ACOUSTICS AND AIR

BARANGAROO SOUTH

COMMERCIAL BUILDING C3
OPERATIONAL NOISE ASSESSMENT

REPORT NO. 10232-O3
VERSION B

WILKINSON MURRAY

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SEPTEMBER 2011

PREPARED FOR

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GLOSSARY OF TERMS

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

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

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

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

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

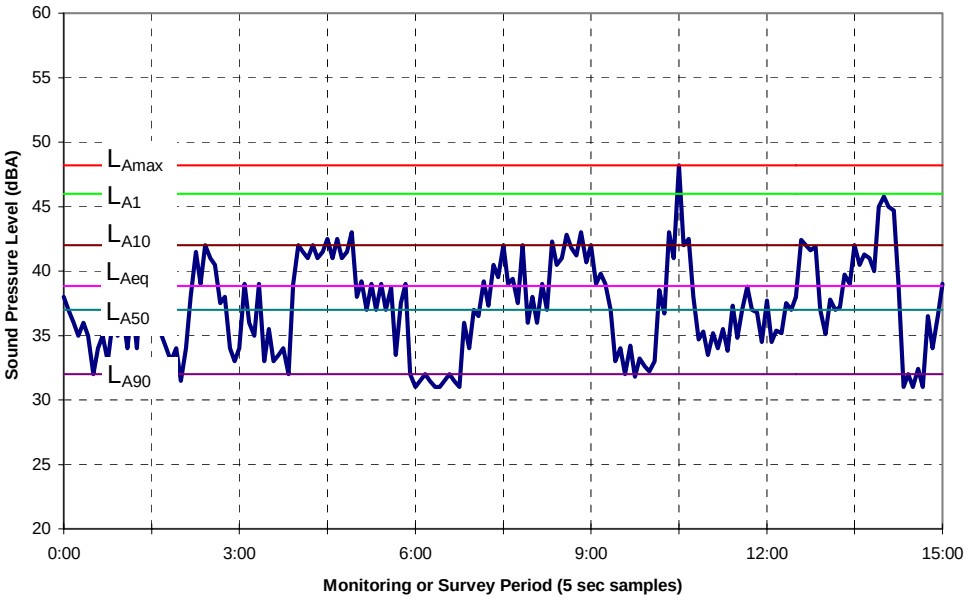
L_{A50} – The L_{A50} level is the noise level which is exceeded for 50% of the sample period. During the sample period, the noise level is below the L_{A50} level for 50% of the time.

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

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

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

Typical Graph of Sound Pressure Level vs Time



1 INTRODUCTION

1.1 Scope of Commission

This report supports a Project Application submitted to the Minister for Planning pursuant to Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act). The Application seeks approval for construction of a commercial building (known as Building C3) and associated works at Barangaroo South as described in the Project Description section of this report.

The assessment addresses operational noise from Building C3 once completed. Construction noise and vibration associated with Barangaroo South basement works, Building C4 and Building C3 have been assessed by Wilkinson Murray Pty Limited (WMPL) in separate reports.

1.2 Background

The 22 hectare Barangaroo site has been divided into three distinct redevelopment areas (from north to south) – the Headland Park, Barangaroo Stage 2 and Barangaroo Stage 1 (herein after referred to as Barangaroo South).

Lend Lease was successfully appointed as the preferred proponent to develop Barangaroo Stage 1 (otherwise known as Barangaroo South) on 20 December 2009.

1.3 Purpose of this Report

This report has been prepared to accompany the Project Application for the C3 Commercial Building and associated works at Barangaroo South. It addresses the relevant Director-General Requirements for the project. These Director-General Requirements are discussed in the Environmental Assessment Report (EAR) that has been prepared to support the application.

1.4 Planning History and Framework

On 9 February 2007 the Minister approved a Concept Plan for the site and on 12 October 2007 the land was rezoned to facilitate its redevelopment. The Approved Concept Plan allowed for a mixed use development involving a maximum of 388,300m^2 of gross floor area (GFA) contained within 8 blocks on a total site area of 22 hectares.

Modification No. 1 was approved in September 2007 which corrected a number of minor typographical errors.

On 25 February 2009 the Minister approved Modification No. 2 to the Concept Plan. The Approved Concept Plan as modified allowed for a mixed use development involving a maximum of 508,300m^2 of gross floor area (GFA) contained within 8 blocks on a total site area of 22 hectares.

On 11 November 2009 the Minister approved Modification No. 3 to the Concept Plan to allow for a modified design for the Headland Park and Northern Cove. The Approved Concept Plan as modified allows for a mixed use development involving a maximum of 489,500m2 of gross floor area (GFA) across Barangaroo as a whole.

On 16 December 2010 the Minister approved Modification No. 4 to the Barangaroo Concept Plan. The Approved Concept Plan as modified allows for approximately 563,965sqm Gross Floor Area of mixed use development across the entire Barangaroo site.

This Project Application forms one of a series of individual Applications that Lend Lease will be submitting to deliver Barangaroo South. This Project Application is consistent with the established planning framework for the site, including the approved Concept Plan (as modified).

A Project Application (MP10_0023) has been approved for the bulk excavation and construction of a basement car park to accommodate up to 880 car parking spaces and associated services and infrastructure to support the initial phases of the future development of Barangaroo South. A Section 75W Modification Application was subsequently submitted seeking to modify MP10_0023 to extend the area of the approved basement to the south. This modification was approved by the Minister for Planning on 3 March 2011.

A further Section 75W application has been submitted to the Department of Planning and Infrastructure (the Department) and is currently being assessed, which seeks the Minister's approval to modify the depth of the excavation and change the reduced levels of the basement structure, using the same construction methodology as detailed and approved as part of the original project application. This includes:

- reduced excavation and bulk earthworks;
- reduced structural works – foundations, basement levels, perimeter retention system etc; and
- installation of associated services and infrastructure to support the initial phases of the future development of Barangaroo South.

A Project Application for the first commercial building, known as C4, was submitted to the Department of Planning on 29 October 2010. This application sought consent for construction and use of a new commercial Building C4 with a maximum 98,514m2 GFA accommodating commercial and retail uses, a child care centre, bicycle parking and associated use and operation of car parking and loading facilities in the basement. Consent was issued by the Minister on 3 March 2011.

A Section 75W application has been submitted to the Department and is currently being assessed which seeks the Minister's approval to modify certain elements of the approved C4 building, including:

- mix of the uses within the building;
- total GFA;
- shape of floor plates of the podium and the tower elements of the building;
- facade details;
- roof treatment; and
- basement layout.

1.5 Site Layout

Barangaroo is located on the north western edge of the Sydney Central Business District, bounded by Sydney Harbour to the west and north, the historic precinct of Millers Point (for the northern half), The Rocks and the Sydney Harbour Bridge approach to the east; and bounded to the south by a range of new development dominated by large CBD commercial tenants.

The site has been most recently used as a shipping container and temporary cruise passenger terminal. While all commercial cargo activities have ceased, the temporary cruise passenger terminal remains in the middle of the site, to the north of Barangaroo South. This facility is expected to remain for another two years.

The Barangaroo site has been divided into three distinct redevelopment areas (from north to south) – the Headland Park, Barangaroo Stage 2 (also known as Barangaroo Central) and Barangaroo South.

The area of land within which development is proposed under this Project Application extends over land generally known and identified in the approved Concept Plan as Block 3 which comprises Lot 5 in DP 876514.

This Project Application seeks approval for the construction of a 49 storey building, comprising ground floor retail, a commercial lobby, childcare, podium and office tower, provision for associated cars and bicycle parking and the construction of the surrounding ancillary temporary public domain which includes access streets and landscaping

2 AMBIENT NOISE LEVELS AND SURROUNDING RECEIVERS

WMPL conducted an ambient noise study associated with Barangaroo Stage 1 for Lend Lease Millers Point Pty Ltd. That study addressed construction noise and vibration assessment for the Bulk Excavation and Basement Car Parking Stage. As part of that study, surrounding residential and commercial receivers that may be affected by noise and vibration were identified. These receivers were supplemented with noise measurements conducted by others, all of which are applicable for this current study of operational noise for Building C3. Surrounding relevant receivers are detailed in Table 2-1.

Table 2-1 Surrounding Receivers

Receiver Address	Comments
Commercial Receivers	
Napoleon St	Aon Australia Building Symantec Building
30 Hickson Rd	Billabond Child Care Centre, Top Floor Café, Lend Lease offices,
Lime St, (King Street Wharf)	Commercial Office Retail including indoor / outdoor cafes
37 High St, Millers Point	KU Lance Preschool and Children's Centre
Barangaroo Site	Temporary Cruise Passenger Terminal
Shelley St	Commercial on Cnr of Sussex and Shelley St
Jones Bay Wharf	Commercial Offices
Residential Receivers	
38 Hickson Rd	Multi Storey Residential Building
High St, Millers Point	Terrace Residences
Kent St	Hotel and Residential
Merriman St, Dawes Point	Double Storey unit blocks and single storey houses
Dalgety Rd, Dawes Point	Double Storey Community housing
Edward St and Little Edward St, Balmain East	Waterfront properties along Balmain peninsula
Northern end of Darling Island Rd and Wharf Cr, Darling Island	Multi Storey High End Apartments
Northern end Sydney Wharf Pirrama Road Pyrmont	Multi Storey High End Apartments
Heritage Receivers	
Former Grafton Bond Store, Hickson Rd, Millers Point	Former Grafton Bond Store Building
20-26 Sussex St, Sydney	The Sussex Hotel - Former Moreton's Hotel
2-4 Jenkins St	Former MWS stores

The site is typical of an inner city urban site, being exposed to a combination of transportation

noise, services noise and characteristic 'urban hum'.

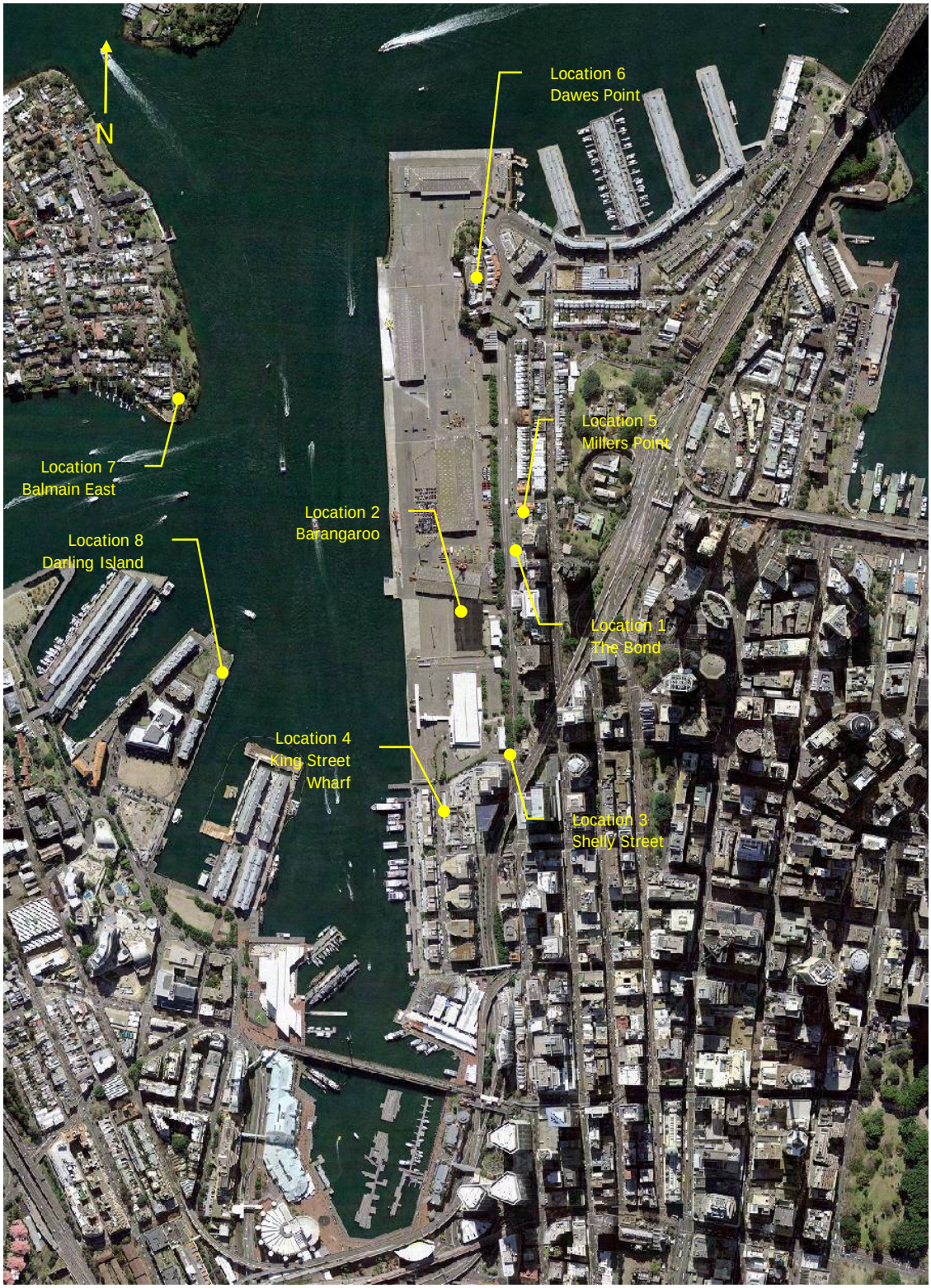
In order to quantify the existing noise environment, long-term ambient noise levels were monitored by WMPL at four locations surrounding the site, selected to cover the range of environments in the potentially affected areas. In addition, ARUP conducted noise monitoring at four further sites. These results are also utilised in the present assessment.

The noise monitoring locations are described in Table 2-2 and shown in Figure 2-1 .

Table 2-2 Long-Term Noise Monitoring Locations

Logger	Location	Monitoring Period in 2010	Company
1	Level 4, The Bond 30-38 Hickson Rd	14 April to 29 April	ARUP
2	Middle of South Barangaroo Site - Representative of Temporary Passenger Terminal	14 April to 29 April	ARUP
3	South West of site adjacent to Sussex St and	14 April to 29 April	ARUP
4	South of site adjacent to King Street Wharf	14 April to 29 April	ARUP
5	3 High St, Millers Point	31 August – 9 September	WM
6	18 Merriman St, Dawes Point	31 August – 6 September	WM
7	25 Edward St, Balmain East	31 August – 9 September	WM
8	Adjacent to 3 Darling Island Rd, Darling Island	31 August – 9 September	WM

Figure 2-1 Aerial showing Noise Monitoring Locations



*Source: Land and Property Management Authority

The noise monitoring equipment used by Wilkinson Murray for noise measurements consisted of ARL Type EL-215 environmental noise loggers set to A-weighting, fast response, continuously monitoring over 15-minute sampling periods. This equipment is capable of remotely monitoring and storing noise level descriptors for later detailed analysis. The equipment calibration was checked before and after the survey and no significant drift was noted.

In the case of noise logging conducted by ARUP, the data was reviewed by WM and is considered suitable to use for assessment purposes.

A noise logger determines L_{A1}, L_{A10}, L_{A90} and L_{Aeq} levels of the ambient noise. L_{A1}, L_{A10} and L_{A90} are the levels exceeded for 1%, 10% and 90% of the sample time respectively. The L_{A1} is indicative of maximum noise levels due to individual noise events such as the occasional pass-by of a heavy vehicle. The L_{A90} level is normally taken as the background noise level during the relevant period.

The graphs show measured values of L_{Aeq}, L_{A90}, L_{A10} and L_{A1} for each 15-minute monitoring period. Table 2-3 summarises the noise results, for daytime, evening and night time periods as defined in the OEH's *Industrial Noise Policy* (*INP*). The summary values are:

- L_{Aeq} (period) – the equivalent continuous L_{Aeq} noise level measured over the assessment period; and
- RBL – Rating Background Level is a measure of typical background noise levels which is used in determining noise criteria.

Table 2-3 Summary of Measured Noise Levels

Noise Logging Site	RBL (dBA)			$L_{Aeq,period}$ (dBA)		
	Daytime 7-6pm	Evening 6-10pm	Night Time 10pm-7am	Daytime 7-6pm	Evening 6-10pm	Night Time 10pm-7am
1	53	53	49	62	61	57
2	52	50	45	56	54	50
3	60	59	49	67	66	62
4	52	60	46	60	62	60
5	47	44	41	58	55	51
6	46	44	40	58	55	50
7	49	45	40	67	51	47
8	47	44	39	54	49	46

Background noise levels at all locations were free of the influence of extraneous noise sources such as mechanical plant or construction activities. Noise data measured during inclement weather was excluded in accordance with OEH procedures.

Results of noise logging are presented in the project applications for the basement works.

3 OPERATIONAL NOISE AND VIBRATION CRITERIA

The following sections detail the applicable site specific operational noise and vibration criteria based on the guidelines of the OEH, being:

- *The NSW Industrial Noise Policy (INP)*;
- *The OEH's Road Noise Policy (RNP)* ; and,
- *Assessing Vibration: A Technical Guideline*.

3.1 Noise Criteria for Mechanical Plant

The *NSW Industrial Noise Policy (INP)* recommends two criteria, "Intrusiveness" and "Amenity", both of which are relevant for the assessment of noise. In most situations, one of these is more stringent than the other and dominates the noise assessment. The criteria are based on the L_{Aeq} descriptor, which is explained in the glossary.

It should be noted that these criteria apply to the whole development, not just Building C3.

3.1.1 Intrusiveness Noise Criterion

The intrusiveness criterion requires that the L_{Aeq} noise level from the source being assessed, when measured over 15 minutes, should not exceed the Rating Background Noise Level (RBL) by more than 5dBA. The RBL (as presented in Table 2-3 for each long term monitoring site) represents the 'background' noise in the area, and is determined from measurement of L_{A90} noise levels, in the absence of noise from the source. The definition of L_{A90} and the procedure for calculating the RBL is presented in the glossary.

An intrusiveness criterion applies for residential receivers only.

3.1.2 Amenity Noise Criterion

The amenity noise criterion sets a limit on the total noise level from *all industrial noise sources* affecting a receiver. Different criteria apply for different types of receiver (e.g. residence, school classroom); different areas (e.g. rural, suburban); and different time periods, namely daytime (7.00am-6.00pm), evening (6.00pm-10.00pm) and night time (10.00pm-7.00am).

The noise level to be compared with this criterion is the L_{Aeq} noise level, measured over the time period in question, due to all industrial noise sources, but excluding non-industrial sources such as transportation.

Where a new noise source is proposed in an area with negligible existing industrial noise, the amenity criterion for that source may be taken as being equal to the overall amenity criterion. However, if there is significant existing industrial noise, the criterion for any new source must be set at a lower value. If existing industrial noise already exceeds the relevant amenity criterion, noise from any new source must be set well below the overall criterion to ensure that any increase in noise levels is negligible. Methods for determining a source-specific amenity criterion where there is existing industrial noise are set out in the *INP.*

3.1.3 Determination of Site Specific Noise Criteria

Table 3-1 presents the intrusiveness criteria for each residential receiver. This was calculated by adding 5dB to the RBL of the nearest long term monitoring location, as discussed in Section 3.1.1 above.

Table 3-1 Barangaroo Intrusive Noise Criteria

Site	Intrusiveness Criterion $L_{Aeq,15min}$ (dBA)		
	Daytime 7-6pm	Evening 6-10pm	Night Time 10pm-7am
38 Hickson Road, Millers Point	58	58	54
37 High Street, Millers Point	52	49	46
187 Kent Street, Millers Point	58	58	54
155-157 Kent Street, Millers Point	58	58	54
127-153 Kent Street, Millers Point	58	58	54
168-170 Kent Street, Millers Point	58	58	54
56 Merriman Street, Millers Point	51	49	45
21 Edward Street, Balmain East	54	50	45
Darling Island Apartments, Pyrmont	52	49	44
Sydney Wharf Apartments, Pyrmont	52	49	44
King Street Apartments, Sydney	57	65	51

For this assessment, all residential receivers were considered as 'urban' with the exception of Balmain East which was considered to the 'suburban', in line with the *INP*. Given our observations on and around site, noise at all locations is dominated by general traffic, urban hum, and other sources that are not classified as industrial. As such, we have assumed that the $L_{Aeq,\ period}$ from industrial noise is more than 10dB below the designated amenity criterion during any time period. Therefore, no correction to the amenity criteria is warranted. Table 3-2 presents the amenity criteria for each receiver.

Table 3-2 Barangaroo Amenity Criteria

Site	Type of Receiver	Amenity Criterion $L_{Aeq,period}$ (dBA)		
		Daytime 7-6pm	Evening 6-10pm	Night Time 10pm-7am
38 Hickson Road, Millers Point	Residential	60	50	45
37 High Street, Millers Point	Residential	60	50	45
187 Kent Street, Millers Point	Residential	60	50	45
155-157 Kent Street, Millers Point	Residential	60	50	45
127-153 Kent Street, Millers Point	Residential	60	50	45
168-170 Kent Street, Millers Point	Residential	60	50	45
56 Merriman Street, Millers Point	Residential	60	50	45
21 Edward Street, Balmain East	Residential	55	45	40
Darling Island Apartments, Pyrmont	Residential	60	50	45
Sydney Wharf Apartments, Pyrmont	Residential	60	50	45
King Street Apartments, Sydney	Residential	60	50	45
The Sussex Hotel, 22-26 Sussex Street*	Commercial	65	65	65
The Bond, 30 Hickson Road	Commercial	65	65	65
American Express, Shelley Street	Commercial	65	65	65
Temporary Cruise Passenger Terminal	Commercial	65	65	65

Intrusiveness noise criteria are expressed in terms of $L_{Aeq,15min}$, whereas amenity criteria are in terms of $L_{Aeq,Period}$, which is generally lower than $L_{Aeq,15min}$ due to variability in noise emission from the source. However, for noise from continuously-operating mechanical plant this differences is small, and in this report it will be conservatively assumed that $L_{Aeq,Period}$ noise levels will be the same as $L_{Aeq,15min}$.

On this basis, the amenity criteria in Table 3-2 are generally more stringent than intrusiveness criteria in Table 3-1 although there are some exceptions. The controlling site specific noise criteria are presented in Table 3-3 .

Table 3-3 Site Specific Criteria for Project Assessment

Site	Type of Receiver	$L_{Aeq,15min}$ (dBA)		
		Daytime 7-6pm	Evening 6-10pm	Night Time 10pm-7am
38 Hickson Road, Millers Point	Residential	58	50	45
37 High Street, Millers Point	Residential	52	49	45
187 Kent Street, Millers Point	Residential	58	50	45
155-157 Kent Street, Millers Point	Residential	58	50	45
127-153 Kent Street, Millers Point	Residential	58	50	45
168-170 Kent Street, Millers Point	Residential	58	50	45
56 Merriman Street, Millers Point	Residential	51	49	45
21 Edward Street, Balmain East	Residential	54	45	40
Darling Island Apartments, Pyrmont	Residential	52	49	44
Sydney Wharf Apartments, Pyrmont	Residential	52	49	44
King Street Apartments, Sydney	Residential	57	50	45
The Sussex Hotel, 22-26 Sussex Street	Commercial	65	65	65
The Bond, 30 Hickson Road	Commercial	65	65	-
American Express, Shelley Street	Commercial	65	65	-
Temporary Cruise Passenger Terminal	Commercial	65	65	65

3.2 Noise Criteria for Road Traffic

Criteria for assessment of road traffic noise are set out in the NSW Government's *NSW Road Noise Policy (RNP)*. Table 3-4 sets out the assessment criteria for residences to be applied to particular types of project, road category and land use.

The roads likely to be affected by additional traffic from Building C3 are best described as "Freeway/arterial/sub-arterial roads", and hence the criteria for item 3 above are applicable and will be adopted in this report.

In summary the noise level goals at the residential receivers, for this project, based on the *RNP* are:

- $L_{Aeq,15hr}$ day 60 dBA.
- $L_{Aeq,9hr}$ night 55 dBA;

Table 3-4 Traffic noise criteria extracted from the NSW *RNP*

Road category	Type of project/land use	Assessment criteria – dB(A)	
		Day (7 a.m.–10 p.m.)	Night (10 p.m.–7 a.m.)
Freeway/ arterial/ sub-arterial roads	1. Existing residences affected by noise from **new** freeway/arterial/sub-arterial road corridors	$L_{Aeq, (15\ hour)}$ 55 (external)	$L_{Aeq, (9\ hour)}$ 50 (external)
	2. Existing residences affected by noise from **redevelopment** of existing freeway/arterial/sub-arterial roads 3. Existing residences affected by **additional traffic** on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq, (15\ hour)}$ 60 (external)	$L_{Aeq, (9\ hour)}$ 55 (external)
Local roads	4. Existing residences affected by noise from **new** local road corridors 5. Existing residences affected by noise from **redevelopment** of existing local roads 6. Existing residences affected by **additional traffic** on existing local roads generated by land use developments	$L_{Aeq, (1\ hour)}$ 55 (external)	$L_{Aeq, (1\ hour)}$ 50 (external)

In additions where the above criteria are already exceeded as a result of existing traffic the policy notes:

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

Accordingly all residences potentially affected by traffic noise will be assessed with respect to the above criteria.

3.3 Vibration Criteria

Vibration levels caused by activities on site (including mechanical plant) should not exceed the limits specified in the OEH document *"Assessing Vibration: A Technical Guideline"* in any neighbouring occupancy. This guideline provides vibration criteria for maintaining human comfort within different types of spaces.

The guideline recommends maximum weighted vibration levels for continuous sources, such as mechanical services plant, and for impulsive vibration due to transient sources or impacts. The weighting curves are obtained from BS6472: *Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)*.

The vibration limits in different occupancies for continuous vibration sources are shown in Table 3-4.

Although not specifically mentioned in the guideline, we recommend that retail occupancies be assessed in line with 'workshops' shown in this table as occupants are less likely to detect adverse levels of vibration than those in an office space.

Table 3-4 Vibration Limits for Varying Occupancies

Location	Maximum z-axis weighted rms acceleration (m/s^2)		Vibration Dose Value ($m/s^{1.75}$)
	Continuous	Impulsive	Intermittent
Residential areas (night)	0.007	0.10	0.13
Residential areas (day)	0.010	0.30	0.20
Office areas	0.020	0.64	0.40
Workshops	0.040	0.64	0.80

3.4 Internal Noise Criteria for Internal Spaces within the Development

Australian Standard 2107 *Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors* provides recommendations for the design of internal spaces of various types. The recommend noise levels within this standard relate to relatively constant noise sources, such as air-conditioning and traffic noise.

An extract from AS2107 is presented in Table 3-5.

Table 3-5 Recommend Internal Noise Levels for Various Spaces

Type of Occupancy	Recommended Design Sound Level (dBA)	
	Satisfactory	Maximum
OFFICE BUILDINGS		
Board and Conference Rooms	30	40
Corridors and Lobbies	45	50
General Office Areas	40	45
Private Offices	35	40
Public Spaces	40	50
Reception Areas	40	45
Toilets	50	55
SHOP BUILDINGS		
Small Retail Stores	45	50
Specialty Shops (where detailed discussion is required)	40	45
Supermarkets	50	55
Shopping Malls	45	55

4 ASSESSMENT OF NOISE AND VIBRATION IMPACTS TO SURROUNDING RECEIVERS

This section presents our assessment of potential operational noise and vibration impacts on the surrounding commercial and residential areas.

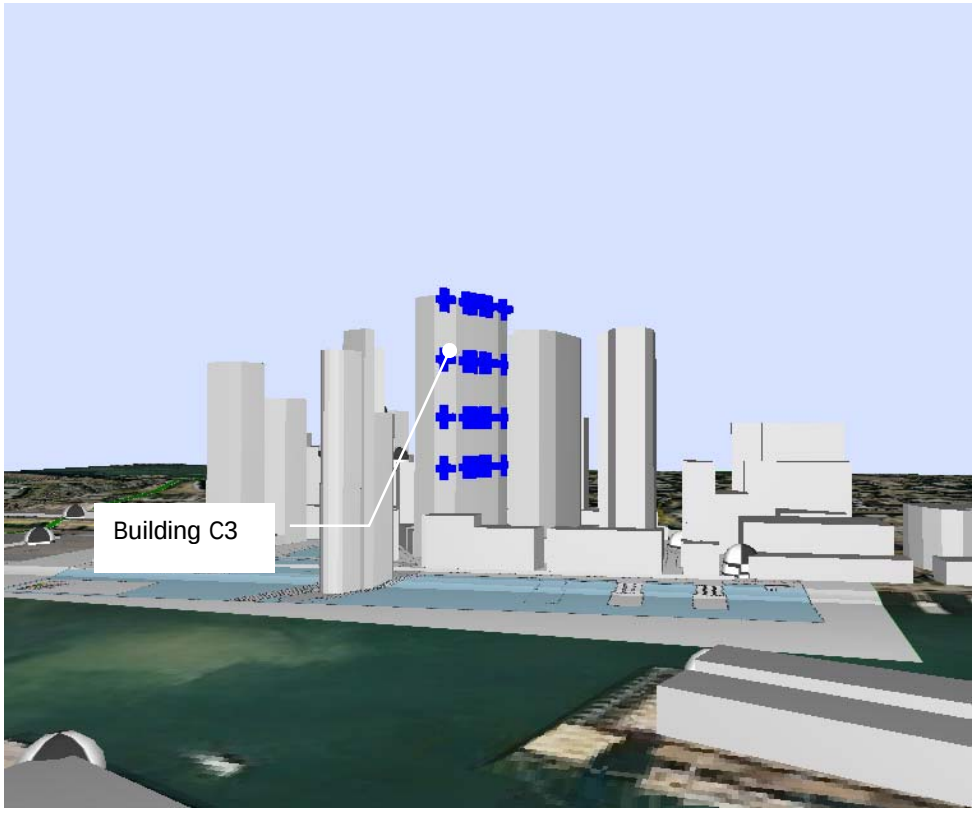
A computer noise model was developed for the assessment of construction noise from the site (Site-related noise emissions were modeled with the “CadnaA” noise prediction program, using the ISO 9613 noise prediction algorithms). This model has updated based on the proposed development design to facilitate the assessment of site operational noise.

Factors that are addressed in the noise modeling are:

- equipment sound level emissions and location;
- screening effects from buildings;
- receiver locations;
- ground topography;
- noise attenuation due to geometric spreading;
- ground absorption; and
- atmospheric absorption.

Figure 4-1 shows the noise model with the C3 building and surrounding buildings.

Figure 4-1 Operational Site Noise Model 3D View



4.1 Noise Produced by Mechanical Plant Specific to Building C3

The major items of mechanical plant specifically associated with Building C3 are located within three basement plant rooms, two mid level building plant rooms and one plant area at roof level. Equipment located in these areas includes:

- air handling units;
- supply and return air fans;
- boilers;
- substation/transformers; and
- general exhaust fans.

It is understood that the load of these items will be continuously monitored and controlled to optimise heating and cooling efficiency.

All heat rejection plant and chillers will be located in the basement and cooled by water from the harbour. Noise produced by the heat rejection plant will therefore be contained within the building structural envelope by the concrete structure. As a result these sources will not be acoustically significant and therefore do not require any further consideration.

A typical plant room layout and preliminary equipment selections was provided by Lend Lease Design and Project Management. While the detailed design of this building is in the early stages and subject to change, this layout provides information to allow determination on the indicative noise emission levels for project approval assessment. This layout was mirrored across all three plant rooms. The external noise sources used for each noise emission point (accounting for typical noise control equipment) are presented in Table 4-1. Note that achievement of these external sound power emission levels will in general require the use of silencers in external openings in plant rooms.

A 5dBA reduction in plant noise levels was assumed to take into account the reduction in system load normally experienced during the night time period when loads on the system are reduced.

Table 4-1 Noise Sources Modelled for Each Plant Room

Noise Source	Sound Power Level (dBA)
Outside Air Intake Louvre (12mx3m)	86
Relief Air Outlet	81
Relief Air Outlet	81
Outside Air Intake Louvre (12mx3m)	86
Relief Air Outlet	81
General Exhaust Outlet	79
General Exhaust Outlet	79
Toilet Exhaust Outlet	71

Based on the above noise levels, predicted noise levels at surrounding receivers are presented in Table 4-2.

Table 4-2 Calculated Noise Levels from Building C3 Mechanical Plant

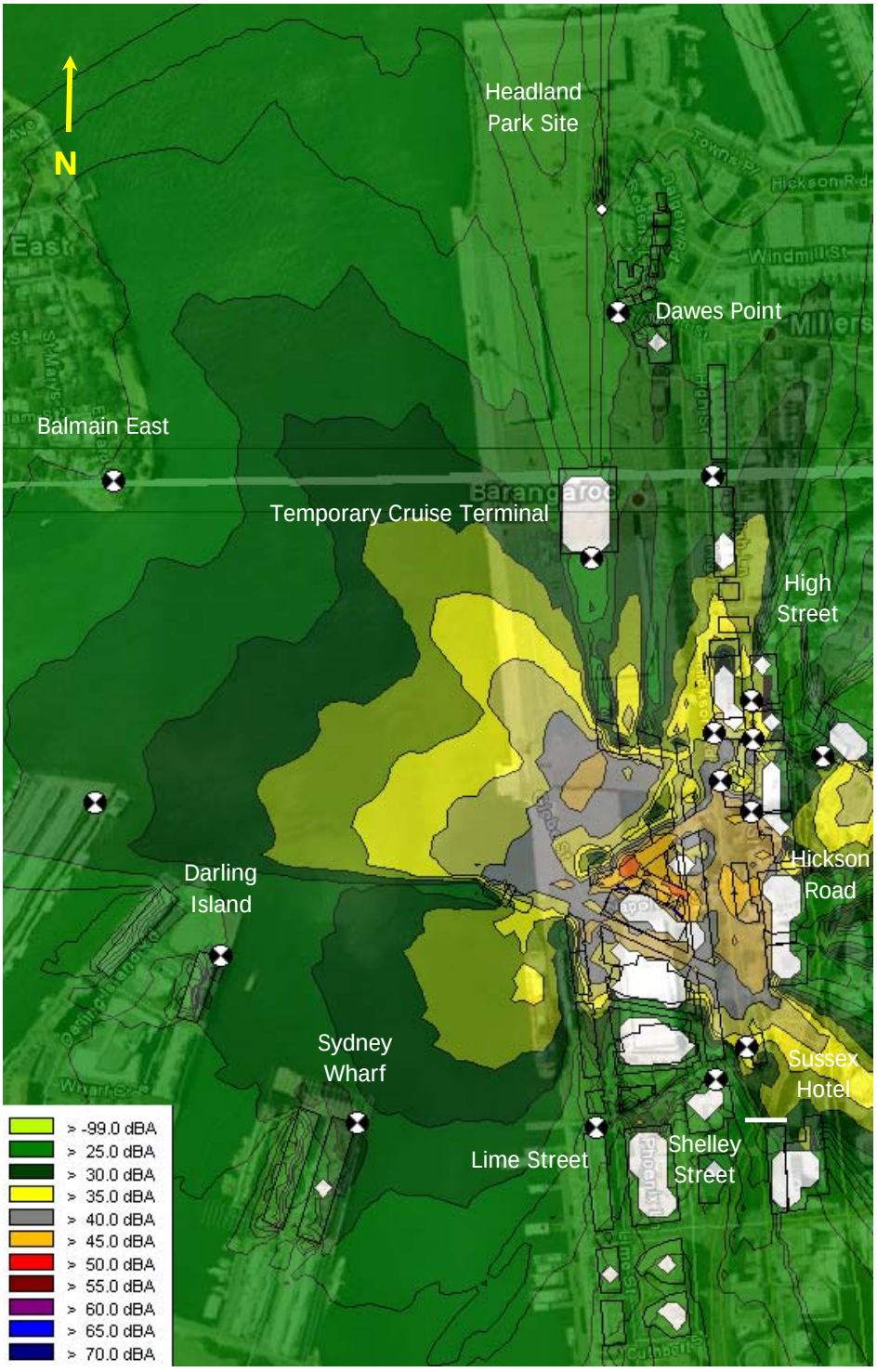
Site	Type of Receiver	Calculated L_{Aeq} (dBA)		
		Daytime 7-6pm	Evening 6-10pm	Night Time 10pm-7am
38 Hickson Road, Millers Point	Residential	34	34	29
37 High Street, Millers Point	Residential	29	29	24
187 Kent Street, Millers Point	Residential	36	36	31
155-157 Kent Street, Millers Point	Residential	41	41	42
127-153 Kent Street, Millers Point	Residential	28	28	23
168-170 Kent Street, Millers Point	Residential	37	37	32
56 Merriman Street, Millers Point	Residential	26	26	21
21 Edward Street, Balmain East	Residential	25	25	20
Darling Island Apartments, Pyrmont	Residential	29	29	24
Sydney Wharf Apartments, Pyrmont	Residential	28	28	23
King Street Apartments, Sydney	Residential	25	25	21
The Sussex Hotel, 22-26 Sussex Street	Commercial	38	38	33
The Bond, 30 Hickson Road	Commercial	40	40	35
American Express, Shelley Street	Commercial	21	21	16
Temporary Cruise Passenger Terminal	Commercial	25	25	20

A noise contour plot showing noise emission from building C3 specific plant is shown in `Figure 4-2. The noise plot is at a nominal height of 4m above ground, specific receivers may be at different heights.

The predicted noise levels at surrounding receivers, based on indicative plant noise levels, are well below the site specific noise criteria. However a review of the design will need to be assessed at detailed design stage to ensure that compliance with established noise criteria is achieved when specific plant selection and design is known.

These levels form part of the assessment of noise from the overall development, discussed further in Section 4.2.

`Figure 4-2 Noise Contours from Building C3 Mechanical Plant (4m height)



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4.2 Cumulative Noise Produced by Mechanical Plant from the Whole Barangaroo South Development

As previously discussed, potential noise impacts produced by the entire development, not just those limited to building C3, must meet the overall site specific noise criteria that have been derived in accordance with the *INP*.

The equipment noise levels used on C3 have been assessed based on the same design methodology and equipment selection as those made for C4 in the project application for that project. It has been assumed that the remaining C5 commercial building will utilise a similar design methodology and equipment selection to those made for C4 and C3. It is noted that building C3 incorporates a third intermediate level plant room.

We have assumed the remaining low height commercial and residential buildings will adopt a similar heat rejection strategy to buildings C3, C4 and C5 with a single rooftop plant room and similar source noise levels.

Car park ventilation has been incorporated in the overall site model, running continuously during the daytime and evening periods. This is a conservative assumption and unlikely to be the case in reality as the system will be controlled on demand by a gas/CO_2 monitoring network. Night time operation is not expected to occur under normal conditions.

Table 4-3 shows the predicted operational noise levels at receivers along with applicable noise criteria (in square bracket).

Table 4-3 Calculated Operational Noise Levels from All Mechanical Plant

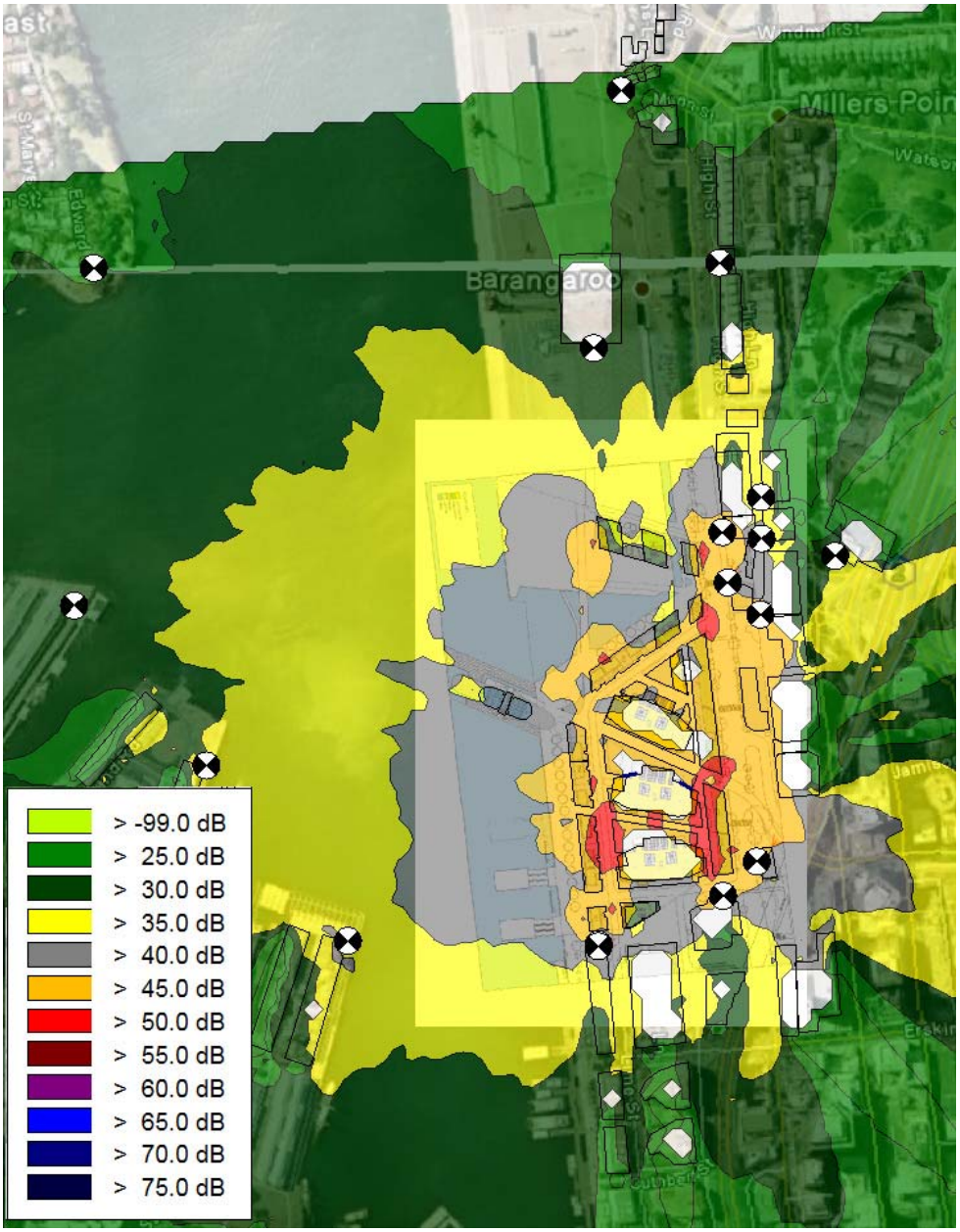
Site	Calculated L_{Aeq} (dBA) and [criterion]			Compliance
	Daytime 7-6pm	Evening 6-10pm	Night Time 10pm-7am	
38 Hickson Road, Millers Point	46 [58]	46 [50]	41 [45]	Yes
37 High Street, Millers Point	32 [52]	32 [49]	27 [45]	Yes
187 Kent Street, Millers Point	46 [58]	46 [50]	41 [45]	Yes
155-157 Kent Street, Millers Point	43 [58]	43 [50]	38 [45]	Yes
127-153 Kent Street, Millers Point	42 [58]	42 [50]	37 [45]	Yes
168-170 Kent Street, Millers Point	43 [58]	43 [50]	38 [45]	Yes
56 Merriman Street, Millers Point	29 [51]	29 [49]	24 [45]	Yes
21 Edward Street, Balmain East	29 [54]	29 [45]	24 [40]	Yes
Darling Island Apartments, Pyrmont	35 [52]	35 [49]	30 [44]	Yes
Sydney Wharf Apartments, Pyrmont	38 [52]	38 [49]	33 [44]	Yes
King Street Apartments, Sydney	41 [57]	41 [50]	36 [45]	Yes
The Sussex Hotel, 22-26 Sussex Street	49 [65]	49 [65]	44 [65]	Yes
The Bond, 30 Hickson Road	45 [65]	45 [65]	40 [N/A]	Yes
American Express, Shelley Street	45 [65]	45 [65]	40 [N/A]	Yes
Temporary Cruise Passenger Terminal	31 [65]	31 [65]	26 [65]	Yes

The results presented above indicate that compliance with site specific noise criteria will be

achieved all locations. The highest noise levels at residents are that are predicted at 38 Hickson Road and 187 Kent Street. Predicted noise levels at these locations are 4dBA below the established noise criteria.

A noise contour plot (4m above ground level) showing mechanical plant noise emission from the whole site is shown in Figure 4-3.

Figure 4-3 Noise Contour for All Mechanical Sources (4m height)



4.3 Noise Produced by Additional Traffic

Transportation has been carefully considered during conceptual design of the development. This approach involved minimising use of private cars and maximising access to several modes of public transport. As such, vehicle movements are generally low for a development of this size.

Access to the car park is via ramps on Margaret Street West and Hickson Road. All on site car parking and loading docks will be below ground, minimising the impact of traffic noise on site. Hence, noise from on site traffic noise will not require further assessment.

Section 3.2 above describes the procedure and goals required to assess traffic noise increases from the development on adjoining roads. Monitoring results from the long term monitoring location at the Sussex Hotel (adjacent to the corner of Sussex and Shelley Streets), provided by ARUP, was reviewed to determine the existing level of traffic noise ($L_{Aeq,1hr}$).

This review indicated that both daytime and night time levels are currently higher than the noise goals required by the *RNP* on most days of monitoring. Therefore, it is necessary to determine the increase in traffic noise due to the development.

A traffic report has been prepared for Building C4. This report, prepared by ARUP[1], presents AM and PM peak hour traffic volume increases due to the addition of Building C4. As the adjacent C3 is of a similar size and usage it is reasonable to assume that C3 generates similar volumes of traffic.

To properly assess traffic noise increases throughout the day, we would require the hourly traffic counts over the whole day (both existing and with building C3, rather than only the peak hour periods. Given that this data is not available, the Roads and Traffic Authority's published traffic volume data (2002 edition) was considered. The nearest appropriate monitoring location with hourly traffic counts is Crown Street. This site shows a steady consistency during the course of the day, with traffic volumes within +/-10% between the hours of 7am and 10pm. On this basis, we have assumed traffic volumes on Sussex Street, and traffic volumes generated by the development, would have a similar daily pattern. In this case, traffic noise increases can be assessed on the basis of the worst AM and PM peak hour data provided by ARUP.

The ARUP report provides a breakdown of traffic volumes by intersection, an example of which is shown below in Figure 4-4.

By adding all intersection breakdowns together to obtain the total traffic volume in and out of the area, increases of 5% and 6% for the AM and PM peak periods were obtained for Building C4. This corresponds to a 0.2dB and 0.3dB increase in traffic noise during the AM and PM peak periods.

To reach the limit of a 2dB increase, the traffic volumes generated by the entire development would need to be over 10 times those reported for building C4. As the addition of C3 is likely to double the traffic generated by C4 alone it is considered unlikely that the 10 times combined volume would be reached, based on this information it is considered that traffic generated by the entire development would comply with the RNP.

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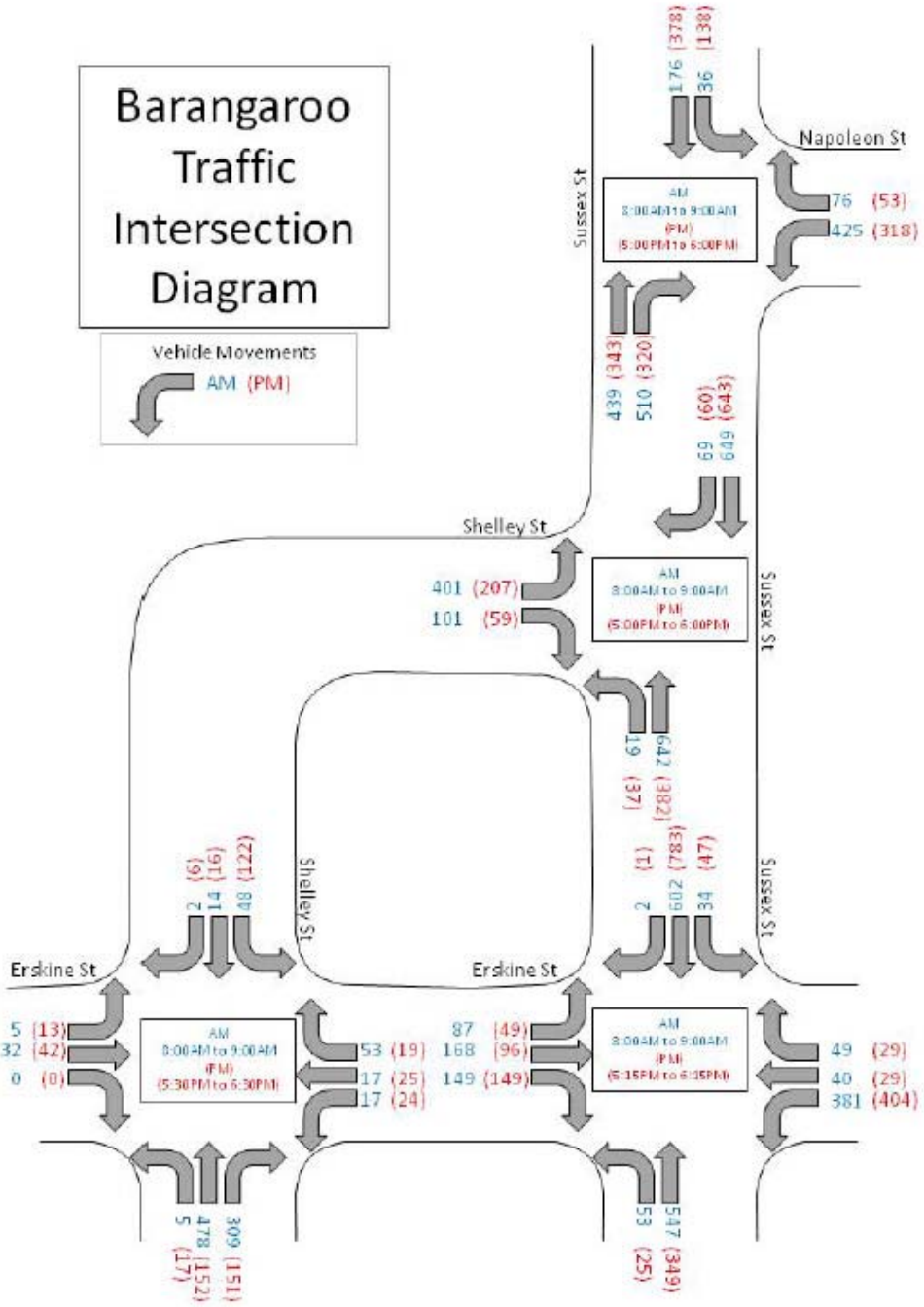
Figure 4-4 ARUP Intersection Breakdown Diagram



4.4 Vibration Produced by the Development

It is extremely unlikely that any commercial tenant will engage in vibration intensive operations. All impulsive activities from the loading docks and car park will be suitably attenuated by resilient bollards and bumpers where appropriate.

In addition all mechanical plant and equipment will incorporate standard engineering vibration controls such as spring mounts and inertia blocks that will be designed and installed in such a way as to minimise vibration.

As a result, vibrations produced by operations within the development are unlikely to be detectable and will be significantly below the limits discussed in Section 3.3 above.

5 ASSESSMENT OF NOISE AND VIBRATION IMPACTS TO RECEIVERS WITHIN THE DEVELOPMENT

The detailed design and selection of mechanical plant associated with Building C3 has not progressed far enough to provide any definitive assessment of noise impacts within the building, this section discusses the main potential noise sources and how they will be addressed.

5.1 Noise Produced by Road Traffic

Traffic noise from Hickson Road, Shelley Street, Sussex Street and other major arterials such as the western distributor and the harbour bridge approaches will all affect the noise environment at the Building C3 site. Internal noise levels from traffic will be designed to meet the recommended noise levels detailed in AS2107, and where advised other policies such a Greenstar. To achieve this, the sound transmission properties of the facade design will be assessed to ensure the noise levels are achieved and the comfort of any occupants will not be adversely affected.

5.2 Noise Produced by Mechanical Plant

Noise from mechanical plant associated with the Barrangaroo Development is more likely to be higher at buildings within the development than for neighbouring existing residences which are further away from the site. To ensure that noise from mechanical plant within the development does not affect the occupants of C3, appropriate noise controls (such as attenuators, internal duct lining, etc) should be incorporated within all buildings to reduce noise in conjunction with the building facade.

5.3 Noise Produced by Public Entertainment

Building C3 may be subject to noise from medium and large scale outdoor events involving amplified music. These events would likely take place outside normal office hours and are unlikely to significantly impact the occupants of C3.

Smaller events during the daytime are unlikely to affect building C3 occupants given the fully sealed facade and other sources of masking noise such as road traffic.

6 CONCLUSION

This report addresses the operational acoustic and vibration issues relevant to building C3 at Barangaroo South. The purpose of this report is to inform and accompany the C3 Commercial Building Planning Application.

The proposed development consists predominantly of office space with retail areas located near ground level and in the podium levels. Two plant rooms are located towards the middle of the building with a third at roof level. These plant rooms predominantly house air handling plant and equipment. All heat rejection plant is housed below ground and cooled by water from the harbour.

Noise impacts to surrounding commercial and residential receivers from mechanical plant and traffic have been assessed on a 'whole of site' basis, and found to meet the required OEH noise limits.

Noise impacts from additional traffic due to building C3 on surrounding roads are predicted to be well within relevant criteria, and this is also believed to be true for traffic generated by the entire site, although details of total traffic generation are not available at this stage.

Vibration from sources within the building can be controlled by various measures as required, and will be well within relevant criteria at surrounding receivers.

Noise impacts within the building due to surrounding sources will be mitigated through careful design of the building facade and mechanical services systems.

Version	Status	Date	Prepared by	Checked by
A	Final	20 September 2011	Brian Clarke	John Wasserman
B	Final	29 September 2011	Ben Lawrence	Brian Clarke