

BARANGAROO SOUTH - STAGE 1B PUBLIC DOMAIN CONSTRUCTION NOISE REPORT

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PREPARED FOR

LEND LEASE MILLERS POINT
LEVEL 14, TOWER THREE, INTERNATIONAL TOWERS SYDNEY
EXCHANGE PLACE, 300 BARANGAROO AVENUE
BARANGAROO NSW 2000

DOCUMENT CONTROL

Version	Status	Date	Prepared By	Reviewed by
A	Final	28 November 2016	Brian Clarke	Sam Demasi

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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.

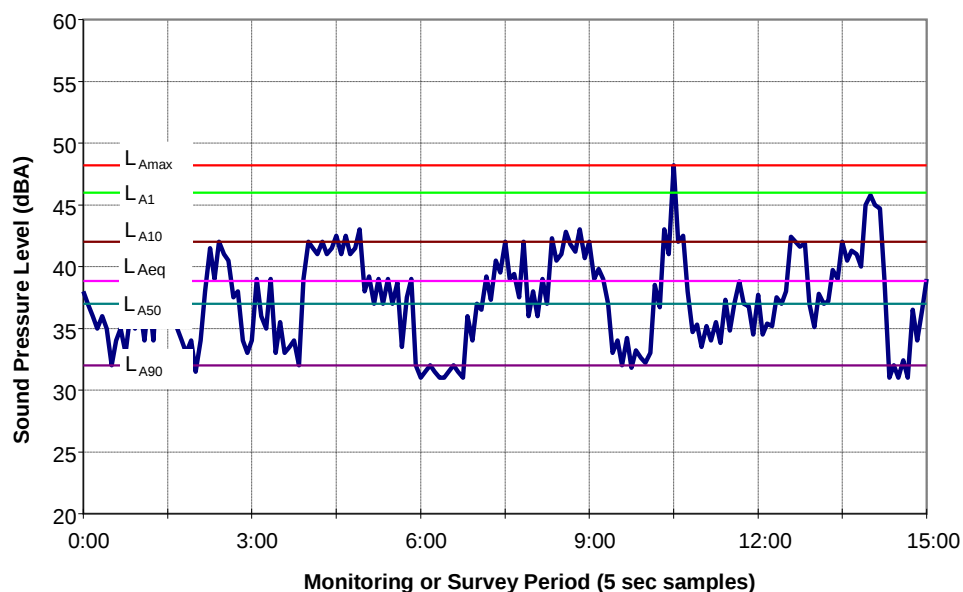
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

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 accompanies a State Significant Development Application (SSDA) (SSD 7944) submitted to the Minister for Planning and Infrastructure pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act). The SSDA seeks approval for public domain works within Stage 1B at Barangaroo South as described in the Overview of Proposed Development section of this report.

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

During the operation stage of the development there are no acoustically significant noise producing sources associated with the Stage 1B Public Domain works. Therefore, no assessment is warranted and has not been dealt with any further in this assessment.

2 OVERVIEW OF PROPOSED DEVELOPMENT

The Public Domain SSDA seeks approval for the all public domain works within 'Stage 1B' of the Barangaroo South Site. These works include typical public domain features such as street paving, street furniture, lighting and planting.

It is noted that the proposed construction activities will not generate significant levels of vibration. Therefore, the issue of construction vibration is not considered further in relation to the above works.

Additional items are also included, such as a timber boardwalk suspended over the harbour, water taxi setdown pontoon, raised planting beds, pedestrian pavement over existing suspended concrete apron.

The latter works consist demolition works and construction at Waterman's Cove. Waterman's Cove will be created by demolishing the existing concrete apron and cutting the existing piles down below the lowest astronomical tide level. This area of apron to be removed is approximately 2200m³. The works will be carried out from a barge.

Piling required to support the new timber boardwalk and pier. The construction of the piles and timber decking will also be done from a barge and the piles will be driven into the harbour floor.

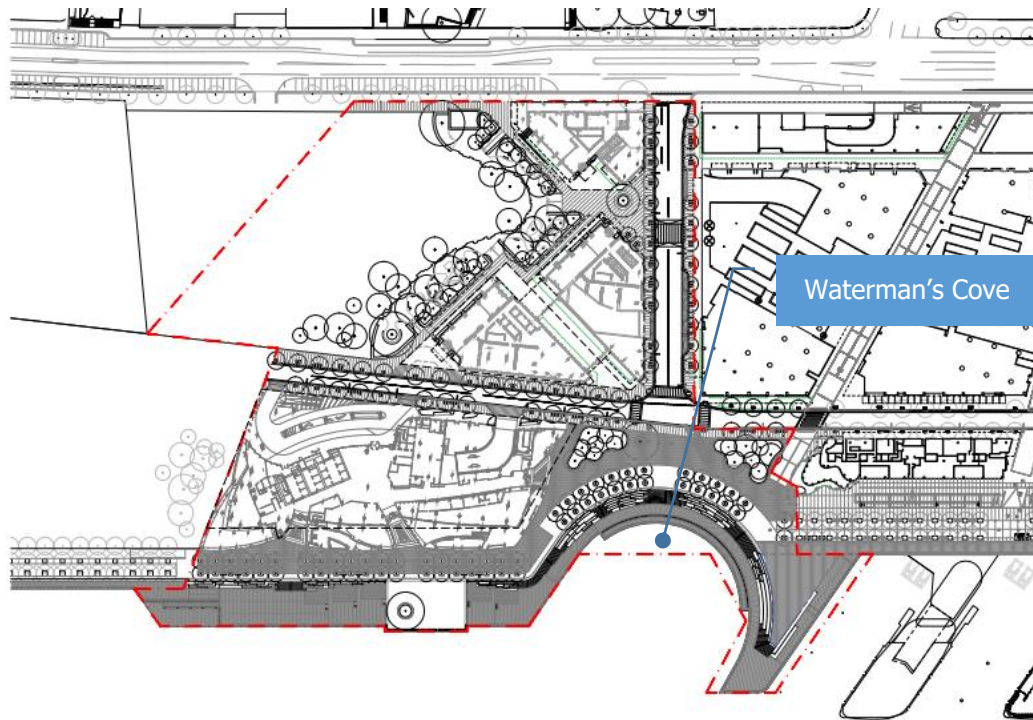
2.1 Site Description

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 Stage 1B Public Domain SSDA Site area is located within Barangaroo South and central as shown in Figure 2-1. The SSDA Site extends over land generally known and identified in the approved Concept Plan as Blocks 5, 4A, 4B and Y and the area of the foreshore between Block X and Darling Harbour.

Figure 2-1 Stage 1B Public Domain Application Site Plan



2.2 Construction

The proposed construction hours are:

- Between 7.00am and 7:00pm Monday – Friday, and;
- Between 7.00am and 5.00pm on Saturdays.

It is noted that the proposed hours for Saturdays are outside EPA's standard hours of construction. However, this extended period of public works will enable the works to be carried out in a more efficient manner, thereby shortening the overall construction period to which sensitive receptors will be exposed.

3 AMBIENT NOISE MONITORING

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.

There is also childcare proposed at podium level of T1 immediately to the south of Basement 1B is proposed. As such noise predictions have been conducted at this potential receiver.

Air conditioning exists or is proposed for both facilities.

In order to quantify the existing noise environment, long-term ambient noise levels were monitored in 2010 at eight (8) locations surrounding the site, selected to cover the range of environments in the potentially affected areas. It is noted that these measurements are considered appropriate for establishing site specific noise management levels as they are free of construction noise and as such represent a conservative representation of noise levels around the Barangaroo South Site.

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

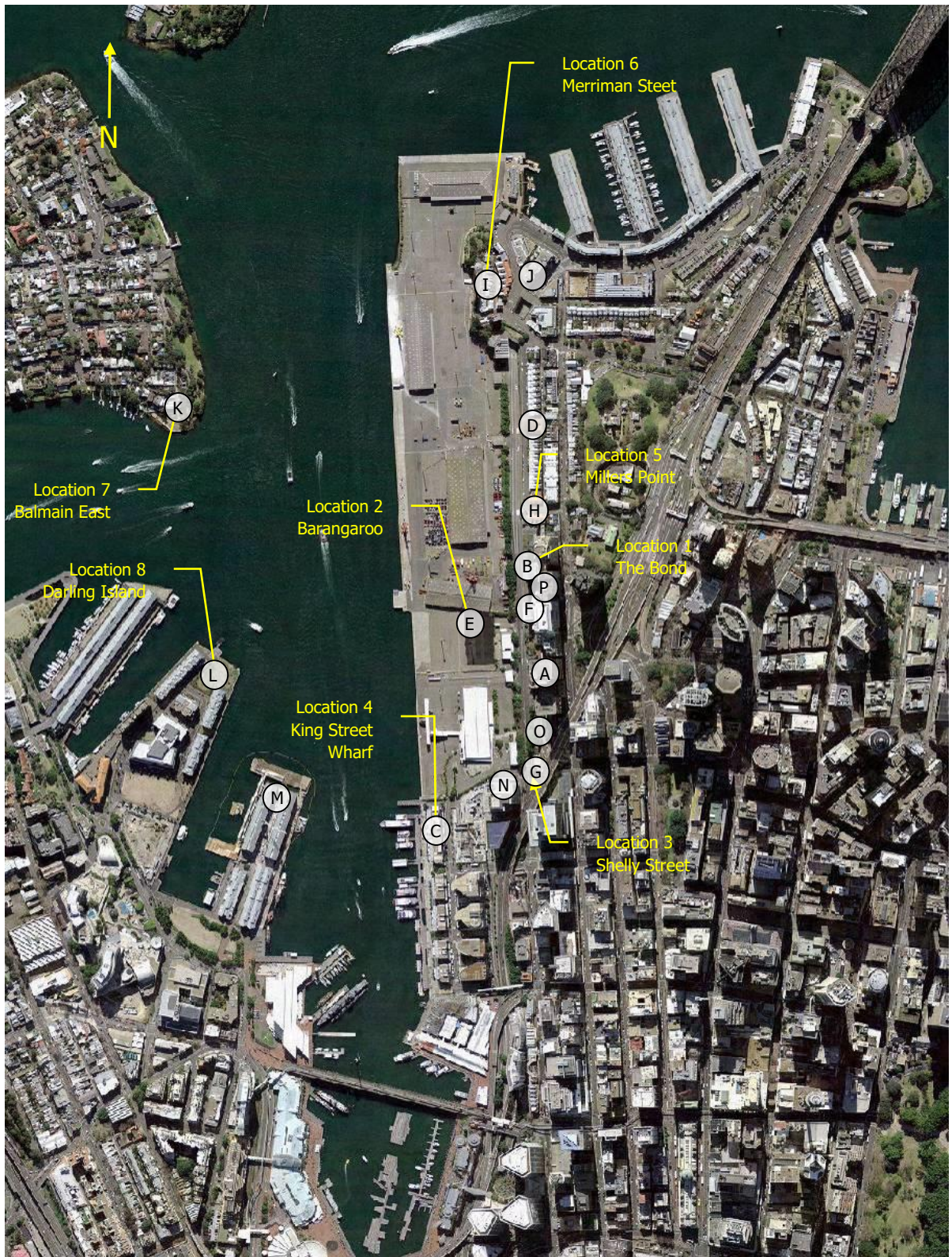
Logger	Location	Monitoring Period in 2010	Company
1	Level 4, The Bond 30-38 Hickson Rd	14 April to 29 April	Arup
2	Middle of South Barangaroo Site	14 April to 29 April	Arup
3	South West of site adjacent to Sussex St and Shelley St	14 April to 29 April	Arup
4	South of site adjacent to King Street Wharf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

The noise monitoring equipment used for the WMPL 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 their 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.

In addition, as construction works are proposed to extend into the evening period up to 7 pm the following weekday RBLs for the period of 6 pm to 7 pm have been determined;

Table 3-4 Summary of Measured Noise Levels

Residential Location	RBL (dBA)
1 – Hickson Road Residences	55
5 – High Street Residences	46
6 – Merriman Street Residences	46
7 – Balmain East Residences	48
8 – Darling Island Residences	47
9 – Sydney Wharf Residences	47

4 NOISE & VIBRATION 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 Construction Noise Criteria

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 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		The noise affected level represents the point above which there may be some community reaction to noise.
Standard Hours:		
Monday to Friday		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.
7am to 6pm	Noise affected	
Saturday	RBL + 10dBA	
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 new residential buildings at R8 and R9 are occupied. Therefore, construction noise management levels at the northern end of building R8 have been predicted based on measurements at Location 1 (Hickson Road Site).

Table 4-2 Site-Specific Construction Noise Management Levels – L_{Aeq} (dBA)

Location	Construction Noise Management Level				Highly noise affected Noise Level
	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 – Sydney Wharf Residences	57	49	44	55	75
10 – 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.

4.2 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, 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'.

5 CONSTRUCTION METHODS, EQUIPMENT & NOISE SOURCE LEVELS

Sound Power Levels (SWLs) for typical Public Domain construction plant are identified in Table 5-1. These SWLs have been measured at other similar construction sites. The table gives both Sound Power Level and Sound Pressure Levels (SPL) at 7m for the equipment. Sound Power Level is independent of measurement position.

Table 5-1 Public Domain Typical Construction Plant Sound Levels – dBA

Plant	Sound Power Level	Sound Pressure Level at 7m
Petrol Portable Generator	102	77
Wheeled Mobile Crane	98	73
Angle Grinder	109	84
Petrol Power Hand Concrete Saw	124	99
Dump Truck	108	83
Paver Cutter	113	88
Compressor (Silenced)	75	50
Bobcat	103	78
Backhoe	96	71
Hand Tools	90	65
Hand Jackhammer	115	90

In addition, typical noise levels associated with proposed works in Waterman's Cove are detailed in Table 5-2.

Table 5-2 Waterman's Cove Typical Construction Plant Sound Levels – dBA

Plant	Sound Power Level	Sound Pressure Level at 7m
Dump Truck	108	83
Concrete Crushing and Screening Plant	116	91
Concrete Saw	113	88
Hydraulic Hammer	122	97
Auger Piling Rig	112	87
Impact Piling Rig	128	103

6 CONSTRUCTION NOISE ASSESSMENT

Assessment of likely noise at surrounding commercial and residential receivers has been assessed for Stage 1B Public Domain works and Waterman's Cove works. These works will be conducted when much of the Barangaroo 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 several construction scenarios. These have been separated into the standard Public Domain works (like Stage 1A) and Waterman's Cove works which are localised to the cove area.

6.1 Public Domain Works

The three works scenarios considered for standard Public Domain works are summarised in Table 6 1.

Table 6-1 Construction Scenarios for Stage 1B Public Domain Works

Scenario	Description	Works
A	Paving Works	The installation of paving on domain area. Equipment includes: • Truck • Compressor • Paving Saw • Hand Tools
B	Landscaping	This scenario includes installation of soil, mulch and plants • Truck • Compressor • Bobcat • Hand Tools
C	Above-Ground Services (Lighting Signs etc)	This scenario includes installation of lights and signs. • Truck • Compressor

Scenario	Description	Works
		• Mobile Crane • Hand Tools • Hand Jackhammer

The public domain works will be undertaken in stages around the precinct where works will commence and be completed before progressing to another area. This is in contrast to major elements of the project where construction activities are more contained to one area.

To address this movement predictions of these works we based on equipment located in three generalised areas of the public domain being in the North around the residential towers, the West near Waterman's Cove and in the centre of the site.

Therefore, noise modelling has been conducted by locating public domain construction activities around the site in calculating noise levels at surrounding receivers. 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 table details the results of noise modelling for each Public Domain scenario.

Table 6-2 Predicted Construction Noise Levels at Residences – $L_{Aeq}(15 \text{ min})$ – dBA

Residential Receiver	Work Location			Max	Weekday	6-7	Sat
	N	Centre	W	Level	NML	NML*	NML
Scenario A – Paving							
1 – Hickson Road Residences	59	36	36	59	63	60	56
5 – High Street Residences	47	28	28	47	57	51	50
6 – Merriman Street Residences	20	15	17	20	56	51	51
7 – Balmain East Residences	27	31	41	41	59	53	51
8 – Darling Island Residences	35	37	43	43	57	52	55
9 – Sydney Wharf Residences	33	37	42	42	57	52	55
10 - R8 Residences	61	68	53	68	63	60	56
Residential Receiver	Work Location			Max	Weekday	6-7	Sat
	N	Centre	W	Level	NML	NML*	NML
Scenario B – Landscaping							
1 – Hickson Road Residences	53	35	35	53	63	60	56
5 – High Street Residences	41	24	24	41	57	51	50
6 – Merriman Street Residences	16	15	17	17	56	51	51
7 – Balmain East Residences	17	30	40	40	59	53	51
8 – Darling Island Residences	33	36	40	40	57	52	55
9 – Sydney Wharf Residences	26	35	39	39	57	52	55
10 - R8 Residences	45	62	61	62	63	60	56
Residential Receiver	Work Location			Max	Weekday	6-7	Sat
	N	Centre	W	Level	NML	NML*	NML
Scenario C – Above-Ground Services							
1 – Hickson Road Residences	45	35	35	45	63	60	56
5 – High Street Residences	47	26	26	47	57	51	50
6 – Merriman Street Residences	18	17	17	18	56	51	51
7 – Balmain East Residences	38	38	41	41	59	53	51
8 – Darling Island Residences	39	40	41	41	57	52	55
9 – Sydney Wharf Residences	38	40	40	40	57	52	55
10 - R8 Residences	61	66	61	66	63	60	56

* The early evening NML is the noise management level based on the measured evening between 6 pm and 7 pm.

A review of results indicates that compliance with noise management levels will be achieved at all surrounding residences during week day construction apart from residences located in the northern end of building R8. This is due to the close proximity of these residences to the area around Waterman's Cove. These exceedances will reduce when works occur in other areas of the public domain.

A 4-dB exceedance is predicted at residences at 38 Hickson Road for Paving works on Saturdays. The exceedances will be intermittent consistent with public domain works which will move around

the site thereby reducing the exposure of noise to any particular group of residences.

It is considered the marginal exceedances are manageable by the existing Construction Management Plan.

Predicted construction noise levels at commercial receivers are presented in Table 6-3 as follows:

Table 6-3 Predicted Construction Noise Levels at Commercial – $L_{Aeq}(15 \text{ min})$ – dBA

Commercial Receiver	Work Location			Max	NML*
	N	Centre	W	Level	
Scenario A – Paving					
Lime Street, (King Street Wharf)	25	27	38	38	70
30 Hickson Road	50	33	33	50	70
Shelly Street	26	26	23	26	70
The Sussex Hotel	24	22	24	24	70
Scenario B – Landscaping					
Lime Street, (King Street Wharf)	19	38	37	38	70
30 Hickson Road	45	31	31	45	70
Shelly Street	22	25	26	26	70
The Sussex Hotel	24	22	24	24	70
Scenario C – Above-Ground Services					
Lime Street, (King Street Wharf)	51	31	32	51	70
30 Hickson Road	39	40	41	41	70
Shelly Street	36	43	38	43	70
The Sussex Hotel	24	22	24	24	70

* NML is the noise management level

A review of the results indicated that noise from the proposed construction works associated with the public domain will comply with established noise management levels at all commercial criteria.

In the case of childcare centres, the maximum predicted noise levels at surrounding receivers have been predicted and presented in Table 6-4.

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

Receiver	Construction Scenario			Max Level	NML **
	A	B	C		
37 High Street	38	33	35	38	55
AON	46	46	46	46	55
T1 Childcare	52	52	53	53	55

** External Level required to achieve 45 dBA internal objective. Based on a 10 dBA reduction across an open door/window

6.1.1 Discussion of Results for Public Domain Works

It is noted that construction noise from the proposed Barangaroo South Stage 1B Public Domain works will, in general, not generate excessive levels of construction noise at surrounding receivers. These works are not generally noise intensive in that smaller equipment will be used for these works whereby hand held tools and manual labour activities will occur for much of the time.

In addition, buildings within the precinct will provide noise shielding to surrounding receivers.

The duration of these works in one location will be limited and will tend to be complete when other major construction activities, such as excavation of basements, have been completed.

6.2 Waterman's Cove Works

The two works scenarios considered for Waterman's Cove works are summarised in Table 6-5.

Table 6-5 Construction Scenarios for Stage 1B Waterman's Cover Works

Scenario	Description	Works
D	Demolition	The demolition of concrete apron. Equipment includes: • Truck • Concrete Crusher • Concrete Saw • Hydraulic Hammer
E	Piling	This scenario includes piling and construction of boardwalk • Truck • Compressor • Impact Piling Rig • Crane

The following table details the results of noise modelling for Waterman's Cove works scenarios.

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

Residential Receiver	Predicted Noise Level*	Weekday NML	6-7 NML*	Sat NML
Scenario D – Demolition				
1 – Hickson Road Residences	40	63	60	56
5 – High Street Residences	36	57	51	50
6 – Merriman Street Residences	28	56	51	51
7 – Balmain East Residences	57	59	53	51
8 – Darling Island Residences	59	57	52	55
9 – Sydney Wharf Residences	60	57	52	55

Residential Receiver	Predicted Noise Level*	Weekday NML	6-7 NML*	Sat NML
10 - R8 Residences	72	63	60	56
Scenario E – Piling				
1 – Hickson Road Residences	44	63	60	56
5 – High Street Residences	40	57	51	50
6 – Merriman Street Residences	32	56	51	51
7 – Balmain East Residences	61	59	53	51
8 – Darling Island Residences	63	57	52	55
9 – Sydney Wharf Residences	64	57	52	55
10 - R8 Residences	76	63	60	56

* The early evening NML is the noise management level based on the measured evening between 6 pm and 7 pm.

** Includes a 5-dBA penalty for the impulsive nature of rock breakers and piling.

A review of results indicates that exceedances of noise management levels particularly those residences at R8 which are located immediately to the south of the Waterman's cove. In addition, smaller exceedances are predicted at residences to the west of the cove during normal weekdays standard hours. Higher exceedances can be expected on Saturdays and the hours of 6 pm to 7 pm.

These levels of exceedance can be expected for rock breaking and impact piling which are considered noise intensive activities.

Predicted construction noise levels at commercial receivers are presented in Table 6-7 as follows:

Table 6-7 Predicted Construction Noise Levels at Commercial – $L_{Aeq}(15 \text{ min})$ – dBA

Commercial Receiver	Predicted Noise Level	NML*
Scenario D – Demolition		
Lime Street, (King Street Wharf)	57	70
30 Hickson Road	37	70
Shelly Street	37	70
The Sussex Hotel	45	70
Scenario E – Piling		
Lime Street, (King Street Wharf)	61	70
30 Hickson Road	39	70
Shelly Street	39	70
The Sussex Hotel	47	70

* NML is the noise management level

A review of the results indicated that noise from the proposed construction works associated with the public domain will comply with established noise management levels at all commercial

receiver outside Barangaroo South.

In the case of the new commercial tenancies at T1 Barangaroo South similar levels to those predicted to R8 where noise levels in the order of 75 dBA can be expected during piling activities.

In the case of childcare centres, the maximum predicted noise levels at surrounding receivers have been predicted and presented in Table 6-8.

Table 6-8 Predicted Construction Noise Levels at Childcare – $L_{Aeq}(15 \text{ min})$ – dBA

Receiver	Construction Scenario		Max Level	NML**
	A	B		
37 High Street	32	36	36	55
AON	49	53	53	55
T1 Childcare	51	55	55	55

** External Level required to achieve 45 dBA internal objective. Based on a 10 dBA reduction across an open door/window

In the case of childcare centres compliance is indicated as these receivers are located further away from the cove work site.

6.3 Noise Mitigation Measures

6.3.1 Public Domain Works

Based on the investigations and findings of this assessment, there are no specific noise and vibration measures that have been identified that need to be adopted for Barangaroo South Stage 1B Public Domain construction works.

It is considered that the procedures and management measures that are included in the existing site Environmental Management Plan are more than adequate to address any noise or vibration generated by the Stage 1B Public Domain construction 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:

6.3.2 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.

6.3.3 Waterman's Cove Works

In the case of Waterman's Cove exceedances of noise management levels are predicted due to the noise intensive activities which are estimated to occur for up to 8 months. The following additional measures are recommended for this area:

- Use the smallest practical rock breakers or alternative (possibly Xcentric Ripper).
- Utilise a localised noise barrier (2.4m height) around the cove site to protect the amenity of ground level retail tenancies that are below R8 residences and in Tower T1 podium.
- Where reasonable and feasible, preference would be given to scheduling construction works within the standard construction hours of:
 - Monday to Friday 7:00 am to 6:00 pm.
 - Saturday 8:00 am to 1:00 pm.
- Equipment which is used intermittently is to be shut down when not in use.
- Where possible, the offset distance between noisy plant items and nearby noise sensitive receptors should be as great as possible (e.g. away from residential receptors).
- Where possible, equipment with directional noise emissions should be oriented away from sensitive receptors.
- Where feasible utilise auger piling rather than impact piling.
- Conduct attended noise/vibration measurements as require to streamline mitigation if required.

6.3.4 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.

6.3.5 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 6-9 extracted from the Sub Plan:

Table 6-9 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 $L_{Aeq}(100Hz)$ (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 6-10 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.

6.4 Cumulative Noise Impact

There are other projects that will be under various stages of construction when the public domain works occur. The other projects that will be under construction and nearing completion are the residential building R4A, the 1B basement structure and Crown Sydney (Indicatively around December 2020).

- Stage 1B Basement
- Waste water plant,
- Crown Sydney, and;
- Residential Building 4a

All other developments at South Barangaroo will be complete at this time, except for R4b And R5 which will start after December 2020.

Table 6-11 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 6-11 Cumulative Construction Noise Increases – dBA

Receiver	1B Basement, R4a Crown Sydney*	Public Domain	Waterman's Cove	Total	Increase
1 – Hickson Road Residences	66	59	44	67	1
5 – High Street Residences	58	47	40	59	1
10 – R8 Residences	63	68	76	77	1

* Determined from previous project applications

Based on a review of the above noise levels the noise from the Stage 1B Public Domain works will be below overall cumulative noise levels at the surrounding most affected receivers with the exception of the residences on and around R8 residence where building works will be the closest. In this location noise from Waterman's Cove will be of a higher magnitude than other construction noise sources.

6.5 Construction Vibration

Operation of piling rigs and rock breakers can generate ground vibration that has the potential to transmit to nearby buildings.

Table 6-12 sets out the typical ground vibration levels at various distances for safe working distances (Extracted from the TfNSW Construction Noise Strategy).

Table 6-12 Recommended safe working distances for vibration intensive plant

Item	Description	Safe working Distance	
		Cosmetic Damage	Human Response
Vibratory Rollers	<50 kN (Typically 1-2 tonnes)	5 m	15-20 m
	<100 kN (Typically 2-4 tonnes)	6 m	20 m
	<200 kN (Typically 4-6 tonnes)	12 m	40 m
	<300 kN (Typically 7-13 tonnes)	15 m	100 m
	300 kN (Typically 13-18 tonnes)	20 m	100 m
	300 kN (>-18 tonnes)	25 m	100 m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7 m	23 m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 m	73 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	20 m
Bored Piling	≤ 800 mm	2 m (nominal)	N/A
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

It is noted that these nearest receivers to the in R8 are a least 20 metres from the nearest location of rock breaking. Whilst cosmetic damage is not expected there may be some perceptible vibration at residences in R8. Therefore, the following measures should be adopted:

- Locate rock breakers on the northern side of the cove as much as possible.
- Use the smallest feasible size of rock breaker.

In the case of piling works the distance from residences is greater. Whilst cosmetic damage is unlikely there may be some perceptible vibration if impact piling occurs. The following measures are recommended:

- Conduct trial vibration testing at R8 to determine the level of potential impact at these residences.
- Utilise auger piling where feasible.

6.6 Construction Traffic Noise

Arup, the traffic consultants, in their report titled "*Barangaroo Stage 1B Public Domain Transport Draft Assessment dated 13 October 2016*" advises the following with respect to the public domain works:

The works associated with construction of the public domain including Barangaroo Avenue and Waterman's Quay will be spread over a 12-month period with truck movements peaking at 8 per hour during high intensity activities. On average a typical hour would involve 4 truck movements. This activity will be occurring at the anticipated peak period in December 2020 and represents a negligible 1% increase in activity. The majority of construction truck movements occur prior to the afternoon peak commuter period, minimising the impact on the local road network.

Given the above statement and projected traffic flows associated with the Stage 1B Public Domain the noise contribution from this associated traffic will also be negligible.

7 CONCLUSION

A noise and vibration review of the Stage 1B Public Domain areas and Waterman's Cove works has been conducted for Barangaroo South.

Site-specific noise criteria that are applicable to this project have been presented. They have been determined for surrounding receivers to be applied on all state significant development applications.

A noise and vibration assessment has been conducted of the proposed construction activities associated with the construction of the Stage 1B Public Domain (including Waterman's Cove) to determine the potential for noise impact at surrounding receivers.

Vibration and traffic noise associated with on-site construction activities is negligible in the case of the typical Public Domain Works. No specific management and mitigation measures to reduce noise impact at receivers have been identified beyond the normal measures.

In the case of Waterman's Cove works there is greater potential for exceedance of noise management levels. Therefore, specific noise management measures have been recommended to minimise impact at nearby receivers, particularly residences in building R8.

In addition, trial testing of impact piling is recommended to determine actual vibration levels at R8 residences if impact piling is proposed.

A Noise and Vibration Management Plan has been prepared by Lend Lease to assist in managing the environmental issues associated with this project.