

ONE SYDNEY HARBOUR RESIDENTIAL BUILDING R4A

CONSTRUCTION AND OPERATIONAL NOISE REPORT

**REPORT NO. 10232-R4A
VERSION B**

APRIL 2017

PREPARED FOR

LEND LEASE PROJECT MANAGEMENT & CONSTRUCTION
30 THE BOND
SYDNEY NSW 2000

DOCUMENT CONTROL

Version	Status	Date	Prepared By	Reviewed By
B	Final	28 July 2016	Brian Clarke	John Wassermann
B	Final	26 April 2017	John Wassermann	-

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GLOSSARY OF ACOUSTIC TERMS

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

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

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

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

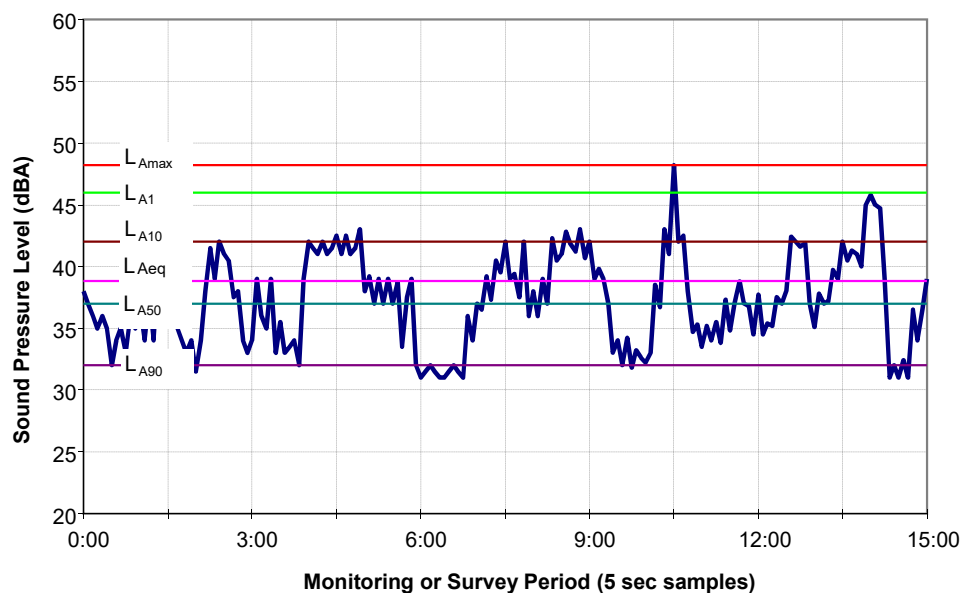
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

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

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

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

Typical Graph of Sound Pressure Level vs Time



1 INTRODUCTION

This report supports a State Significant Development Application (SSDA) (SSD 6964) submitted to the Minister for Planning and Environment pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act). The Development Application (DA) seeks approval for construction of a residential flat building (known as Residential Building R4A) and associated works at Barangaroo South as described in the Overview of Proposed Development section of this report.

Wilkinson Murray Pty Limited has reviewed and assessed the drawings and relevant documentation prepared in respect of the Significant Development Application (SSDA) submission. Wilkinson Murray has prepared the noise and vibration assessments to support the Development Applications for all major components of the South Barangaroo project.

The assessment has taken into account the following requirements:

The assessment has taken into account the following requirements in item 14:

Noise

The applicant must include a Noise and Vibration Assessment of construction, operation, traffic and cumulative noise impacts prepared in accordance with the relevant EPA guidelines. This assessment must consider any potential noise impacts on nearby noise sensitive receivers and outline proposed noise mitigation and monitoring issues.

→ *Relevant Policies and Guidelines:*

- *NSW Industrial Noise Policy 2000 (EPA)*
- *NSW Industrial Noise Policy – application notes 2013 (EPA)*
- *Interim Construction Noise Guideline 2009 (DECC)*
- *Assessing Vibration: A Technical Guideline 2006 (DECC)*
- *NSW Road Noise Policy (DECCW 2001)*
- *NSW Road Noise Policy – application notes 2013 (EPA).*

The Residential Building R4A DA seeks approval for the construction and use of a 72 storey residential flat building comprising 327 apartments, ground floor retail, the allocation of car parking, services, plant and storage within the Stage 1B Basement (subject of a separate concurrent DA), and the construction of ancillary landscaping and temporary public domain.

Approval for the construction of Residential Building R4A's core and associated plant and services within the basement is being sought as part of the concurrent Stage 1B Basement DA and do not form part of this DA.

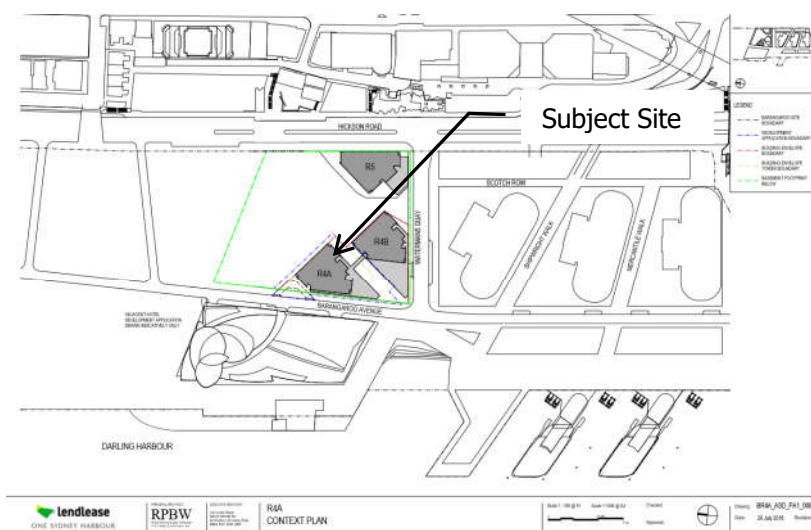
The operation of the building will consist of normal residential operations where noise from mechanical plant presents the main source of any potential noise emissions from the site.

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

The R4A DA Site area is located within Barangaroo South as shown in Figure 2-1. The DA Site is located on land generally known and identified in the approved Concept Plan as Block 4A

Figure 2-1 R4A Residential Building Development Application Aerial Site Location Plan



2.2 Construction Hours

The proposed construction hours for the works are between 7.00am and 6.00pm Monday – Friday and between 7.00am and 5.00pm on Saturdays.

This extended period of construction hours is consistent with the City of Sydney's approach to hours of works within the CBD, which recognises the urban nature of the city environment. It is also consistent with the approach already approved under SSD5897 and SSD6533 development consents for remediation of the Declaration Area, and the MP10_0023 project approval for the Stage 1A Basement.

It is noted that the Saturday hours are longer than the standard EPA hours of 8am to 1pm as mobilisation of works on a site of this size requires a full days work to be effective. If standard EPA Saturday hours were adopted it would not be practical to work on Saturdays. This would extend the project duration by 6-7 months, resulting in a longer duration of exposure of residents to construction noise.

No construction work is proposed to be undertaken outside the proposed construction hours, including on Sundays or Public Holidays, with the exception of emergency work.

2.3 Construction Traffic

Indicative forecast maximum truck movements are described below. More details regarding traffic movements associated with the works contemplated are detailed in the Construction Traffic Management Plan prepared by ARUP that accompanies the Project Application being:

- 16 Truck movements per hour associated with R4A,
- Cumulative construction truck movements are also presented in the report, where maximum hourly truck movement of 66 are predicted in December 2020.

2.4 Exceptions to Proposed Hours of Operation - Out of Hours Works

Anticipated out of hours works to be undertaken during construction include:

- Concrete pours that need to be completed to prevent waste and re-working.
- Service installation works and cut-overs during temporary utility shutdowns or off peak periods.
- Works behind a façade (such as plastering, internal fit out, painting and finishes).
- Delivery to site, and removal from site, of over-sized plant and equipment to conform to RMS requirements.
- Use of internal lifts and internal electric hoists.
- Crane and hoist installation, maintenance, climbing and dismantling 9am - 5pm Sundays, for worker and public safety.
- Environmental controls required (such as operation of a water treatment plant, monitoring equipment and dust suppression).

- Other critical works that are generally inaudible at nearby sensitive receivers (such as concrete curing, post tensioning and membrane placement).

Some other out of hours activities may be required throughout construction. These activities may be required to be undertaken out of hours to:

- undertake works for safety reasons for the protection of workers and members of the public.
- reduce disruption to traffic and the community.
- satisfy operational requirements of government agencies or authorities.
- due to unforeseen circumstances.

3 AMBIENT NOISE MONITORING

3.1 Ambient Noise Levels at South Barangaroo

Residential and commercial receivers surrounding the site that may be affected by construction and operational noise from the site have been identified in previous relevant applications for the Barangaroo South site. These receivers are also relevant in assessing noise impacts from the broader site. They are detailed in Table 3-1.

Table 3-1 Surrounding Receivers

Receivers	Comments
Commercial Receivers	
A – Napoleon St	Aon Australia Building Symantec Building
B – 30 Hickson Rd	Top Floor Cafe, Lend Lease offices,
C – Lime St, (King Street Wharf)	Commercial office Retail including indoor / outdoor cafes
D – 37 High St, Millers Point	KU Lance Preschool and Children’s Centre
F – Shelley St	Commercial on Cnr of Sussex and Shelley St Commercial on Cnr of Lime and Shelley St
Q- Building T1 Hickson Road	Proposed Podium Level Childcare
R – AON 201 Kent Street	Ground Floor Childcare
Residential Receivers	
G – 38 Hickson Rd	Multi storey residential building
H – High St, Millers Point	Terrace residences
I – Merriman St, Millers Point	Double storey unit blocks and single storey houses
J – Dalgety Rd, Millers Point	Double storey Community housing
K – Edward St and Little Edward St, Balmain East	Waterfront properties along Balmain peninsula
L – Northern end of Darling Island Rd and Wharf Cr, Darling Island	Multi storey high end apartments
M – Northern end Sydney Wharf Pirrama Rd, Pyrmont	Multi storey high end apartments
Q – Residential Building R8	Multi storey high end apartments
Heritage Receivers	
N – Former Grafton Bond Store, Hickson Rd, Millers Point	Former Grafton Bond Store Building

Receivers	Comments
0 – 20-26 Sussex St , Sydney	The Sussex Hotel – Former Moreton's Hotel
P – 2-4 Jenkins St	Former MWS stores

In addition to the Ku-Lane childcare there is a more recent childcare centre that operates in the vicinity of the subject site being one facing west at the AON building at 201 Kent Street.

Further a childcare at podium level of T1 immediately to the south of Basement 1B is proposed. It is also proposed for this facility that the outdoor area will not be used whilst construction activities occur. As such noise predictions have been conducted at this potential receiver. Air conditioning exists or is proposed for both these facilities.

In order to quantify the existing noise environment, long-term ambient noise levels were monitored at eight (8) locations surrounding the site, selected to cover the range of environments in the potentially affected areas.

The locations are presented in Table 3-2. The noise logger locations are shown in Figure 3-1.

Table 3-2 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	14 April to 29 April	Arup
3	South West of site adjacent to Sussex St and Shelley St	14 April to 29 April	Arup
4	South of site adjacent to King Street Wharf Boulevard	14 April to 29 April	Arup
5	3 High St, Miller Point	31 August – 9 September	WM
6	18 Merriman St, Millers 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

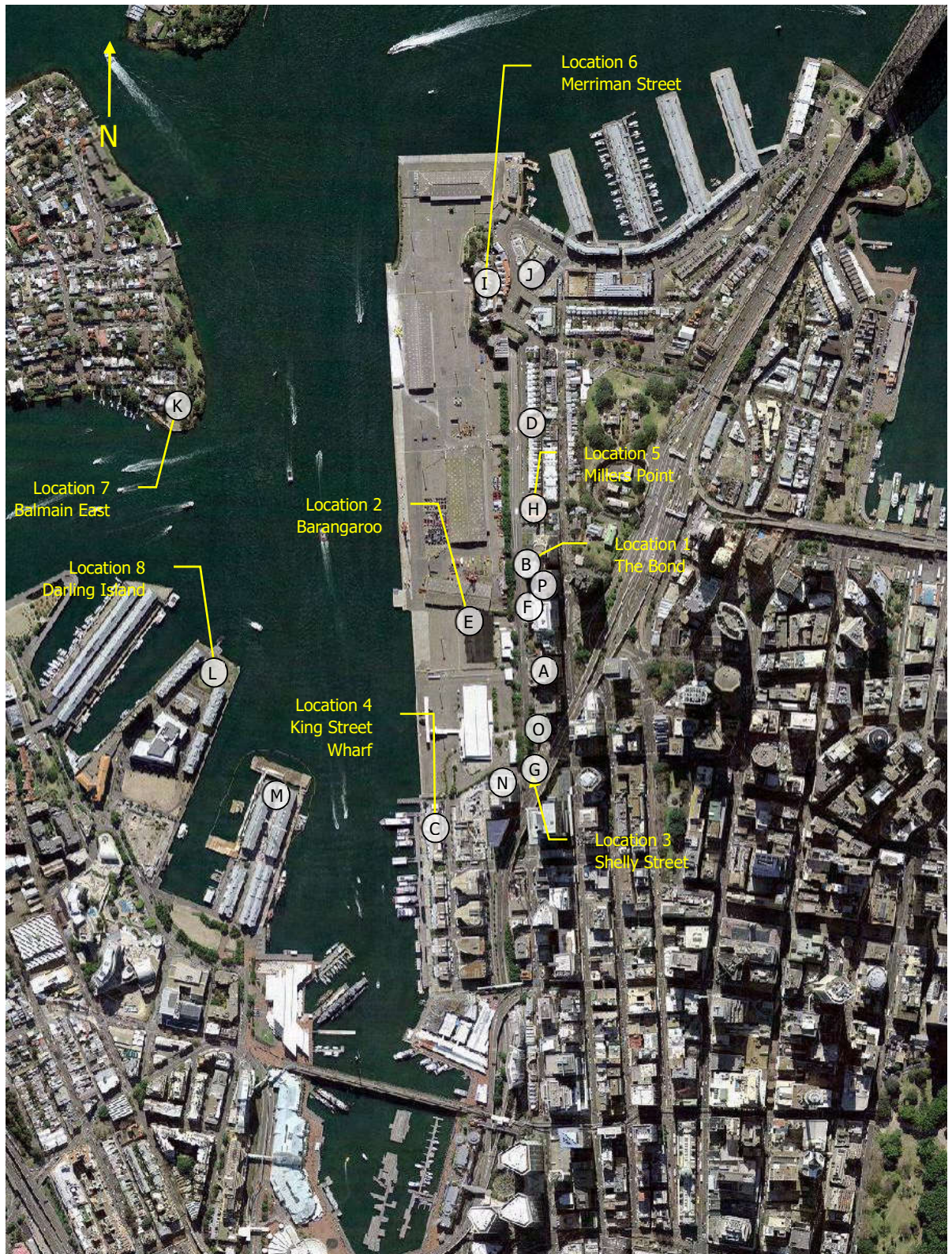
* Monitoring conducted by Arup and Wilkinson Murray.

The noise monitoring equipment used for the Wilkinson Murray noise measurements consisted of ARL Type EL-215 environmental noise loggers set to A-weighted, 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 and is considered suitable to use for assessment purposes. The details of the noise measurement equipment and calibration can be referred to within the report.

The 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 (see Glossary for definitions). 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.

Figure 3-1 Aerial showing Noise Monitoring Locations



*Source Land and Property Management Authority

Table 3-3 summarises the noise results, for daytime, evening and night time periods as defined in the EPA's Construction Noise Guidelines (CNG) and the NSW Industrial Noise Policy (INP). Additionally, noise monitoring results for Saturday (7.00am-5.00pm) has been included as Lend Lease proposes to operate outside standard CNG hours during that time.

Table 3-3 Summary of Measured Noise Levels

Noise Logging Site	RBL (dBA)				L _{Aeq,period} (dBA)			
	Daytime 7am-6pm	Evening 6-10pm	Night Time 10pm-7am	Saturday 7am-5pm	Daytime 7am-6pm	Evening 6-10pm	Night Time 10pm-7am	Saturday 7am-5pm
1	53	53	49	51	62	61	57	60
2	52	50	45	50	56	54	50	56
3	60	59	49	57	67	66	62	66
4	52	60	46	48	60	62	60	60
5	47	44	41	45*	58	55	51	55
6	46	44	40	46*	58	55	50	56
7	49	45	40	46*	67	51	47	56
8	47	44	39	50*	54	49	46	56

* Determined from the afternoon on Saturday 4 September 2010 as the morning was affected by rain.

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

4 CONSTRUCTION NOISE ASSESSMENT

4.1 Construction Noise Criteria

The following sections detail the applicable site-specific noise and vibration criteria based on the guidelines from EPA, being:

- Interim Construction Noise Guideline; and
- Road Noise Policy (RNP).

4.1.1 Construction Noise Management Levels

The EPA released the "Interim Construction Noise Guideline" (CNG) in July 2009. The guideline provides noise goals that assist in assessing the impact of construction noise.

For residences, the basic daytime construction noise goal is that the $L_{Aeq, 15min}$ noise level should not exceed the background noise (RBL) by more than 10dBA. This is for standard hours: Monday to Friday 7.00am to 6.00pm, and Saturday 8.00am to 1.00pm. Outside the standard hours, the criterion would be background + 5dBA. Table 4-1 details the CNG noise goals.

Table 4-1 Construction Noise Goals at Residences using Quantitative Assessment

Time of Day	Management Level $L_{Aeq, (15min)}$	How to Apply
Recommended		
Standard Hours:		
Monday to Friday	Noise affected RBL + 10dBA	The noise affected level represents the point above which there may be some community reaction to noise.
7am to 6pm		Where the predicted or measured $L_{Aeq, (15min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise.
Saturday		
8am to 1pm		The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
No work on		
Sundays or Public		
Holidays		
	Highly noise affected 75dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided.

Time of Day	Management Level $L_{Aeq, (15min)}$	How to Apply
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2.

In addition, the following construction noise management levels $L_{Aeq, 15 min}$ are recommended for other receivers and areas.

- Active recreation areas (such as parks): external $L_{Aeq, 15 min}$ 65dBA
- Industrial premises: external $L_{Aeq, 15 min}$ 75dBA
- Offices, retail outlets: external $L_{Aeq, 15 min}$ 70dBA
- Classrooms at schools and other educational institutions: internal $L_{Aeq, 15 min}$ 45dBA

Based on the above, Table 4-2 presents the applicable noise management levels for construction activities at surrounding receivers that have been adopted for all applications. It is noted that at the time of construction the new residential buildings at R8 and R9 will be occupied. Therefore noise levels at the northern end of building R9 have been predicted based on measurement at Location 1 (Hickson Road Site).

Table 4-2 Site-Specific Construction Noise Management Levels

Location	Construction Noise Management Level, $L_{Aeq} - dBA$				Highly noise affected Noise Level, $L_{Aeq} - dBA$
	Day	Evening	Night	Saturday (7am – 5 pm)	
1 – Hickson Road Residences	63	58	54	56	75
5 – High Street Residences	57	49	46	50	75
6 – Merriman St Residences	56	49	45	51	75
7 – Balmain East Residences	59	50	45	51	75
8 – Darling Island Residences	57	49	44	55	75
9 – Residential Building R8	63	58	54	56	75
All Commercial Properties			70		
Schools / Preschools			65 / 55*		
Parks / Outdoor Play Areas			65		

* The external NML of 65 / 55dBA is based on a 20/ 10dBA reduction through a closed and open window respectively to meet an internal level of 45dBA.

4.1.2 Traffic Noise Criteria

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

Table 4-3 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	L _{Aeq} , (15 hour) 60 (external)	L _{Aeq} , (9 hour) 55 (external)
	3. Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments		
Local roads	4. Existing residences affected by noise from new local road corridors	L _{Aeq} , (1 hour) 55 (external)	L _{Aeq} , (1 hour) 50 (external)
	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		

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

- L_{Aeq,1hr} day 55dBA; and
- L_{Aeq,1hr} night 50dBA

In addition, 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'".

4.2 Construction Equipment & Noise Source Levels

Sound Power Levels (SWLs) for typical construction plant are identified in Table 4-4. These SWLs have been measured at other similar construction sites. The table gives both Sound Power Level and Sound Pressure Levels (SPL) at 7m from the equipment. Sound Power Level is independent of measurement position.

Table 4-4 Typical Construction Plant Sound Levels – dBA

Plant	Sound Power Level	Sound Pressure Level at 7m
Mobile Crane	104	79
Concrete Truck	109	84
Angle Grinder	109	84
Concrete Pump	112	87
Concrete Saw	116	91
Mobile Crane	98	73
Dump Truck	108	83
Compressor	100	75
Ground Water Pump, extraction and treatment plant	106	81
Bobcat	103	78
Hand Tools	90	65
External Hoist	94	69
Tower Crane	104	79

4.3 Construction Noise Predictions

Assessment of likely construction noise at surrounding commercial and residential receivers has been assessed for the Building R4A construction works. These works will be conducted when much of the Barrangaroo South development is complete or the structure of the buildings is well progressed. Therefore, noise modelling has been conducted with many of the buildings included.

Site-related noise emissions were modeled with the "CadnaA" noise prediction program, using the ISO 9613 noise prediction algorithms. 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.

Modelling has been conducted for a number of construction scenarios. The three works scenarios considered specifically for Building R4A are summarised in Table 4-5.

Table 4-5 Construction Scenarios for the Residential Building R4A Construction Works

Scenario	Description	Works
A	Building Construction	This scenario includes concreting and structural works. 2 concrete pumps, 2 forklifts, 2 compressors, 2 cranes, 2 hoists and compressors are assumed to operate in 15minutes. Also concrete trucks and normal delivery trucks assumed to be 8 movements in 15minutes.
B	Facade	This scenario assumes that the construction of the facade occurs in isolation. Forklift, truck, cranes and power tools assumed. 4 truck movements in 15minutes assumed.
C	Fitout	Internal fitout works assume internal works with power tools and internal lift access.

In addition a cumulative noise scenario (Scenario D) of acoustically significant works consisting of R4A along with water treatment plant and 1B basement works have been modelled based on a period in 2020 where all three towers are being constructed, as follows:

- Building R4A Building Construction
- Basement 1B Structure
- Wastewater Plant Operation

Noise modelling has been conducted for each of the above scenarios, with plant located across the construction site as follows.

Line Noise Source – Truck routes are modelled as line noise sources with the number of trucks on the haulage route in a 15 minute period applied to these sources.

Point Noise Sources – Fixed plant and equipment are modelled as point sources.

The modelling assumes a “typical worst case” scenario whereby all plant, is running continuously. As such the modelling represents likely noise levels that would occur during intensive periods of construction. Therefore the presented noise levels can be considered in the upper range of noise levels that can be expected at surrounding receivers when the various construction scenarios occur.

Once noise sources have been applied to the model, the resultant noise levels at identified

surrounding receivers are predicted. These results are then compared with established site-specific noise criteria.

The following tables detail results of noise modelling for each scenario.

Table 4-6 Predicted Construction Noise Levels at Residence – $L_{Aeq}(15 \text{ min})$ – dBA

Residential Receiver	Predicted Noise Level	Weekday NML	Exceedance Level	Sat NML	Exceedance Level
Scenario A – Structure Construction					
1 – Hickson Road Residences	61	63	0	56	5
5 – High Street Residences	54	57	0	50	4
6 – Merriman Street Residences	31	56	0	51	0
7 – Balmain East Residences	41	59	0	51	0
8 – Darling Island Residences	43	57	0	55	0
9 – Sydney Wharf Residences	46	57	0	55	0
10 – R8 Residences	58	63	0	55	3
Scenario B – Facade					
1 – Hickson Road Residences	53	63	0	56	0
5 – High Street Residences	54	57	0	50	4
6 – Merriman Street Residences	31	56	0	51	0
7 – Balmain East Residences	41	59	0	51	0
8 – Darling Island Residences	43	57	0	55	0
9 – Sydney Wharf Residences	46	57	0	55	0
10 – R8 Residences	58	63		55	3
Scenario C – Fitout					
1 – Hickson Road Residences	43	63	0	56	0
5 – High Street Residences	49	57	0	50	0
6 – Merriman Street Residences	22	56	0	51	0
7 – Balmain East Residences	30	59	0	51	0
8 – Darling Island Residences	30	57	0	55	0
9 – Sydney Wharf Residences	29	57	0	55	0
10 – R8 Residences	38	63		55	0
Scenario D – Cumulative 1B (Basement, R4A and Water Plant)					
1 – Hickson Road Residences	65	63	0	56	9
5 – High Street Residences	58	57	0	50	8
6 – Merriman Street Residences	36	56	0	51	0
7 – Balmain East Residences	46	59	0	51	0
8 – Darling Island Residences	44	57	0	55	0
9 – Sydney Wharf Residences	49	57	0	55	0
10 – R8 Residences	57	63	0	55	2

Predicted noise levels at commercial receivers are presented in Table 4-7.

Table 4-7 Predicted Construction Noise Levels at Commercial – $L_{Aeq}(15 \text{ min})$ – dBA

Residential Receiver	Predicted Noise Level	Weekday NML	Exceedance Level	Sat NML	Exceedance Level
Scenario A – Structure Construction					
Lime Street, (King Street Wharf)	43	70	0	70	0
30 Hickson Road	56	70	0	70	0
Shelly Street	30	70	0	70	0
The Sussex Hotel	37	70	0	70	0
Scenario B – Facade					
Lime Street, (King Street Wharf)	43	70	0	70	0
30 Hickson Road	56	70	0	70	0
Shelly Street	30	70	0	70	0
The Sussex Hotel	37	70	0	70	0
Scenario C – Fitout					
Lime Street, (King Street Wharf)	< 30	70	0	70	0
30 Hickson Road	45	70	0	70	0
Shelly Street	20	70	0	70	0
The Sussex Hotel	< 30	70	0	70	0
Scenario D – Cumulative 1B Basement, R4a and Water Plant)					
Lime Street, (King Street Wharf)	48	70	0	70	0
30 Hickson Road	62	70	0	70	0
Shelly Street	33	70	0	70	0
The Sussex Hotel	50	70	0	70	0

Predicted noise levels at the preschools at are presented in Table 4-8 to 4-10.

Table 4-8 Predicted Noise Levels at Ku Lance Pre School– $L_{Aeq,15min}$

Predicted Noise dBA	Day Playground			Day Internal Noise		
	Criteria dBA	Exceedance dBA	Compliance	Criteria dBA	Exceedance dBA	Compliance
Scenario A – Structure Construction						
53	65	0	Yes	55	0	Yes
Scenario B – Facade						
54	65	0	Yes	55	0	Yes
Scenario C – Fitout						
37	65	0	Yes	55	0	Yes
Scenario D – Cumulative 1B (Basement 1B, R4A and water)						
56	65	0	Yes	55	1	Marginal

Table 4-9 Predicted Noise Levels at AON Pre School– $L_{Aeq,15min}$

Predicted Noise dBA	Day Playground			Day Internal Noise		
	Criteria dBA	Exceedance dBA	Compliance	Criteria dBA	Exceedance dBA	Compliance
Scenario A – Structure Construction						
57	65	0	Yes	55	2	No
Scenario B – Facade						
49	65	0	Yes	55	0	Yes
Scenario C – Fitout						
37	65	0	Yes	55	0	Yes
Scenario D – Cumulative 1B (Basement 1B, R4A and water)						
62	65	0	Yes	55	8	No

Table 4-10 Predicted Noise Levels at Proposed T1 Pre School– $L_{Aeq,15min}$

Predicted Noise dBA	Day Playground			Day Internal Noise		
	Criteria dBA	Exceedance dBA	Compliance	Criteria dBA	Exceedance dBA	Compliance
Scenario A – Structure Construction						
56	65	0	Yes	65	0	Yes
Scenario B – Facade						
50	65	0	Yes	65	0	Yes
Scenario C – Fitout						
36	65	0	Yes	65	0	Yes
Scenario D – Cumulative 1B (Basement 1B, R4A, R4B and R5)						
60	65	0	Yes	65	0	Yes

4.4 Discussion of Results (Scenarios A, B & C)

It is noted that construction noise from the proposed Residential Building R4A works will not generate excessive levels of construction noise at surrounding receivers during normal weekday works. Exceedances of up to 5 dBA may occur at surrounding residences on Saturdays however these levels are not considered excessive by construction standards and can be managed by existing construction management procedures.

A review of the results indicated that noise from the proposed construction works associated with the residential Building R4A will comply with all commercial noise management levels.

4.5 Noise and Vibration Mitigation Measures

The construction equipment associated with the structure and facade construction are not significant generators of vibration there are no specific noise and vibration measures that have been identified that need to be adopted for building R4A works.

It is noted that a Construction Noise and Vibration Management Sub Plan titled "*Noise & Vibration Management Sub-Plan Barangaroo South Document No: H010106LLC004*" has been prepared by Lend Lease for the Barangaroo South Site in its entirety. It is intended that this plan be a "live document" whereby project-specific noise and vibration control measures are incorporated into the noise and vibration sub plan. The following project specific mitigation measures are recommended:

4.5.1 General Measures

- Plant Noise Audit – Noise emission levels of all critical items of mobile plant and equipment should be checked for compliance with noise limits appropriate to those items prior to the equipment going into regular service. To this end, testing should be

established with the contractor.

- Operator Instruction – Operators should be trained in order to raise their awareness of potential noise problems and to increase their use of techniques to minimise noise emission.
- Equipment Selection – All fixed plant at the work sites should be appropriately selected, and where necessary, fitted with silencers, acoustical enclosures and other noise attenuation measures in order to ensure that the total noise emission from each work site complies with EPA guidelines.
- Site Noise Planning – Where practicable, the layout and positioning of noise-producing plant and activities on each work site should be optimised to minimise noise emission levels.
- Install a noise barrier between the site and street frontages. This should be a minimum 17mm thick structural plywood or equivalent panel. (Included in noise modelling)

The adoption of the above measures and application of the procedures in the Project Noise and Vibration Management Sub Plan are aimed at working towards achieving the noise management levels established at surrounding receivers.

4.5.2 Community Liaison & General Approaches to Mitigation

An effective community relations programme should be put in place to keep the community that has been identified as being potentially affected apprised of progress of the works, and to forewarn potentially affected groups (e.g. by letterbox drop, meetings with surrounding tenants, etc.) of any anticipated changes in noise and vibration emissions prior to critical stages of the works, and to explain complaint procedures and response mechanisms. This programme will be included in Lend Lease's *Community and Stakeholder Engagement Strategy* that has been specifically developed for the Barangaroo Project.

Close liaison should be maintained between the communities overlooking work sites and the parties associated with the construction works to provide effective feedback in regard to perceived emissions. In this manner, equipment selections and work activities can be coordinated where necessary to minimise disturbance to neighbouring communities, and to ensure prompt response to complaints, should they occur.

4.5.3 Noise & Vibration Management Plan

Lend Lease have prepared a construction Noise and Vibration Management Sub-Plan for the Barangaroo South Stage 1B site. The sub-plan is revised as needed for additional assessments and planning approvals. Measures required by this assessment and any subsequent planning approval requirements, will be incorporated into a revised version of the sub-plan. Areas that have been addressed in plan include:

noise and vibration monitoring;

- response to complaints;
- responsibilities;
- monitoring of noise emissions from plant items;

- reporting and record keeping;
- non-compliance and corrective action; and
- Community consultation and complaint handling.

Details of monitoring procedures are shown in Table 4.11 extracted from the Sub Plan:

Table 4.11 Sub- Plan Monitoring Procedures

Detail	Frequency	Standards	Reporting	Action if non-complying	Responsibility
Continuous unattended noise monitoring at locations shown in Appendix D, both L_{Aeq} and $L_{Aeq}(1000Hz)$ (using web-based monitoring).	Real-time monitoring using a web-based system.	NMLs in Appendix D, Table 4.	Monthly	Follow noise response table below. Seek professional acoustic input if required.	EHS Manager (Environment) Noise Specialist
Construction equipment monitoring (noise audit) to assess compliance with expected noise levels, and to allow any increase in noise levels to be detected and addressed.	If equipment is perceived as being noisy or noisier than other similar equipment, or in response to complaints.	Levels in Appendix D, Table 2 – Typical Plant & Equipment Noise Levels. AS 2012	N/A	Assess equipment and undertake remedial action such as repair, noise-proofing, redeployment or removal.	Subcontractors Noise Specialist
Attended noise monitoring: • in response to complaints, as per noise response table below, • to refine construction methods to minimise noise, • to differentiate between construction noise sources and other sources (eg. road traffic or Crown works), • to assess internal construction noise levels at commercial premises, if needed, or • as needed during site establishment.	As required.	NMLs in Appendix D, Table 4. AS 1055	As required as part of monthly reports	Follow noise response table below. Seek professional acoustic input if required.	EHS Manager (Environment) Noise Specialist
Attended vibration monitoring: Trial testing at locations in Appendix D where equipment identified as having potential to exceed human comfort criteria is proposed.	As required for changes in works or complaints. As required to determine least impact work distances and equipment.	EPA guidelines BS6472 DIN4150 Part 3	As required as part of monthly reports	Cease relevant activities, and/ or implement additional measures. Seek professional vibration input if required.	EHS Manager (Environment) Vibration Specialist
Integrity of site hoarding.	Weekly.	Hoarding intact.	Weekly Site Checklist	Construction Manager to repair or replace	Foreman

Table 4.12 Additional Noise Mitigation Procedures

Scenario	Mitigation measures $L_{Aeq}(15 \text{ minute})$ noise level above NML	
	0 to 10 dBA Noticeable	> 10 dBA Clearly audible – potentially intrusive
Approved hours, no complaints received		• Review noise data and current work practices.
Approved hours, complaint(s) received	• Respond to complainant • CRM entry indicating additional reasonable and feasible measures (see Appendix G)	• Respond to complainant • CRM entry indicating additional reasonable and feasible measures (see Appendix G)
Planned out of approved hours, no complaints received	• Letter box drops prior to works • Inform relevant authorities prior to works	• Letter box drops prior to works • Inform relevant authorities prior to works • Briefing of residents via CCLG • CRM entry indicating close out actions
Planned out of approved hours, complaint(s) received	• Letter box drops prior to works • Inform relevant authorities prior to works • Respond to complainant • CRM entry indicating additional reasonable and feasible measures for next planned out of approved hours work.	• Letter box drops prior to works • Inform relevant authorities prior to works • Respond to complainant • CRM entry indicating additional reasonable and feasible measures for next planned out of approved hours work.

4.6 Cumulative Noise Impact (Scenario D)

The other project that will be under construction and nearing completion when the residential building R4A is the 1B basement structure is (Indicatively around December 2020).

All other developments at South Barangaroo will be complete at this time.

Table 4-8 presents cumulative noise impact noting that at the time of the cumulative assessment there will be reduced 1B structural works on the site due to tower construction.

Table 4-13 Cumulative Construction Noise Increases – dBA

Receiver	Construction Noise Level		Increase
	Building R4A Works Only (structure)	Cumulative Scenario	
1 – Hickson Road Residences	61	65	4
5 – High Street Residences	54	58	4
10 – R8 Residences	58	60	2

Based on a review of the above noise levels the noise from the R4A building will be below overall cumulative noise levels at the surrounding most affected receivers with the exception of residences on and around R8 residence where building R4A is closest. In this location noise from R4a will be of a similar magnitude to other construction noise sources.

Construction noise levels in play areas of identified Preschools are predicted to comply with the 65dBA noise objective for active outdoor recreation areas with the exception of the T1 outdoor area of Preschool. However as this outdoor area is not currently used there will be no affected receivers at this location.

In the case of the internal areas of the Ku Lance Preschool, a relatively small exceedance of internal noise objectives by up to 1 dBA is expected, if windows are open. This exceedance is considered acoustically insignificant.

In the case of the AON Preschool exceedance of internal noise criteria is indicated if windows and doors are open. Therefore, at times, windows and doors should be closed if it is determined by staff that noise is too loud. As this area is air conditioned this measure can be readily implemented.

It is further noted that when windows are closed no exceedance of internal objectives is anticipated. Accordingly, windows could potentially be closed during intensive periods of construction, if required. It is noted that these predicted noise levels can be considered **typical worst case** noise levels whereby noise levels can be expected to reduce as works progress on the site.

Accordingly no specific additional noise mitigation is required to address cumulative noise impacts at this stage of the development of South Barangaroo.

The above consideration does not preclude the application of the management procedures contained in the site environmental management plan which of course should be consistently applied to the construction works.

4.7 Construction Traffic Noise

Morning peak traffic flows are presented in Table 4-14 based on information provided by ARUP, the traffic consultants, report titled "Lend Lease Barangaroo South - Building R4a Transport Assessment."

These volumes are based on traffic flow determined in 2013 and apportioned in the same

percentages to projected operational traffic flows in December 2020. In the case of construction traffic these has been applied on a 50/50 based for north and southbound flows.

Table 4-14 AM Traffic Flows on Hickson Road South of Site Entrance– Vehicles

Condition	Northbound AM Peak Hour	Southbound AM Peak Hour
2013 Traffic	621 (4.7%HV)	254 (20.5%HV)
December 2020 Operational Traffic	838 (5.6% HV)	325 (3.5 % HV)
December 2020 with R4A Construction	846 (6.5% HV)	333 (25.1 % HV)
December 2020 Total Operational and Construction	871 (7.7% HV)	358 (27.4 % HV)

*Data is not available for existing traffic volumes over the 15 hour day and 9 hour night.

AM peak hour traffic noise levels at the nearest residences on Hickson Road have been predicted using the *Calculation of Road Traffic Noise (CORTN)* traffic noise prediction technique based on a "worst-case" assumption that all construction traffic travels south from the site access.

The point in time where the maximum impact of traffic noise from R4a is around December 2020. At this point, there will be operational traffic from some of the Barangaroo South projects and these have been included in traffic figures.

Table 4-15 details predicted peak hour traffic noise levels with and without R4a construction traffic.

**Table 4-15 Predicted AM peak Traffic Noise Levels at Hickson Road Residences
– $L_{Aeq,1hr}$ – dBA**

Construction Traffic	Calculated Traffic Noise Level
Base 2013 Traffic	67.1
December 2020 Operational Traffic	68.6
December 2020 with R4a Construction	68.7
December 2020 Total Operational and All Construction Traffic	69.5

A review of traffic noise predictions, with respect to the 2 dB increase objective, indicates the following;

- R4a traffic will increase future traffic noise levels at Hickson Road residences by approximately 0.1 dBA;
- When Stage 1B basement and R4a construction traffic is included an increase of 0.9 dBA is predicted above operational 2020 traffic. Traffic noise levels are therefore not predicted to exceed the 2dBA objective due to construction and operational traffic in December 2020; and
- The predicted changes in hourly peak hour flows are considered representative of the changes over a 15-hour daytime period.

5 OPERATIONAL NOISE AND VIBRATION

Operational noise from the proposed R4A building will be from mechanical plant located predominantly on the rooftop of the development and plant in dedicated plant areas.

5.1 Operational Noise Criteria

Noise impact from the general operation of the proposed residential buildings is to be assessed with respect to the site specific noise criteria based on site monitoring and the NSW Industrial Noise Policy (INP). The assessment procedure in terms of the INP has two components:

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

In accordance with the INP, noise impact is assessed in terms of both intrusiveness and amenity. Based on the background and ambient noise monitoring carried out at the nearest affected residential locations, as detailed in Table 3-3, applicable site specific noise criteria are detailed in Table 5.1.

Table 5-1 Site Specific Operational Noise Criteria for South Barangaroo*

Site	Type of Receiver	L _{Aeq,15min} (dBA)		
		Daytime 7-6pm	Evening 6-10pm	Night Time 10pm-7am
1 – Hickson Road Residences	Residential	58	50	45
5 – High Street Residences	Residential	52	49	45
6 – Merriman Street Residences	Residential	51	49	45
7 – Balmain East Residences	Residential	54	45	40
8 – Darling Island Residences	Residential	52	49	44
9 – Sydney Wharf Residences	Residential	52	49	44
10 – R9 Residences	Residential	58	50	45
Commercial Receivers	Commercial	65	65	65

*Criteria has been derived from previous project applications at South Barrangaroo.

5.2 Operational Noise Assessment and Recommendations

Detailed specifications of mechanical services equipment that would otherwise allow an acoustic assessment of noise emission from the site are not available at this stage of the project as selection and design is conducted after project approval. In line with the approvals for other development within Barangaroo, and not unlike other similar development within the City of Sydney area, limitations on operational noise emission should form a conditional requirement of the development, to be satisfied prior to the issue of the construction certificate.

Mechanical plant such as rooftop exhausts, air-conditioning and refrigeration associated with the development will be selected, having regard to nearby residential and commercial properties surrounding the development, and to future development within Barangaroo South.

It is noted that all three residential towers at the One Sydney Site are the closest in proximity to Hickson Road and High Street residences therefore at assessment stage the combined noise emissions from the three towers will be address and future noise mitigation of services.

5.3 Road Traffic Noise Assessment

Arup, the traffic consultants, presents the operational traffic flows in Table 6-5 with respect to all three residential components that will utilise Stage 1B basement as detailed in ARUPs report *One Sydney Harbour – Building R4A – Transport Management and Accessibility Plan (TMAP)*.

Table 6-5 AM Traffic Flows on Hickson Road

Condition	Northbound AM Peak Hour	Southbound AM Peak Hour
2013	621 (4.7%HV)	254 (20.5%HV)
1B Basement (R4A, R4b and R5)	23	86
Traffic Flows at Completion in 2022	820 (2.0% HV)	434 (1.8% HV)

PM peak hour traffic noise levels at the nearest residences on Hickson Road have been predicted using the *Calculation of Road Traffic Noise (CORTN)* traffic noise prediction technique based on a "worst case" assumption that all traffic travels south.

Table 6-6 details predicted traffic noise levels due peak traffic movements with and without the Hotel operational traffic.

**Table 6-6 Predicted PM peak Traffic Noise Levels at Hickson Road Residences –
L_{Aeq,1hr} – dBA**

Construction Traffic	Calculated Traffic Noise Level
Base 2013 Traffic (Existing)	67.1
1B Basement (R4A, R4b and R5)	55.6
Total Operational at Completion 2022	67.5

A review of predictions indicates the following:

- Overall operational traffic noise levels at residences on Hickson Road will increase be 0.5 dBA once the development is complete.
- The traffic noise contribution of 1B Basement (R4A, R4B and R5) alone is predicted to be well below existing nose levels on Hickson Road; and
- Traffic noise levels are not predicted to exceed the 2dBA objective due to all South Barangaroo operations alone

6 CONCLUSION

A noise review of the R4A residential building has been conducted for Barangaroo South. Site-specific noise criteria that are applicable to this project have been presented. These have been determined for surrounding receivers to be applied on all state significant development applications.

A noise assessment has been conducted of the proposed construction activities associated with the construction of the R4A and adjacent development within stage 1B that will occur concurrently to determine the potential for noise and vibration impact at surrounding receivers. No exceedance of noise management levels is expected at surrounding receivers is predicted during normal weekday construction. On Saturdays exceedances of up to 5 dBA are predicted during intensive periods of construction.

Vibration associated with on-site construction activities is considered to be negligible. No specific management and mitigation measures to reduce noise impact at receivers have been identified beyond the normal measures.

Construction traffic noise has been assessed and the increase in noise has determined to be marginal. A Noise and Vibration Management Plan has been prepared to assist Lend Lease in managing the environmental issues associated with this project.

Site specific operational noise criteria has been determined for the project based on ambient noise monitoring. It is envisaged that compliance will readily be achieved at surrounding noise sensitive receptors and will be addressed during the detailed design phase.

The contribution of the project to operational traffic noise levels at residences on Hickson Road will be negligible when compared to existing or future traffic noise levels.

APPENDIX A

ANALYSIS OF POSSIBLE NOISE REDUCTION MEASURES

Analysis of reasonable and feasible noise reduction measures

The following table provides an evaluation of whether measures are reasonable and feasible to implement.

Noise Reduction Measure	Measure type	Source	Day or Night	Reasonable and feasible?
In previous documents				
Encapsulate engine chambers and fit silencers to equipment. This typically provides 5dBattenuation, but can achieve attenuation up to 10dB(A) .	Quiet equipment		Day & night	Yes – install on equipment operating long term on-site.
Minimise equipment use especially during off peak hours.	Procedure		Night	Yes – reduce equipment used whenever practical.
Use temporary barriers or berms to shield construction equipment. Examples include: – Stacking containers around noisy equipment; – Constructing a shield around operation equipment such as dewatering pumps.	Shielding		Day & night	Yes – provide hoardings around the site, and barriers for pumps and static plant if needed. Provide barriers during permanent stormwater works.
Restricting times when noisy work is carried out (respite periods).	Procedure		Day	Yes – provide periods of relief when practical during noise intensive activities such as rock breaking.
Placement of work compounds, parking areas, equipment and material stockpile sites away from noise-sensitive locations.	Design		Day & night	Yes – current location of these facilities is away from noise-sensitive receivers.
Where noise barriers/walls are to be constructed, program this as early as possible to reduce noise impacts on neighbouring residents.	Procedure		Day & night	Yes – hoardings will be built at the commencement of construction.
Ensure that least noisy construction methods, vehicles, plant and equipment are used, and adopting alternative construction measures.	Quiet equipment		Day & night	Yes – bored piling preferred. Otherwise generally not feasible due to specialised construction equipment required.
Consider alternatives to, or curtailing of reversing alarms.	Quiet equipment		Day & night	Yes – non-tonal alarms for on-site equipment.
Prevent vehicles and plant queuing and idling outside construction hours.	Procedure		Day & night	Yes – procedural.
Identify measures to be implemented to ensure that where movement alarms are fitted to vehicles, plant or equipment entering or operating on the site, such alarms are of a type	Quiet equipment		Day & night	Yes – non-tonal alarms.

Noise Reduction Measure	Measure type	Source	Day or Night	Reasonable and feasible?
that minimised noise at noise sensitive receivers.				
Minimise use of impact piling techniques.	Quiet equipment / design		Day	Yes, bored piling preferred. Dependant on piling equipment used.
Based on current construction methods				
Silenced generators.	Quiet equipment		Day & night	Yes
Quiet compressors & pumps.	Quiet equipment		Day & night	Yes
Notify community two days in advance of noisy or planned out of hours activities.	Procedure		Day & night	Yes
Verification of noise model by monitoring equipment.	Procedure		Day & night	Yes, when operating as per predicted scenarios.