Responsible Person periodically (ie once per week) checks the commercial tenants around the site and nearby residences for noise problems so that solutions can be quickly applied.
- Ensuring that the Responsible Person keeps the precinct (and local community) advised on expected activities and coordinates scheduling and locations of noisy works around any critical user events where practicable. This shall include face to face meetings with tenants if requested and a letter box drop.
- Maintaining appropriate records of complaints to include timing, reported issues, actions taken and measures to be included for ongoing works. The complaints log will need to be filed with the Precinct Management.

B4.7 Respite

It is likely that noise levels during construction will be below the Management Levels in the ICNG for most of the construction period. As such, no respite periods are expected to be strictly necessary. In any event, the introduction of respite periods would not reduce the overall long term 'noise dose' given that it would just extend the programme.

The potential for construction work to impact on the existing uses of the WBAP and surrounds is recognised. The Contractor will be required to liaise with the Precinct Management so that noise from construction does not impact on any critical events taking place within the existing accommodation.

Appendix C

Event Noise Management Plan

C1 Introduction

This section outlines the proposed protocols for managing large events at the Walsh Bay Arts Precinct and has been prepared in response to the Stage 1 SSDA conditions and to address particular issues raised during the exhibition of the Stage 2 SSDA.

The intention of this report is to define specific generic policies relating to occasional and more frequent events within the WBAP. Specific events will require a detailed noise management plan that relates to the issues associated with that particular event.

The potential noise issues associated with day to day operation of the precinct is considered separately in the main body of this document.

A glossary of acoustic terms is included in Appendix A of this report.

C2 Events

The precise nature of the events to take place at the precinct are not known at this stage but are limited by the Stage 1 DA and amendments to the Stage 2 DA for events held within the public domain including the Waterfront Square and include the following:

The types of events are split into the following categories:

- Category 1 – Major Events
- Category 2 – Arts and Cultural Festivals
- Category 3 – Community
- Category 4 - Private Events

Category 1 - Major Events

- up to 7,500¹¹ people moving through the site at any one time
- max 4 times per year
- must not occur over more than one day
- must not occur before 7 am or after midnight on any day, except New Year's Eve (when the use may occur until 2 am the following day.)
- music to be ceased by 11 pm in all cases (with the exception of New Year's Eve)
- set-up/dismantle time for the use must not start earlier than 6 am, or end later than 1 am, on any day, except New Year's Eve when dismantle may occur until 2 am the following day

¹¹ The largest number of people in the waterfront square would be 1500 at any one time.

- clean up time for the use must end no later than 2 hours after the use was to stop occurring or may be undertaken the following day

Category 2 - Arts and Cultural Festivals

- up to 5,000 people moving through the site at any one time
- can occur over consecutive days up to 90 days
- max 6 times per year
- use must not occur before 7 am or after midnight on any day, including set up/dismantle and clean up time
- music to be ceased by 11 pm in all cases

Category 3 - Community Events

- up to 5,000 people
- Up to 150 community events held in a year
- can occur over consecutive days up to 35 days
- use must not occur before 7 am or after midnight on any day, including set up/dismantle time and clean up
- music to cease by 11 pm in all cases
- use of localised low output amplified sound system for announcements or for live intimate entertainment only

Category 4 - Private Events

- up to 1,000 people
- Up to 50 private events held in a year
- use must not occur before 7 am or after midnight, including set up/dismantle and clean up time, and up to 3 consecutive days in duration
- music to cease by 11 pm in all cases
- private event should not restrict or impede public access to public outdoor areas
- use of localised low output amplified sound system for live intimate entertainment only

C2.1 Nature of Events

The principles for a curatorial framework for events have been developed that provides less emphasis on “traditional” programmed events such as concerts and large festivals. Instead, the focus will be on low impact, intimate entertainment and passive and immersive activation to guide the development of events held within the Waterfront Square.

Events, and in particular category 2 and 3 events, have been chosen that intentionally provide niche and focused activations and involve smaller interactions held over longer periods to reduce the impact on neighbouring business and residents.

For example Art and About (Category 3), the Biennale (Category 2), and Artist in Residence (Category 3) events will have minor impacts on the precinct. They have long run consecutive durations but provide low impact daily visitation that support the activation goals of the precinct.

It is reasonable to expect that all events may require the use of low output amplified sound for announcements, entertainment and/or feature intimate music.

Given the nature of the events and the intended audience, it is expected that most would take place primarily outside normal 'office hours', although some setup would take place during the normal working day.

C3 Existing Environment

The existing acoustic environment has been established by noise surveys using attended measurements and long term noise logging. This has included measurements by WSP in 2013 and 2014 as part of the initial concept study.

The survey details are presented in the Appendixes to this report (Appendix A Appendix A).

Also included in Appendix A are details of some additional noise measurements conducted by Arup in December 2016 which assess noise levels local to the Shore Sheds between Pier 2/3 and Wharf 4/5.

C4 Noise Sensitive Receivers

C4.1 Site Location

The site location is illustrated below in Figure 15. The outdoor events are intended to take place on a new platform located between the piers (clouded in yellow below) and along the aprons of the piers.

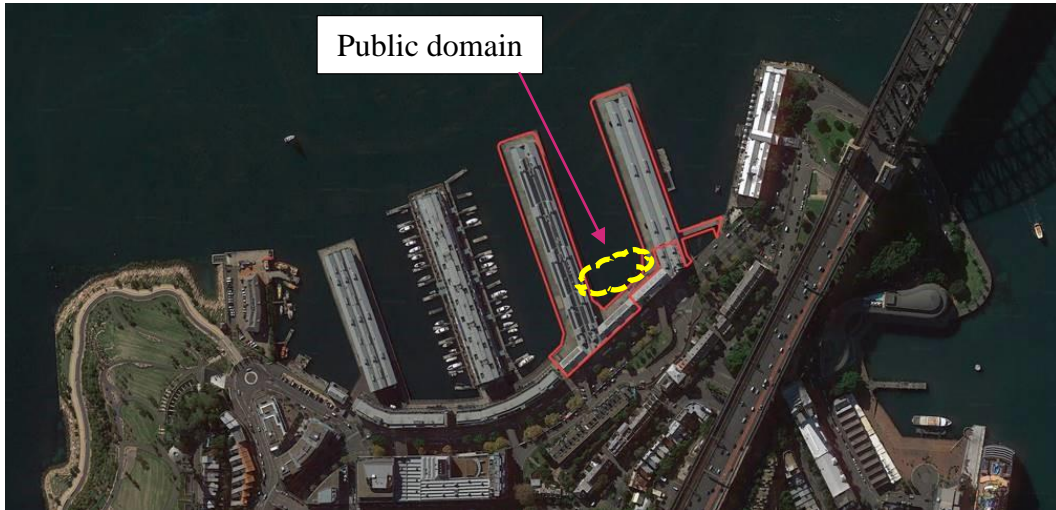


Figure 15: Site Location and Proposed Waterfront Square Event Plaza (public domain)

A close up of the layout is shown below in Figure 16.



Figure 16: Plan view showing new public domain Waterfront Square located between the Piers 2/3 and 4/5

C4.2 Key Noise Receptors

The key receptors are shown below in Figure 3. Of particular note are the residential receivers located in Piers 6/7, along the landside close to Pier 6/7 and in Pier 1. There are also residential developments alongside Hickson Road.

There will be a degree of acoustic screening between the event plaza and the nearest residential units by the Pier 2/3 and 4/5 structures, and the Shore Shed buildings alongside Hickson Road. Figure 17 shows the view from the *end* of Pier 3 looking south where the tops of the residences are just visible. The event plaza would be further inshore and therefore screened from these units.

Other receivers include existing commercial tenancies including offices and restaurants in the shore sheds and new commercial and retail tenancies in Pier 2/3 and Wharf 4/5.



Figure 17: View from the end of Pier 3 facing towards the overlooking residences in the distance with the city beyond. Note that the proposed event location will be at the landward end of Pier 2/3 and will be screened from these residences by the Pier 2/3 structure.

C5 Proposed Noise Criteria

There are established criteria in Sydney¹² and approaches used in NSW¹³ and interstate to guide noise emissions from large places of public entertainment. It is common practice in Sydney to use an *absolute* noise limit for the assessment of noise from occasional outdoor events. The more frequent events (i.e. Community and Private Events) have a more-onerous criterion that has been derived in relation to the existing background noise level.

Whilst the dB(A) metric is commonly used to assess most types of noise, an additional requirement using the dB(C) metric is sometimes used in Sydney to take account of the low frequency content in some styles of music (e.g. rock/pop).

The current proposals are for no overall site licensing for the public domain, rather that each tenant or event organiser is responsible for their own license.

Liquor & Gaming NSW has a set of default noise clauses for licensed premises which they often apply to license approvals in the absence of other site specific noise criteria. For consistency in noise policy, it is recommended that the noise criteria proposed in this report (i.e. the final SSD consent conditions relating to noise) are used for all future liquor license approvals for precinct events, instead of the default Liquor & Gaming NSW noise clauses. There is a precedent for this approach being adopted by Liquor & Gaming NSW at other large precinct developments such as Barangaroo that have site-wide noise management policies.

C5.1 Category 1 - Major Events

The following residential noise limits are proposed for Category 1 - Major Events. They cover noise from setup and take down as well as noise generated by the event itself.

Included in the table are suggested noise limits for 0000h to 0200h. This would only apply for New Years Eve.

Table 14: Noise Criteria for Major Events (free-field noise criteria to be met at any residential boundary)

Activity	Early Morning (0700h to 1000h)	Daytime (1000 to 2200h)	Late Evening (2200h to 2400h ¹⁴)	Night – New Years Eve only (0000 to 0200h)
Setup / takedown	L _{Aeq,15m} <55	L _{Aeq,15m} <65	L _{Aeq,15m} <55	L _{Aeq,15m} <50
Sound Check	None allowed	L _{Aeq,15m} <65 L _{Ceq,15m} <80	L _{Aeq,15m} <55 L _{Ceq,15m} <70	None allowed
Event	None allowed	L _{Aeq,15m} <65 L _{Ceq,15m} <80	L _{Aeq,15m} <55 L _{Ceq,15m} <70	L _{Aeq,15m} <50 L _{Ceq,15m} <65

¹² City of Sydney Event Guidelines. V2.3 April 2015

¹³ Noise Guide for Local Government, 2013, NSW EPA

¹⁴ Events to finish at 2300h except on New Year's Eve

C5.2 Category 2 - Arts and Cultural Festivals

As these events are more frequent than the Major Events, and last for longer, a lower residential noise criterion will need to be adopted. These are given below in Table 5.

Table 15: Noise Criteria for Arts and Cultural Festivals (free-field noise criteria to be met at any residential boundary)

Activity	Early Morning (0700h to 1000h)	Daytime (1000h to 2200h)	Late Evening (2200h to 2300h)
Setup / takedown	$L_{Aeq,15m} < 50$	$L_{Aeq,15m} < 60$	$L_{Aeq,15m} < 50$
Sound Check	None allowed	$L_{Aeq,15m} < 60$ $L_{Ceq,15m} < 75$	$L_{Aeq,15m} < 50$ $L_{Ceq,15m} < 65$
Event	None allowed	$L_{Aeq,15m} < 60$ $L_{Ceq,15m} < 75$	$L_{Aeq,15m} < 50$ $L_{Ceq,15m} < 65$

The above criteria apply for any one single day during the duration of a multi-day event. For the rest of the days of the event, the Category 3 event noise criteria in Table 16 apply.

C5.3 Categories 3 and 4 - Community and Private Events

Noise from these type of events would have to comply with the normal expectations for environmental noise emissions. The noise criteria in the INP have been applied to this source to be consistent with the previous DA submissions for this project. No music would be allowed after 2300h.

These criteria are given in the following Table 16.

Table 16: Summary of Project Specific Noise Criteria (free-field noise criteria to be met at boundary of receiver)

Location	Time Period	Project Specific Noise Criteria (L _{Aeq} 15min)
Receiver R1: Residential Apartments	Day (7:00 – 18:00)	57
	Evening (18:00 – 22:00)	52
	Night (22:00 – 7:00)	44
Receiver R2: Terraced houses	Day (7:00 – 18:00)	57
	Evening (18:00 – 22:00)	52
	Night (22:00 – 7:00)	51
Receiver R3: The Seibel Hotel	Day (7:00 – 18:00)	57
	Evening (18:00 – 22:00)	52
	Night (22:00 – 7:00)	51
Receiver R4: McMahons Point	Day (7:00 – 18:00)	54
	Evening (18:00 – 22:00)	47
	Night (22:00 – 7:00)	42
Receiver R5: McMahons Point	Day (7:00 – 18:00)	54
	Evening (18:00 – 22:00)	47
	Night (22:00 – 7:00)	42
Receiver C1: Café Restaurants <i>(applicable only when in use)</i>	Day (7:00 – 18:00)	65
	Evening (18:00 – 22:00)	60
	Night (22:00 – 7:00)	58
Receiver C2: Shops and Cafes <i>(applicable only when in use)</i>	Day (7:00 – 18:00)	62
	Evening (18:00 – 22:00)	60
	Night (22:00 – 7:00)	58
Receiver C3: Shops and Cafes and offices <i>(applicable only when in use)</i>	Day (7:00 – 18:00)	55
	Evening (18:00 – 22:00)	54
	Night (22:00 – 7:00)	44

C6 Noise Estimates

C6.1 Scenarios

Noise levels have been estimated for the following scenarios.

- Outdoor cinema (two options for screen location)
- Large gatherings without music
- Occasional events with low level music, intimate performances / announcements

Note that the current proposals for use of the public domain do not include any uses with music in a concert format – although there may be some music within a film soundtrack.

C6.2 Calculations

Calculations have taken account of the sound energy from the activities described above. Losses associated with distance and screening from large elements such as buildings have been included in the calculations.

The level of noise from reinforced events is difficult to predict with accuracy given that there are a number of parameters which will affect the level of noise that will result at the nearest receiver. These include:

- Loudspeaker type – different loudspeaker types have different directional properties. More-directional loudspeakers will achieve the same overall noise levels with less spillage to the side.
- Number of loudspeakers – a greater number of distributed loudspeakers will mean that sufficient volume at the audience area can be achieved with a lower sound level from each loudspeaker. This can reduce the levels of noise spill from the site.
- Height and location of the loudspeakers – there is some potential screening of the nearest residential receivers by the WBAP buildings. This is dependent on the location of the loudspeakers relative to the building (both the height and the distance from the façade).
- Frequency content of the sound – the screening attenuation of surrounding buildings is related to the spectrum content of the sound, which results in variation of the noise levels at noise sensitive receivers (e.g. a rock concert would have significantly different spectral content to an orchestral performance). In addition, different types of sound will potentially be perceived differently by the residents/community.

Assumptions have been made regarding these parameters based on the likely type of loudspeakers and their location. The directivity corrections associated with noise propagation direction have been included in the calculation, based on a typical loudspeaker directivity pattern. The predicted noise levels presented in this

Plan can be considered indicative of a “typical” event, however noise levels from individual events may vary compared to these predictions.

C6.3 Outdoor Cinema

The primary type of outdoor event expected involves cinema with a screen located at the northern edge of the public domain but possibly other locations as well. The size of the screen will vary as will the type of screen. Smaller LED screens are likely to be required for daytime screenings whereas a larger conventional screen / projector combination could be used for evening showings.

It is also anticipated that there would be some ‘silent cinema’ events where the soundtrack is relayed through headphones. This has the potential for an improved listener experience (i.e. less disturbance from passing harbour traffic, surround sound) as well as lower overall noise emission. This format has not been modelled as it is not expected to generate any significant noise.

The assessment has been based on a notional noise level for the audience listeners of 88 dBL_{Aeq, 15 min}.

C6.4 Low Level Music and Announcements

Using multiple low-output loudspeakers allows good coverage of the ground plane of the outdoor area whilst minimising the noise impact to nearby commercial and residential receivers.

The noise from announcements and low level music has been modelled using a distributed loudspeaker system integrated into the smart poles. The output of the loudspeakers has been set in the model to give a sound level at ear height of 70 dBL_{Aeq}. As the arrangement of the smart poles has still to be finalised, the arrangement of loudspeakers is conceptual and noise levels will be reassessed as part of the detailed design.

C6.5 Patron Noise

Noise from crowds is notoriously difficult to predict because of the complex relationship between the noise source and the ambient level of noise – particularly the ‘Lombard Effect’ where people tend to speak louder to overcome the noise from people talking. This results in a feedback effect, leading to an overall increase in noise level.

A recent paper¹⁵ has proposed a methodology for predicting patron noise. Measurements by Arup have shown that this methodology provides reasonable agreement with actual examples, although there is very little validation for large crowds.

¹⁵ Prediction of Noise from Small to Medium Sized Crowds. M.J. Hayne, J.C. Taylor, R.H. Rumble and D.J. Mee. Proceedings of ACOUSTICS 2011

Predictions of patron noise have been made for outdoor crowd sizes associated with the different event types listed for the Waterfront Square (see section 5.3).

Crowd Size	Predicted Noise Levels at Noise Sensitive Receivers, dB(A) L_{eq}					
	Residential units at Piers (R1)	Residential units on Lower Fort St. (R2)	Commercial on Hickson Road (C2)	Commercial at Shore Sheds north façade (C3)	Hotel at 5051 Hickson Road (R3)	North Sydney (R4)
1,500	41	41	44	58*	40	46
1,000	39	39	41	58*	38	44

* Receivers at the C3 location within the public domain area are not considered to be exposed to the full sound power of the large crowd because of its close proximity to the boundary of the crowd. As such, predictions at C3 have been derived from the nearest group of 30 people with one third of them talking simultaneously in a 'raised voice' at an average distance of 10m.

Noise from patrons is not expected to be a significant issue at surrounding residential and commercial receivers. It is noted that a small exceedance for commercial receivers at the C3 location has been predicted if assessed against the Category 3 noise criteria. However, this is considered similar to existing noise conditions near the shore shed façade that is regularly exposed to existing outdoor dining areas and pedestrian groups walking past.

C7 Noise Model

Noise from the outdoor events has been modelled using the SoundPlan 7.4 environmental noise prediction software. The model has included the terrain and taken into account the screening afforded by the existing buildings and the acoustical reflection properties of water.

The modelling has been used to assess operational noise (from internal and external events) and noise from ventilation plant.

Screen shots of the acoustic model are shown below (Figure 20, Figure 21, Figure 22). The receiver locations can be seen as small yellow dots on the façade of the key buildings. Various receivers have been included at the same address to map the noise levels over different areas of the façade.

The model has included for the possible effect of noise leakage through the western passageway into the precinct from Hickson Road. Because of software limitations, this has been modelled as a full height opening as a conservative assumption. The other opening to the east of the waterfront square is less critical because the residential receivers are much better screened by the landscape.

For cinema use, two locations of the screen have been modelled. In one configuration the screen is located on the shore near the shore sheds (see Figure 18) and an alternative configuration with the screen located on a barge between the two piers (Figure 19). Notional loudspeaker stacks have been located either side of the screen to model cinema noise (see Figure 20 and Figure 21).



Figure 18: Sketch showing configuration in large screen mode



Figure 19: Sketch showing configuration with screen on barge

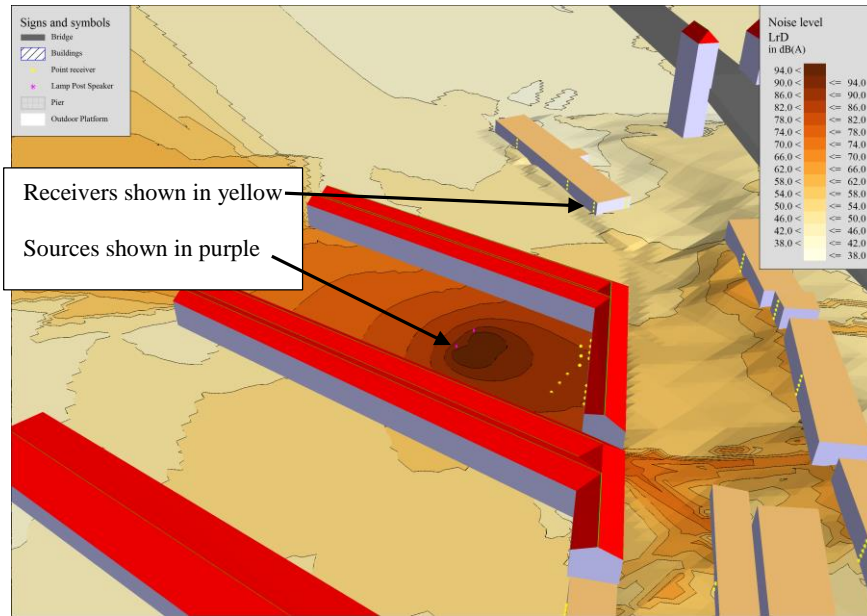


Figure 20: Screenshot of acoustic model showing nearby receivers and the noise sources for cinema with screen on a barge

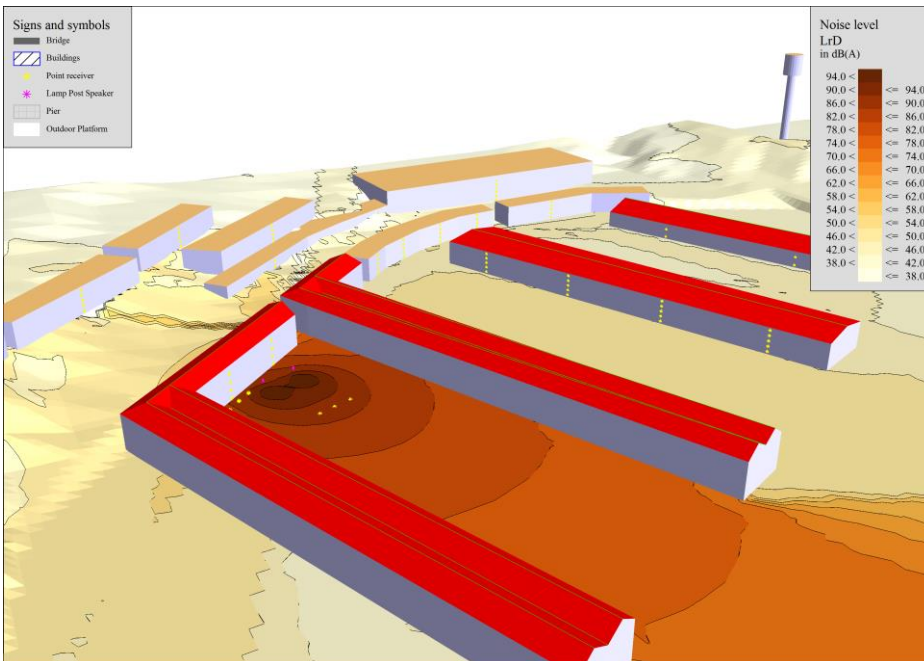


Figure 21: Screenshot of acoustic model showing nearby receivers and the noise sources for cinema with screen near the shore sheds

Figure 22 below shows a larger view of the model with the noise receivers to the north of the site.

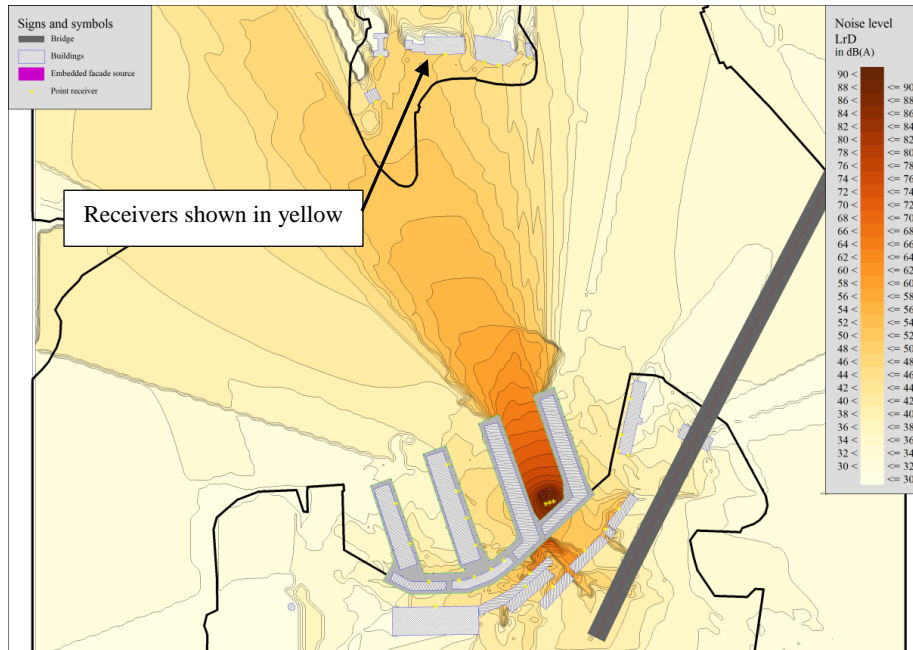


Figure 22: Screenshot of acoustic model showing distant receivers

As many of the tenancies within the complex are performance venues, retail units and commercial venues (some naturally ventilated), the potential for outdoor activities to disturb these units needs also to be taken into account, as well as noise impacts to the community outside the site.

Receivers have also been located in the public domain space so that the level and quality of sound for the cinema attendees in the audience area can also be assessed.

C7.1 Outdoor Cinema Noise Results

Noise levels have been modelled based on achieving a sound level of 88 $dB_{L_{Aeq, 15mins}}$ at the back of the audience zone for each of the different configurations. This level would be acceptable (from the audience point of view) for most type of cinema but would exclude particularly loud 'blockbuster' type films.

The results are shown in the following figures as noise contours.

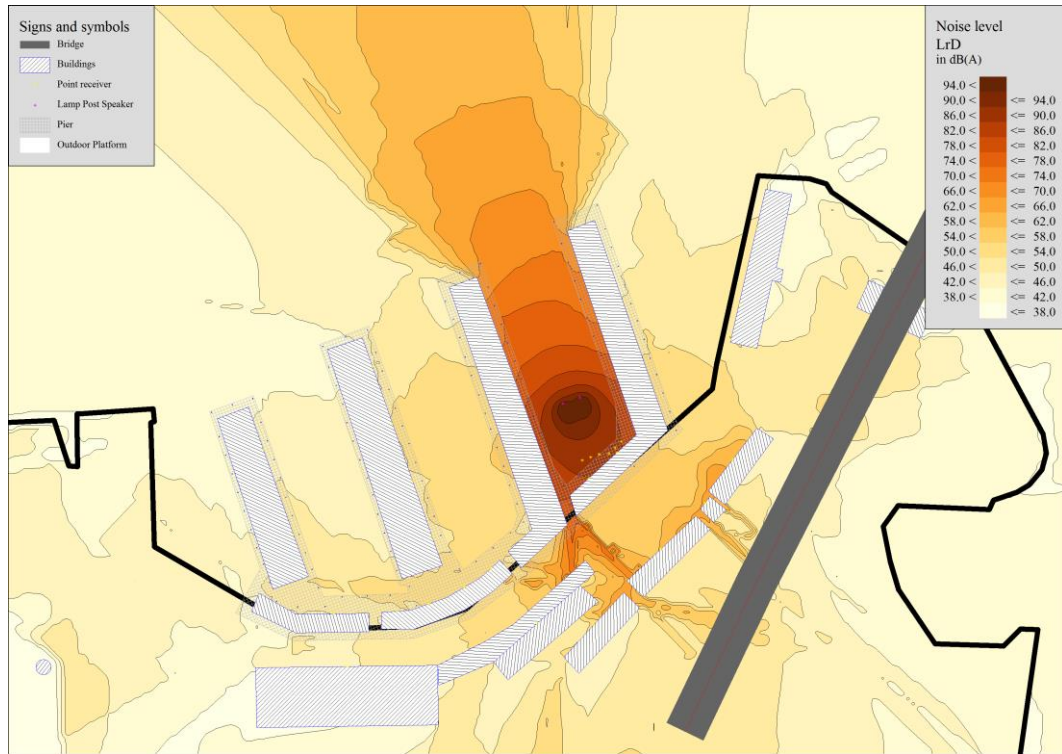


Figure 23: Noise modelling output noise levels with screen on barge

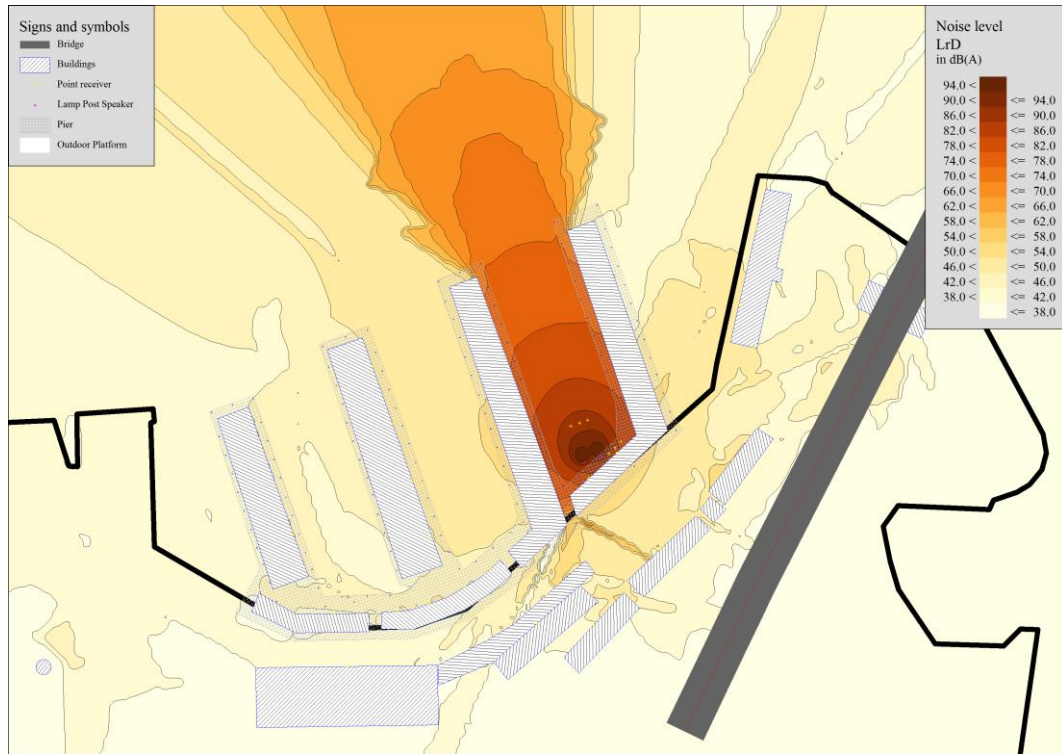


Figure 24: Noise modelling output noise levels with screen near the shore sheds
 The levels of noise affecting the receivers to the north is shown below in Figure 25.

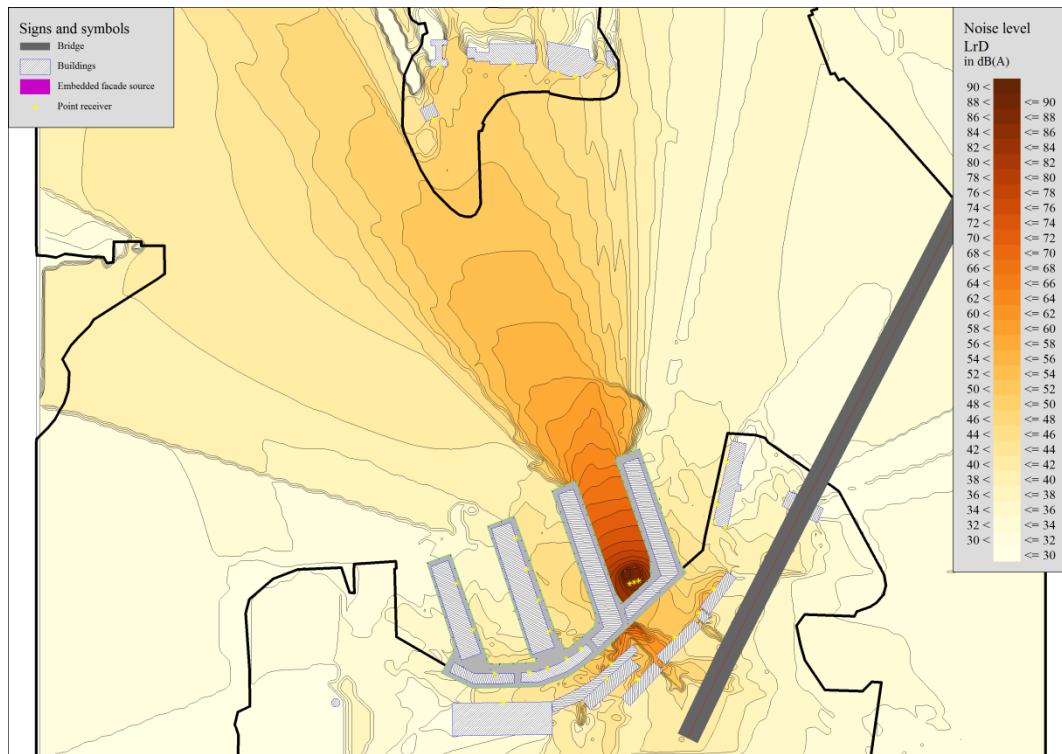


Figure 25: Noise modelling output showing receivers to north of site

The resulting noise levels are also given below in Table 17 which shows the calculated noise level at the key locations around and within the site, including the worst affected residential location.

Table 17: Calculated noise levels at receivers for cinema event

Noise Sensitive Receivers	Predicted Noise Levels, $L_{Aeq,15min}$	
	Screen on barge	Screen at shore sheds
Residential units at Piers (R1)	45 - 49	45 - 48
Residential units on Lower Fort St. (R2)	60 - 64	47 - 49
Hotel at 5051 Hickson Road (R3)	48 - 50	46 - 47
North Sydney (R4)	44 - 51	49 - 55
Worst affected residential locations	64 (Lower Fort Street)	55 (Blues Point Road)
At back of the viewing area in the waterfront square	88	88
Offices and commercial premises overlooking public domain (C3)	88	88

As can be seen above, noise levels from cinema with the screen on the barge are just acceptable in terms of the proposed criteria at residential receivers for Category 1 Events ($<65 \text{ dBL}_{Aeq, 15min}$) for activities that will end at 2200h. For more frequent events, lower noise levels will need to be met and this will require a reduced sound level in the viewing area or a smaller viewing area (if the screen is on the barge).

Lower residential noise impacts are predicted for when the screen is located near the shore sheds and facing north. In this configuration, for events that end by 2200h, the predicted residential noise levels are compatible with both Category 1 Events ($<65 \text{ dBL}_{Aeq, 15min}$) and the single loudest day allowed for within Category 2 Events ($<60 \text{ dBL}_{Aeq, 15min}$).

In terms of noise levels within the precinct itself, both configurations will inevitably be high and may impact on precinct users.

C7.2 Noise from announcements and intimate performances

The results of the predictions of noise levels from localised announcement are shown below in Figure 26. This shows general levels around the public domain of around 70 dB(A) with sound levels close to loudspeakers of 76-78 dB(A). This is considered acceptable for occasional announcements, low-level background music and small localised intimate performances where listeners are located close to performers.

The predicted noise levels from the different noise receivers in the model are shown below.

Table 18: Noise levels from announcements and intimate performances

Location	Predicted Noise Levels, dB LAeq
3m from source	75
External seating areas	66 – 68
Shore Sheds façade (location C3)	63 - 65
Between loudspeaker poles	69 - 70

In the case of announcements, the noise levels expressed in $dB L_{Aeq, 15min}$ will be lower than the values given above because announcements would be intermittent rather than constant.

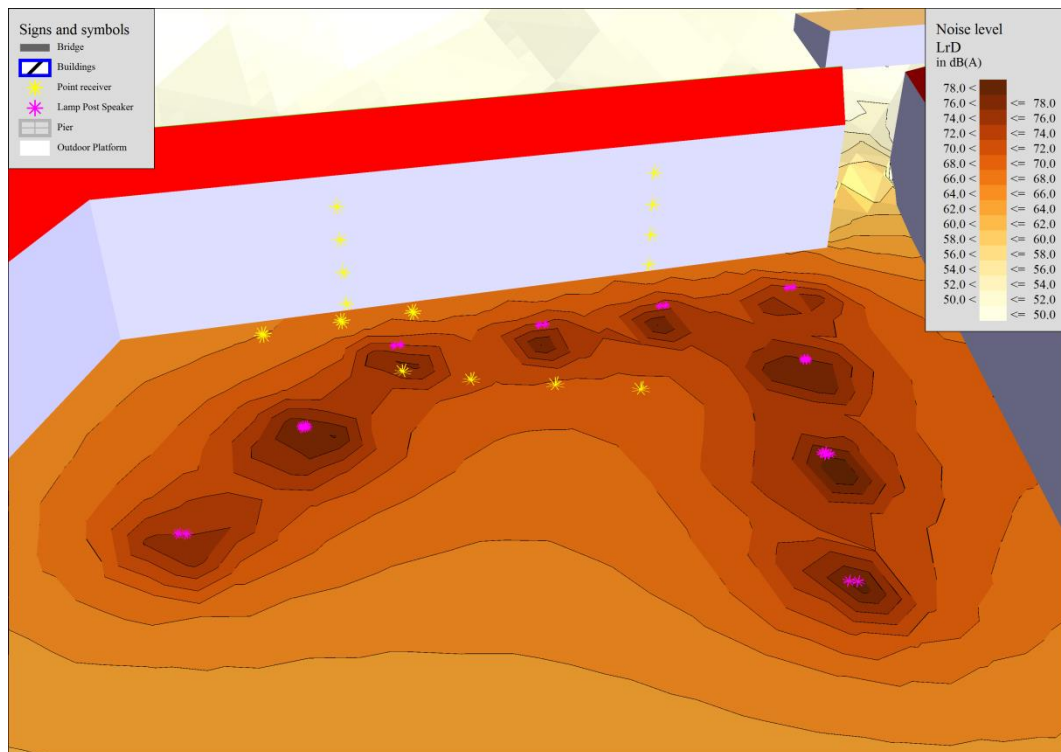


Figure 26: Listener plane noise level predictions for low level announcements and intimate performances

C7.3 Assessment

C7.3.1 Outdoor Cinema

The contour maps highlight that the buildings around the Public Domain act effectively as an acoustic screen and help contain noise levels within the “courtyard” formed by Pier 2/3 and Wharf 4/5. This effect is maximised by locating the screen at the shore sheds.

The calculations show that with a sound level of $88 \text{ dB} L_{Aeq, 15min}$ at the back of the cinema viewing area, the target noise level for Category 1 events can just be achieved at the most-affected residential receiver for activities up to 2200 h, with

the screen on a barge (the least preferable configuration for noise to residences). With the screen at the shore sheds, the more onerous criteria for the one louder day allowed for within Category 2 events can be achieved at residences. For more frequent events, lower noise levels will need to be met and this will require a reduced sound level in the viewing area or a smaller viewing area.

A sound level of 88 dB_{L_{Aeq,15min}} in the audience would be acceptable for most types of cinema but may be too quiet for movies relying heavily on *very* loud sound effects. Certain types of film may be significantly quieter than this.

It will be important to have some curatorial control on the type of films shown – with a requirement for the audio for some types of film to be delivered through headphones rather than loudspeakers (an effective technology that has been used in other outdoor locations in Sydney).

The modelling also shows that venues *within* the precinct could be significantly affected by conventional cinema operation at the Waterfront Square. This will mean that cinema events will have to be carefully coordinated with the other users and tenants by the Precinct Management (particularly those who have naturally ventilated venues or who are close to the screen) so that disturbance is minimised.

There is potential for exceeding noise criteria at C3 and significant impact on offices and retail spaces close to the area where levels could be up to 88 dB(A), depending on the nature of the film. Events and functions currently held within the precinct are likely to create similar levels of noise from time to time.

Most of the film showings would be expected to take place outside normal office hours, which would limit the risk of disturbance to office activities. However, noise levels outside some tenancies could be disturbing if there were noise sensitive events taking place at the same time as a film showing. Therefore careful management of events will be required.

C7.3.2 Announcements and intimate performances

The modelling shows that using a pole-mounted overhead distributed loudspeaker system can help to reduce noise spillage whilst still providing even coverage over the intended audience plane.

The noise impact from announcements will depend on the frequency of these. The noise modelling shows that these could be 63 to 65 dB(A) although with gaps between announcements, noise levels are expected to be below this when assessed against the noise criteria which are based on 15-minute time intervals (i.e. dB L_{Aeq,15min}). There is potential for a small exceedance for more constant sources to commercial receivers at C3 when assessed under Category 3 event noise criteria.

Proposed mitigation may include that more constant sources (i.e. music performance) should either be avoided during office hours or be located and orientated away from sensitive locations so as to achieve the target noise criteria. As with all the events, the precinct management will have a key role to play to coordinate activities to optimise precinct activities whilst minimising disturbance.

C7.3.3 Conclusion

The analysis shows that an outdoor cinema is viable within the precinct in terms of the impact on the nearest residential units. However, care will be needed to ensure that noise levels do not adversely affect the nearby residential receivers or the other performance venues and commercial uses within the precinct.

Uses *not* classified as Major Events or Arts and Cultural Events (i.e. Community or Private Events) could run cinema style events and still meet the noise criteria for residential properties outside the site but noise levels will need to be significantly lower in the audience area and events would also need to finish at 2200 h. To minimise noise levels during these events, the screen should be located at the Shore Sheds as this maximises the natural noise shielding from the existing buildings. Cinema at this lower level should still be acceptable for some film genres, but again would need to be programmed so as not to impact on commercial tenants at the C3 location and events taking place in the other venues within the precinct.

For film types that have a very powerful sound track, the use of ‘silent cinema’ should be considered so that the patrons can experience the movie without undue disturbance to receivers in the precinct and the nearest residences.

It is proposed to make use of the smart poles to integrate a sound system into the waterfront square. The use of low powered loudspeaker close to the listeners helps to reduce noise spillage such that noise from announcements and intimate performances can take place without disturbance to residences. Some care will still however be needed with regards to noise affecting the commercial receivers within the precinct.

C8 Proposed Noise Management Protocols

C8.1 Delivery Noise

As well as controlling delivery timings, there will be a requirement for delivery vehicles to use specific routes for gaining access to the precinct, for both safety and noise mitigation reasons.

There will be a system for vehicles to flow through the Public Domain without needing to reverse (thus avoiding noise from reversing alarms). Vehicles moving along the piers will be required to turn only at the ends of the piers and not allowed to drive in reverse at any other location. Again, this will avoid the need for reversing alarms outside noise sensitive premises.

C8.2 Event Waste Removal

The stores for event waste are located on the Pier 2 and Wharf 4. Vehicles collecting event waste from events will therefore not need to drive past the northern façade of the shore sheds between Pier 2/3 and Wharf 4/5, minimising the noise impact to commercial receivers at the C3 location. Due to the distance between the wharfs and the nearest residential receivers, removal of waste is not expected to cause a significant disturbance. Event waste removal is also recommended to be scheduled outside of the night time period.

C8.3 Event Scheduling

The control and mitigation of noise in the waterfront square will require events to be scheduled carefully in coordination with the venue users and commercial tenants in the precinct so that noise from such events does not interfere with any planned noise-sensitive activities within the precinct venues or other tenancies.

For film events, as part of this coordination with other precinct users, the type of film and the expected level of noise emission (and particularly the frequency content – e.g. between an “art house” film with primarily dialogue, or a “blockbuster” film with loud special effects) should be taken into consideration to help to understand any disruption that might be caused to the venues.

C8.4 Noise Management Plan

Any events would need to submit a Noise Management Plan to the Precinct Management for approval prior to the event. This would cover proposals for the whole event (setup, sound checks, performance, clear up). The Plan would be required to include as a minimum:

- Whole event programme confirming cut-off times for all activities
- Confirmation of predicted noise levels
- Proposals for consultation
- Event classification

- Contractual responsibilities
- Sound system design, loudspeaker orientations/locations and installation
- Noise monitoring proposals and named personnel with responsibility for noise levels
- Complaints handling procedure

C8.5 Noise Monitoring

When required, and in accordance with a specific Event Management Plan, noise monitors would be located as near as possible sensitive receivers and above local ground level, both for security and to give representative data for noise impacts at elevated locations, which are likely to be most-exposed to noise from events in the Public Domain. The monitoring system would need to be carefully calibrated to provide representative free-field measurements of noise levels at the boundaries of the affected buildings.

Given the size of the precinct, it is expected that at least three monitors would be required. These are suggested to be located, depending on the category and nature of the event:

- At or near to the façade of the Hotel on Pier One
- At or near the high level of the apartments behind Hickson Road
- At or near the high level of the apartments on Pier 6/7
- On the north façade of the shore sheds between Pier 2/3 and Wharf 4/5

Sophisticated systems are available which will allow remote connection to the outputs and recordings, which may be useful if there are disputes and/or to check whether noise levels triggering the systems are the result of noise from an event or from extraneous noise sources. Additional consideration may be required depending on final monitoring locations to account for any significant façade reflections to derive free-field measurements appropriate for assessment against the criteria.

In combination with the noise monitoring system, provision would be made for 'alerts' to be issued in the event of an exceedance. These would make use of technologies within the noise monitoring system to send automatic messages to the event organiser when alert thresholds are breached. When noise reaches the 'alert' threshold, the person controlling the sound levels would take action to prevent the maximum limit being exceeded.

C8.6 Event Infrastructure

It is proposed to install basic technical infrastructure into the public domain in the form of power, cabling, data and audio control infrastructure etc. This will help to control noise by:

- Simplifying the preparation for an event, requiring less noise-generating activities as part of the set up and later starts

- Predetermining the most appropriate control position that will allow better control of noise levels

The current design of the waterfront square allows for fixed, distributed 3-Phase power. This will allow for many events to be held without the need to hire in temporary power, which in itself could be a significant noise source both in terms of delivery, installation, operation and removal.

Any temporary generators and water pumps must be appropriately selected and located so as to ensure that the total noise emissions from the temporary plant/equipment do not exceed the WBAP noise performance criteria for the type of event being held and the anticipated operational hours at any surrounding noise sensitive receptors. This may require the use of containerised silenced generators, acoustic screening and selective location of temporary plant.

C8.7 Consultation

Local residents will need to be notified when there is an event. This should include as a minimum:

- Date of the event (at least 5 days in advance)
- Duration / finishing time of event
- Setup / clear up times and times for sound checks
- Complaints hotline number
- Impacts (if any) expected on local transport

C8.8 Complaints

A complaints hotline will need to be set up for the management of complaints, as required in the SSD Consent. This will be monitored during the course of an event and afterwards. The event organiser will be required to respond to the complaint and investigate appropriately.

Users will be required to log complaints, including timing, reported issues, actions taken and measures to be included for future events. The complaints log will need to be filed with the Precinct Management.

C8.9 Review

It is suggested that there be a review after each event so that there is a 'lessons learnt' process to improve outcomes for all.

The above noise limits and management protocols should be reviewed to assess their effectiveness in light of experience. The frequency of review will depend on the number of events and the outcomes. As a minimum it is suggested that within the first year of full WBAP operation, a review is held after the first event of each category. If exceedances or complaints occur, measures are recommended and implemented for all subsequent events to lower the impact to meet the agreed noise limits.

Appendix D

Acoustic Terminology

Ambient Noise Level

The ambient noise level is the overall noise level measured at a location from multiple noise sources. When assessing noise from a particular development, the ambient noise level is defined as the remaining noise level in the absence of the specific noise source being investigated. For example, if a fan located on a city building is being investigated, the ambient noise level is the noise level from all other sources without the fan running. This would include sources such as traffic, birds, people talking and other nearby fans on other buildings.

Background Noise Level

The background noise level is the noise level that is generally present at a location at all or most times. Although the background noise may change over the course of a day, over shorter time periods (e.g. 15 minutes) the background noise is almost-constant. Examples of background noise sources include steady traffic (e.g. motorways or arterial roads), constant mechanical or electrical plant and some natural noise sources such as wind, foliage, water and insects.

Decibel

The decibel scale is a logarithmic scale which is used to measure sound and vibration levels. Human hearing is not linear and involves hearing over a large range of sound pressure levels, which would be unwieldy if presented on a linear scale. Therefore a logarithmic scale, the decibel (dB) scale, is used to describe sound levels.

An increase of approximately 10 dB corresponds to a subjective doubling of the loudness of a noise. The minimum increase or decrease in noise level that can be noticed is typically 2 to 3 dB.

dB(A)

dB(A) denotes a single-number sound pressure level that includes a frequency weighting (“A-weighting”) to reflect the subjective loudness of the sound level.

The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, and so the A-weighting is used to account for this effect. An A-weighted decibel level is written as dB(A).

Some typical dB(A) levels are shown below.

Sound Pressure Level dB(A)	Example
130	Human threshold of pain
120	Jet aircraft take-off at 100 m
110	Chain saw at 1 m
100	Inside nightclub

Sound Pressure Level dB(A)	Example
90	Heavy trucks at 5 m
80	Kerbside of busy street
70	Loud stereo in living room
60	Office or restaurant with people present
50	Domestic fan heater at 1m
40	Living room (without TV, stereo, etc)
30	Background noise in a theatre
20	Remote rural area on still night
10	Acoustic laboratory test chamber
0	Threshold of hearing

L₁

The L₁ statistical level is often used to represent the maximum level of a sound level that varies with time.

Mathematically, the L₁ level is the sound level exceeded for 1% of the measurement duration. As an example, 87 dB L_{A1,15min} is a sound level of 87 dB(A) or higher for 1% of the 15 minute measurement period.

L₁₀

The L₁₀ statistical level is often used as the “average maximum” level of a sound level that varies with time.

Mathematically, the L₁₀ level is the sound level exceeded for 10% of the measurement duration. L₁₀ is often used for road traffic noise assessment. As an example, 63 dB L_{A10,18hr} is a sound level of 63 dB(A) or higher for 10% of the 18 hour measurement period.

L₉₀

The L₉₀ statistical level is often used as the “average minimum” or “background” level of a sound level that varies with time.

Mathematically, L₉₀ is the sound level exceeded for 90% of the measurement duration. As an example, 45 dB L_{A90,15min} is a sound level of 45 dB(A) or higher for 90% of the 15 minute measurement period.

L_{eq}

The ‘equivalent continuous sound level’, L_{eq}, is used to describe the level of a time-varying sound or vibration measurement.

L_{eq} is often used as the “average” level for a measurement where the level is fluctuating over time. Mathematically, it is the energy-average level over a period

of time (i.e. the constant sound level that contains the same sound energy as the measured level). When the dB(A) weighting is applied, the level is denoted dB L_{Aeq} . Often the measurement duration is quoted, thus $L_{Aeq,15\text{ min}}$ represents the dB(A) weighted energy-average level of a 15 minute measurement.

L_{max}

The L_{max} statistical level can be used to describe the “absolute maximum” level of a sound or vibration level that varies with time.

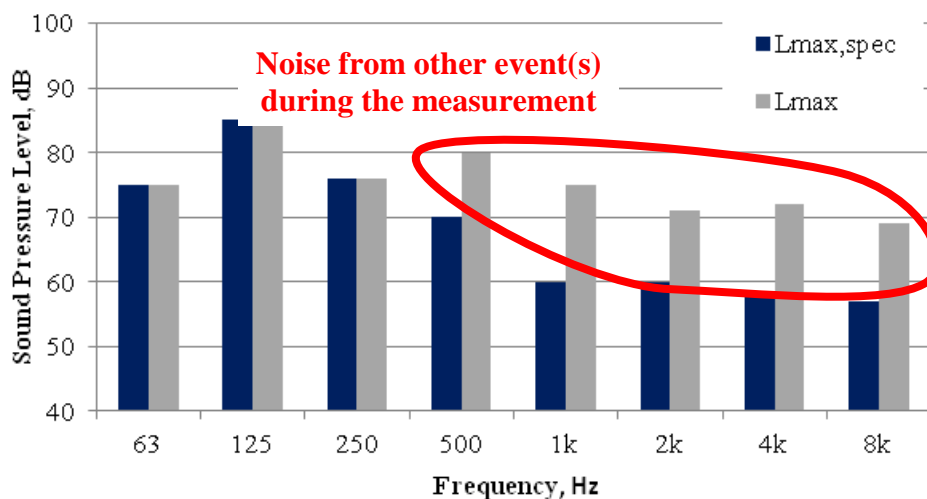
Mathematically, L_{max} is the highest value recorded during the measurement period. As an example, 94 dB L_{Amax} is a highest value of 94 dB(A) during the measurement period.

Since L_{max} is often caused by an instantaneous event, L_{max} levels often vary significantly between measurements.

$L_{max\text{ spec}}$

$L_{max\text{ spec}}$ is another representation of the highest noise or vibration levels during the measurement period.

$L_{max\text{ spec}}$ is the spectrum of the event that caused the highest overall sound or vibration level during the measurement period is denoted by dB $L_{max\text{ spec}}$. An example of the relationship between dB L_{max} and dB $L_{max\text{ spec}}$ is shown below.



L_{max} (see definition above), when measured on an octave band or 1/3 octave band meter, is the spectrum obtained by recording the highest measured value in each band. However, the highest measured values in each band may occur at different times.

Hence, $L_{\max \text{ spec}}$ represents a real event, while L_{\max} is often the mathematical addition of frequency band values from different times and often does not represent a real-world event.

Since $L_{\max \text{ spec}}$ is caused by an instantaneous event, $L_{\max \text{ spec}}$ levels often vary significantly between measurements.

Frequency

Frequency is the number of cycles per second of a sound or vibration wave. In musical terms, frequency is described as “pitch”. Sounds towards the lower end of the human hearing frequency range are perceived as “bass” or “low-pitched” and sounds with a higher frequency are perceived as “treble” or “high pitched”.

Sound Power and Sound Pressure

The sound power level (L_w) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level (L_p) varies as a function of distance from a source. However, the sound power level is an intrinsic characteristic of a source (analogous to its mass), which is not affected by the environment within which the source is located.

Vibration

Waves in a solid material are called “vibration”, as opposed to similar waves in air, which are called “sound” or “noise”. If vibration levels are high enough, they can be felt; usually vibration levels must be much higher to cause structural damage.

A vibrating structure (eg a wall) can cause airborne noise to be radiated, even if the vibration itself is too low to be felt. Structureborne vibration limits are sometimes set to control the noise level in a space.

Vibration levels can be described using measurements of displacement, velocity and acceleration. Velocity and acceleration are commonly used for structureborne noise and human comfort. Vibration is described using either metric units (such as mm, mm/s and mm/s²) or else using a decibel scale.