Appendix 02 - Waste Management plan

Your ref
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Con Giannoulis,
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3 May 2013

Dear Con

Barangaroo – Westpac fitout waste management during construction

This correspondence has been prepared to clarify that the Waste Management Plan prepared for the C4 Project Application and the most recently updated R8/R9 Residential Building covered waste during construction and operation. These report refer to the disposal of waste from the site being covered in the CTMP.

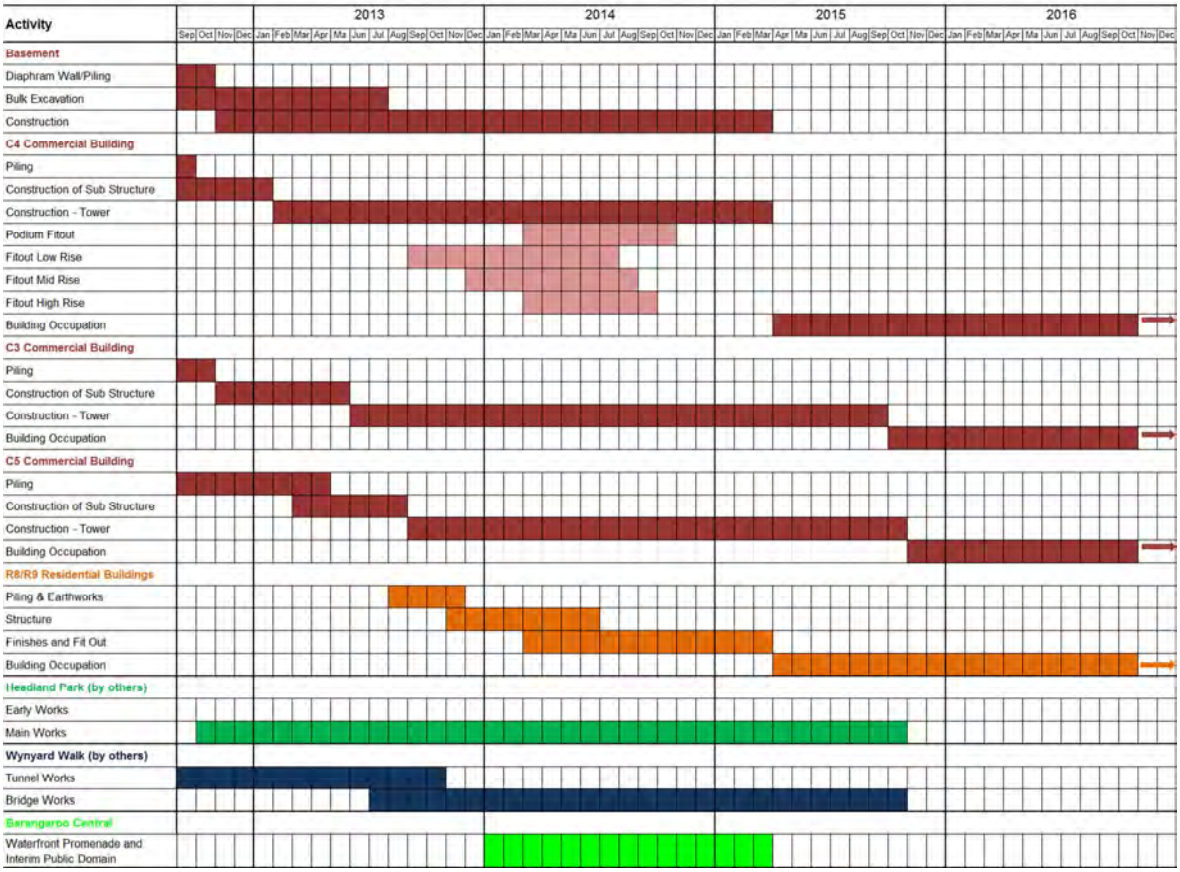
The Construction Traffic Management Plans (CTMP) prepared at the Project Application stage for each development includes all construction activities from site excavation through to building occupation. This includes the tenant fitout occurring in the later stages of the tower construction.

The construction program was last updated for the R8/R9 Building CTMP and this has been included below. The work areas now include within this most recent report include the basement area, C4 Commercial Tower, C3 Commercial Tower, C5 Commercial Tower and the R8/R9 Residential Buildings.

The anticipated stages of fitout for the C4 Building have been added to the program. The traffic analysis undertaken for the peak periods for each CTMP includes the cumulative effect of all work areas for the trucks arriving with materials for the fitout and trucks leaving with any construction waste.

On this basis, Arup is of the opinion that the Waste Management Plan previously submitted for C4 Commercial Building and the subsequent R8/R9 Residential Building included the fitout stage and therefore no further investigation or analysis is required at this stage of planning and design.

BARANGAROO SOUTH INDICATIVE CONSTRUCTION PROGRAM



Yours sincerely

Andrew Hulse
Senior Associate

Lend Lease (Millers Point) Pty Limited

Barangaroo South - R8 & R9 Residential Buildings

Waste Management Plan - Project Application

Waste Management Plan - Project Application

Rev C | 8 November 2012

Job number 220316

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Contents

1 Introduction

This report supports a Project Application (MP11_0002) submitted to the Minister for Planning pursuant to Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act). The Application seeks approval for construction of two residential flat buildings (known as Buildings R8 and R9) and associated works at Barangaroo South as described in the Overview of Proposed Development section of this report.

1.1 Overview of Proposed Development

The R8 and R9 Project Application seeks approval for the construction and use of two residential flat buildings comprising 159 apartments, ground floor retail, allocation of car parking spaces from the Bulk Excavation and Basement Car Parking Project Application, and the construction of the surrounding ancillary temporary public domain and landscaping.

1.2 Site Location

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 R8 and R9 Project Application Site area is located within Barangaroo South as shown in Figure 1. The Project Application Site extends over land generally known and identified in the approved Concept Plan as Block X.

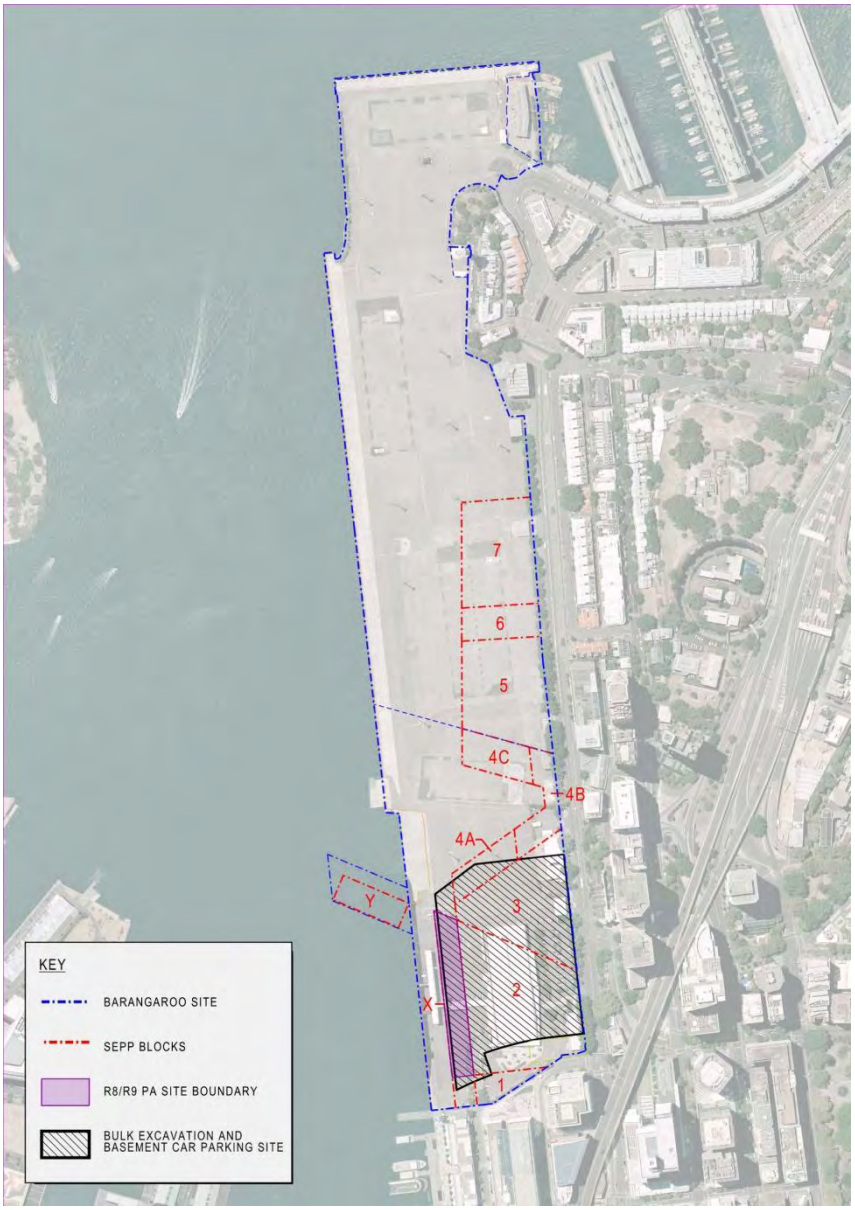

Figure 1: R8 and R9 Residential Building Project Application (MP11_0002) Aerial Site Location Plan

1.3 Purpose of this Report

This report has been prepared to accompany the Project Application for the R8 & R9 Residential Buildings and associated works at Barangaroo South. It addresses the relevant Director-General Requirements for the project.

The Waste Management Plan (WMP) identifies waste sources during construction and operation and proposes measures to manage waste in a way that generally satisfies all legislative requirements.

The WMP is provided in a format which can assist with the completion of a Construction Waste Management Plan which will be required by the contractor prior to the construction of the development.

In summary, the key purposes of the WMP are to:

- Address the waste management requirements for the proposal to a standard suitable for approval under Part 3A of the EP&A Act;
- Provide guidance for the project in waste minimisation from construction activities;
- Nominate effective waste separation, recycling and re-use measures; and
- Develop management requirements for construction and operation.

1.4 Assumptions and Limitations

The principles outlined in this WMP will be incorporated into the building design and submitted with the Project Application for the R8 & R9 Residential Buildings.

All figures and calculations are based on the building layout as set out in the R8 & R9 Residential Building drawings included in the Project Application. Waste generation estimations have been made using industry estimates and where appropriate devised from the waste estimation tables contained within City of Sydney's Policy for Waste Minimisation in New Developments 2005 (CoS Waste Policy).

All waste facilities and equipment will be designed and constructed in accordance with City of Sydney requirements as outlined in their Waste Policy where appropriate, the BCA, and Australian Standards.

2 Legislative Requirements

2.1 NSW State Legislation

2.1.1 The Protection of the Environment Operations Act 1997

The Protection of the Environment Operations Act 1997 covers the requirements for waste generators in terms of storage and correct disposal of waste and establishes the waste generator as having responsibility for the correct management of waste, including final disposal.

2.1.2 Waste Avoidance and Resource Recovery Act 2001

The object of the Waste Avoidance and Resource Recovery Act 2001 is to encourage the most efficient use of resources, to reduce environmental harm, and to provide for the continual reduction in waste generation in line with the principles of ecologically sustainable development (ESD).

This Waste Management Plan relates to a new development in NSW and is therefore written with reference to the NSW Waste Avoidance and Resource Recovery Strategy 2003, made under the Act.

The following hierarchy for managing waste, from most desirable to least desirable, meets the objectives of the Act:

- Avoid unnecessary resource consumption;
- Recover resources (including reuse, reprocessing, recycling and energy recovery); and
- Dispose (as a last resort).

2.1.3 The NSW Waste Reduction and Purchasing Policy (WRAPP) 1999

The NSW Waste Reduction and Purchasing Policy (WRAPP) requires all state government agencies and state owned corporations to develop and implement a WRAPP plan to reduce waste in four scheduled areas:

- Paper products;
- Office equipment and components;
- Vegetation material; and
- Construction and demolition materials.

The WRAPP is not directly applicable to the project, but has been used as a suitable guiding document for waste initiatives.

2.2 City of Sydney Council Policy

2.2.1 City of Sydney Council Policy for Waste Minimisation in New Developments 2005

The Council of the City of Sydney Policy for Waste Minimisation in New Developments 2005 (CoS Waste Policy) supports the Department of Environment, Climate Change and Water's (DECCW) NSW Waste Avoidance and Resource Recovery Strategy 2003. This Waste Policy is the guiding document for many of the waste initiatives and requirements for the Barangaroo development.

3 Green Star Requirements

The Green Star tool rates buildings on all relevant aspects of their environmental performance, with the rating divided into nine separate environmental categories:

- Management;
- Indoor Environment Quality;
- Energy;
- Transport;
- Water;
- Materials;
- Land Use and Ecology;
- Emissions; and
- Innovation.

These categories are further divided into credits, each addressing an initiative that improves or has the potential to improve a design, project or building's environmental performance.

3.1 Construction Waste – Residential

Within the Management category of Green Star, Waste Management (Man-7) indicator addresses construction waste management and is worth a possible 2 points.

The maximum of 2 points is awarded for achieving 80% reuse or recycling of construction materials by weight, with 1 point awarded for achieving 60%.

The Man-7 indicator is the only directly applicable Green Star indicator to be influenced by the Construction Waste Management Plan.

3.2 Operational Waste – Residential

Within the Material category of Green Star Multi Unit Residential (V1), Recycling Waste Storage (Mat-1) indicator allows up to a possible 2 points for inclusion of storage space that facilitates the recycling of resources used within buildings to reduce waste going to landfill.

Up to two points are awarded as follows:

- One point is awarded where any three of the five initiatives below are implemented; and
- Two points are awarded where all of the four initiatives below are implemented.

Dedicated storage area - Dedicated storage area for the separation, collection and recycling of waste is provided and it:

- Can be easily accessed by all building occupants;

- Has suitable access for recycling companies; and
- Is sufficiently sized to accommodate the storage equipment for the following recyclables, as a minimum:
    - cardboard;
    - glass;
    - plastics - mixed containers;
    - plastics - soft plastics;
    - plastics - polystyrene;
    - metals; and
    - batteries.

Convenience of recycling - Disposal of recycling is at least as convenient as disposal of general waste, for example where waste chutes are provided for general waste, chutes are also provided for recycling.

Waste Chutes - Recycling and general waste chutes are provided on each floor in close proximity to each other.

Compost Facilities - Facilities are provided for on-site disposal and re-use of compost and green waste.

Facilities for over-sized household items - Space is provided in common areas for the collection of over-sized household items to facilitate re-use within the building and it must be:

- Large enough to contain a $2m^3$ cage;
- Clearly labelled for items for re-use;
- Separated from the general waste and recycling area; and
- Its existence and location must be communicated to tenants.

4 Construction Waste

During construction it is anticipated that a significant volume and variety of waste will be generated.

Figure 2 shows an overview of the major waste streams to be expected from the project.

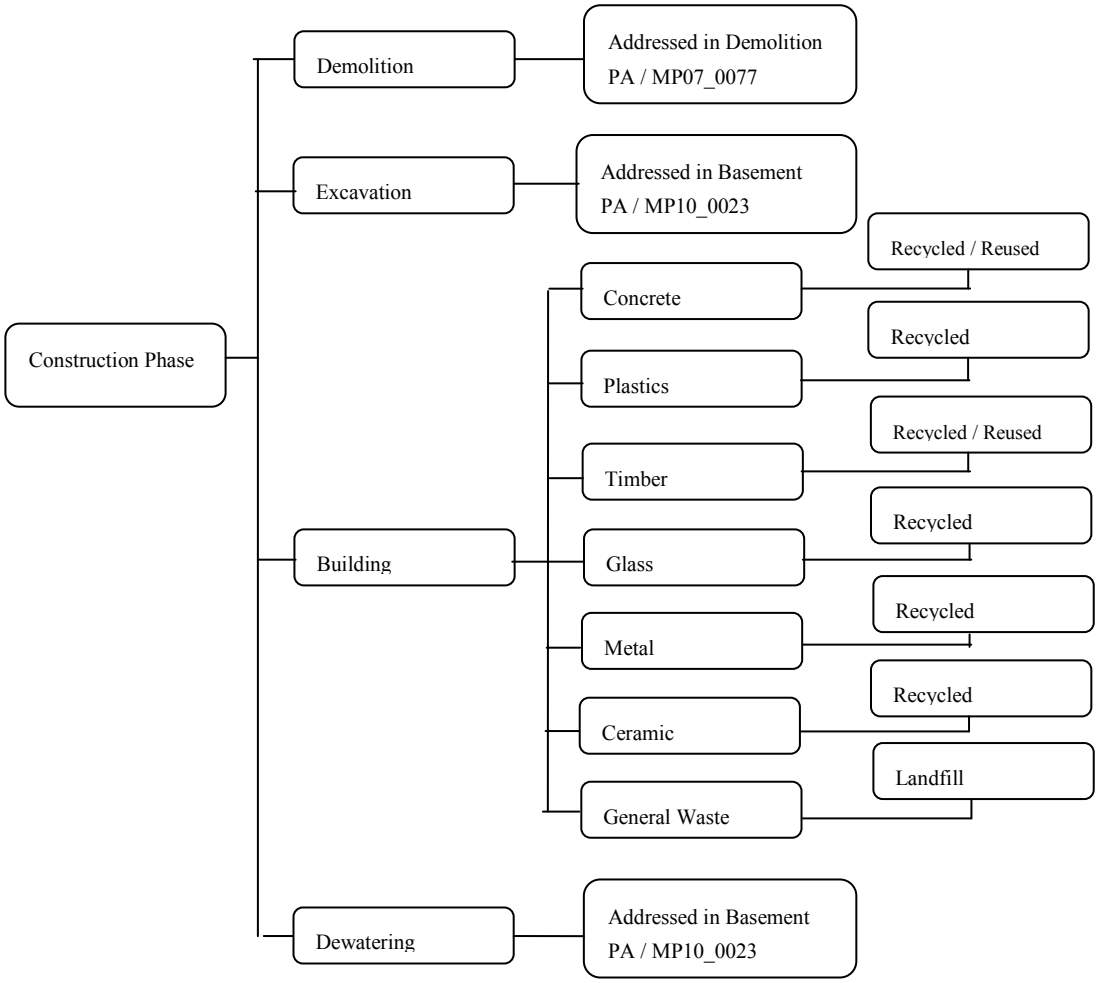

Figure 2: Overview of major waste streams expected from the project

4.1 Demolition & Excavation

Waste management of the site during demolition and excavation is addressed by the following two separate Planning Applications and relevant WMP's:

- Demolition of structures is addressed in the WMP for the Demolition of Existing Structures, East Darling Harbour Planning Application, which was approved by The Minister for Planning in November 2007(MP07_0077); and
- Excavation is addressed in the WMP for the Bulk Excavation and Basement Car Parking Planning Application (MP10_0023). There is likely to be a small amount of additional excavation for the slab which extends beyond the basement footprint, and an additional row of foundation piles. The

management of this excavated material will be as per the WMP for the Bulk Excavation and Basement Car Parking PA.

Waste management during demolition and excavation was detailed under these WMP's in terms of types waste generated and the management strategies. Emphasis was on reuse and recycling.

4.2 Building / Construction

The first goal for construction waste management is the reduction of waste generated. Waste reduction is the responsibility of all on site, as it relates to materials procurement, handling, storage and use. Any residual waste generated during construction will be reused, recycled, or as a last resort disposed to landfill.

While waste reduction is the goal, effective recycling of the waste that is generated will also be undertaken on site.

Waste collection during construction of the building will be appropriately managed through the staged nature of construction and the use of known quantities of materials. The majority of recyclable material that can be recovered during construction is likely to be off cuts and discards of glass, pipe, timber, steel, flooring, tiles and plasterboard. Waste material is also expected from construction packaging materials.

If material is required to be disposed of off-site, it will be classified for off-site disposal and disposed of in accordance with the DECCW's Waste Classification Guidelines 2008.

4.3 Goals / Targets

4.3.1 Overall Project Commitments

Lend Lease are committed to minimising waste to landfill and greenhouse gas emissions associated with waste generation and movement of waste from the site.

The target for construction waste is:

- Greater than 97% reduction of construction waste to landfill.

4.3.2 Green Star Credit

Up to two points are sought for the Man-7 Waste Management credit under the Green Star Multi Unit Residential (V1). To obtain these points the contractor must:

- Implement a Construction Waste Management Plan (CWMP), retain waste records and quarterly reports to the building owner; and
- Reuse or recycle a percentage (by mass) of all demolition and construction waste as follows:
  - One point for 60% of the waste
  - Two points for 80% of the waste

4.4 General Waste Management Measures

The main goal in the construction phase will be to reduce the total volume of waste produced, which is to be achieved by effective materials procurement, management and supply.

Project managers, engineers, builders and subcontractors will play a key role in achieving on-site waste reduction targets on a day-to-day basis.

The waste management measures that will be implemented during the construction are generally outlined below. Actual strategies and management measures will be refined as the construction program and phasing is defined. This will be documented in the Construction Waste Management Plan (CWMP) for the project.

4.4.1 Waste Management Hierarchy

Waste that cannot be reused or recycled will be disposed in a licensed landfill.

4.4.2 Waste Avoidance and Reduction

Strategies to reduce the actual amount of waste generated during construction may include:

- Use of pre-cut and prefabricated materials where possible;
- Purchasing in bulk;
- Requesting metal straps rather than shrink wrap;
- Using returnable packaging such as delivery and storage pallets and reels;
- Returning packaging to suppliers or bring unpacked goods to site;
- Educating site workers in avoidance procedures;
- Ensuring that subcontractors use new purchasing guidelines;
- Materials being delivered by suppliers only when needed. This reduces the opportunity for waste through error in estimates. It also permits orders to be made from on-site measurements rather than from drawings, and it provides for any modifications that the client may request; and
- Appropriate storage arrangements established to protect products from damage due to weathering or moisture.

4.4.3 Resource Recovery

The 90% resource recovery target will be delivered through an on-site waste segregation solution with all waste streams arising that cannot be reused on-site, being transported to an appropriately licensed facility for recycling, reuse or disposal.

Waste collected from bins around the site will be consolidated into larger bulk bins located in docks around the site. This process will dramatically reduce the processing required to enable this waste to feed into recycled resources production processes.

Separated wastes are a more valuable resource. Waste streams will be separated on site where possible to save double handling and time and labour intensive sorting. On-site solutions will involve setting up waste handling systems, including a bin coding system on site, to segregate the waste into separate streams as it is produced.

The provision of waste skips or bins at the site (or separation off site) will be made for the following materials (as outlined by Man-7 of the Green Star Manual) as relevant and appropriate to the phase of construction;

- Cardboard;
- Timber;
- Metal;
- Soft Plastic;
- Polystyrene;
- Insulation;
- Concrete;
- Glass; and
- Bricks.

Note that recyclables may be combined in a skip so long as evidence is provided that the waste contractor will separate these materials off-site.

4.4.4 Training

Waste education will be included in site inductions to provide a better understanding of the development from a sustainability and environmental perspective.

All contractors, sub contractors and employees are to be informed of the waste management measures to be enforced during the construction, and given appropriate training in performing their duties so as to achieve the set waste minimisation goals.

Through the site induction training process, site staff will be made aware of the placement of the bins and their responsibility to separate materials.

4.4.5 Waste Utilisation on Alternate Sites

If possible it is desirable to co-ordinate with other construction jobs occurring at the time. Waste from the Barangaroo Buildings R8 & R9 project may find an immediate use as a construction material on other parts of the site and/or on another site, and hence save on some costs of collection and disposal.

4.4.6 Good Housekeeping

Litter management will be implemented on site to reduce air borne litter and litter entering the storm water system or Harbour.

4.4.7 Monitoring and Reporting

Documentation of waste removal, deliveries and final disposal is required for confirmation of waste recycling targets under the Green Star rating system. This documentation requirement relates to all three processes of demolition, excavation and construction.

A Waste Tracking Form to assist in the monitoring and reporting process for demolition and construction waste can be obtained from the City of Sydney Council Waste Code. This sheet (or similar) is to be used and regularly updated to document the progress towards the 97% target.

Records must be kept by the contractor to demonstrate the actual percentage of waste recycled, including weight and volume of all wastes leaving the site and destination and name of the recycler/waste hauler, in accordance with legal and the Green Star Man-7 requirements. All documentation of materials disposed, including landfill receipts, contracts and waste plans, will be kept and maintained.

4.4.8 Materials and Procurement

A number of other initiatives will be incorporated to reduce the impact associated with material use during the construction phase of the project. These include:

- Use of off-site pre-assembly wherever possible – building components made off site using more efficient practices that minimise resource consumption, energy, water and waste to landfill; and
- Procurement and re-use of materials from a waste partner or approved waste manager/operator. The approved waste manager/operator can provide materials including recycled aggregates and glass fines that can be reused into new materials on site.

4.4.9 Transportation of Waste

Transportation of construction waste is discussed in the Construction Traffic Management Plan.

5 Operational Waste

The importance of both minimising the generation of waste and importantly the value of waste as a resource is reflected in the commitments for the Barangaroo project and this WMP. The Barangaroo integrated waste strategy is based on the principles of reduce, reuse, recycle and recover. It is designed to deliver the following outcome for operational waste;

- Greater than 80% diversion of operational waste to landfill.

This target involves various third parties and authorities, and will need partnerships and commitments to work with and toward this target. This ambition will be evaluated, measured and reviewed progressively throughout the project life.

The aim is to secure owner and occupant commitment to the following key strategies:

- **Sustainable consumption and waste minimisation** through education and awareness raising, information and monitoring systems, active intervention and assistance and a focus on product stewardship and extended producer responsibility.
- **Source segregation, storage and collection –** simple, easy to use systems will be applied across the precinct to maximise source segregation. Waste collection processes will be improved through precinct wide collection of separated waste streams
- **Resource recovery of recyclable waste** through the engagement of an approved waste manager/contractor with a Material Recycling Facility achieving 90-95% recovery of co-mingled recyclables.
- **Resource recovery and green power generation** using mixed solid waste through approved waste manager/operator's Mixed Waste Processing Facility. Biological treatment can produce inert organic material and methane that is used to power an off-site co-generation plant.

5.1 Waste Estimation

Waste volumes for R8 & R9 Residential Buildings have been estimated in order to determine the waste storage area and waste storage bins which will be required. Each of the residential buildings are served by 4 waste chutes leading to dedicated storage rooms in the basement (a total of 8 rooms). From there the waste will be transferred and combined into the precinct wide waste management and collection systems which has been detailed in the Project Applications for the large commercial buildings.

All waste estimates are based on the waste generation rates for residential and retail development provided in the CoS Waste Policy. The waste storage area required is calculated based on the Plan Area Bin sizes provided in the CoS Waste Policy:

Table 1: Bin Sizes

Bin Capacity (L)	Plan Area Bin (m^2)
240	0.43
660	0.96

Only 240L and 660L bins have been considered as practical for these buildings given the need to transfer the waste readily to the central facility.

The breakdown of the area for R8 & R9 Residential Buildings is presented in the table below. These estimates have been used for the waste calculations presented in this WMP.

Table 2: Barangaroo R8 & R9 Areas

Description	Unit	Waste generation rate source
R8 Residential	81 apartments	CoS Waste Policy generation rate for residential
R8 Retail	~1,000m^2 GFA	CoS Waste Policy generation rates for retail
R9 Residential	77 apartments	CoS Waste Policy generation rate for residential
R9 Retail	~1,200m^2 GFA	CoS Waste Policy generation rates for retail

Waste Estimation for R8 & R9 Residential Buildings is described in the tables below. The different generation rates for retail are shown for information and have not been used in the total waste estimation as the breakdown of different types of retail has not yet been determined. All estimates are based on the applicable waste generation rates in the CoS Waste Policy. Waste generation is calculated using the total figures from Table 2.

Table 3: Barangaroo R8 & R9 Residential Building General Waste Estimation

Description	General Waste Generation Rate		General Waste (L/day) (Rounded Up)
R8 Residential	1.2	kg/unit/day	750
R8 Retail	17	kg/100m^2/day	1,300
R9 Residential	1.2	kg/unit/day	750
R9 Retail	17	kg/100m^2/day	1,600
TOTAL			**4,400**

Table 4: Barangaroo R8 & R9 Residential Building Recyclables Estimation

Description	**General Waste Generation Rate**		**General Waste (L/day) (Rounded Up)**
R8 Residential	0.5	kg/unit/day	350
R8 Retail	11	kg/100m^2/day	850
R9 Residential	0.5	kg/unit/day	300
R9 Retail	11	kg/100m^2/day	1,000
TOTAL			**2,500**

5.2 Waste Storage

The provisions included within the Council of the City of Sydney Policy for Waste Minimisation in New Developments 2005 (Section A, All Developments - Construction) will generally be followed for Waste Storage Design where appropriate.

The waste storage areas will be located at the base of each residential waste chute (4 in each building) in the Basement. The retail areas have access to 2 good lifts within each building for the transfer of waste to the basement.

The appropriate space allocation has been made in the Basement for the R8 & R9 Residential Buildings based on the waste generation figures presented above and the associated bin requirements presented below.

The waste storage area figures are based on daily collection for both residential and retail waste, consistent with the precinct wide collection strategy;

Table 5: Residential Waste Storage Options (collection daily - all figures rounded up to nearest m^2)

Bin Capacity Options (L)	No. bins: General Waste	No. bins: Paper & Card	No. bins: Other Recyclables	Plan Area Bin (m^2)	Total Plan Area: General Waste (m^2)	Total Plan Area: Recyclables (m^2)
240	7	3	1	0.43	3	2
660	3	1	1	0.96	3	2

The above figures are to be distributed across 8 storage rooms however to allow flexibility for collection, a strategy of 1 660L bin for General Waste and 1 660 L bin for Recyclables in each room is proposed.

Using 660L bins with a plan area of 2 m^2 would require each waste storage areas to have at least twice this amount of floor area (e.g. x 4 m^2). This is to allow for access to the waste room and movement of bins, cleaning etc. This does not allow for space for a compactor(s).

Table 6: Retail Waste Storage Options (daily collection with 2:1 compaction on general waste and paper/cardboard) (all figures rounded up to nearest m^2)

Bin Capacity Options (L)	No. bins: General Waste	No. bins: Paper & Card	No. bins: Other Recyclables	Plan Area Bin (m^2)	Total Plan Area: General Waste (m^2)	Total Plan Area: Recyclables (m^2)
240	12	3	5	0.43	6	4
660	5	1	2	0.96	5	3

Given that waste is to be transported via goods lift, 240L bins are considered the most feasible option. The above figures need to be distributed across 4 goods lifts. The expected minimum space requirement for each retail stream via goods lift is;

- General waste – 3 x 240L bins
- Recyclables – 2 x 240L bins

Using 240L bins with plan area of 3m^2 would require each waste storage area to have at least twice this amount of floor area (e.g. 6m^2). This is to allow for access to the waste room and movement of bins, cleaning etc. This does not allow for space for a compactor(s).

5.2.1 Compactors

It is unlikely that dedicated compactors will be provided for the R8 & R9 Residential buildings however they may be shared with the larger commercial/retail developments for Barangaroo South.

5.3 Waste Management Responsibility

The General, Space, Access and Amenity requirements detailed in Section A (All Developments) and Section D (Mixed Use Developments) in the CoS Waste Policy have generally been followed in determining waste management and

storage requirements for Barangaroo. Green Star requirements on waste management and waste storage have also been addressed (see Section 3).

5.3.1 Residential Waste Management

The following waste management measures are proposed to be adopted for the R8 & R9 residential buildings. The exact arrangements will be subject to further design development:

- Occupants from each unit will place their general and recyclable waste down a waste chute which will automatically segregate the general waste from recyclable waste based on a selection made by the resident at the chute entry point. The waste will be collected in waste storage rooms within the basement;
- For the purposes of this assessment, waste & recyclables collection has been assumed to be by City of Sydney or an approved waste manager/operator (operating under a precinct waste management agreement) occurring daily as part of the same collection for the large commercial buildings.

The final management requirements will be subject to design development.

5.3.2 Retail Waste Management

The following is likely to be adopted for retail waste management within the R8 & R9 buildings:

- Waste will be segregated into 240L bins within the retail store and then taken via the goods lift to a dedicated waste storage area;
- For the purposes of this assessment, waste & recyclables collection has been assumed to be by City of Sydney or an approved waste manager/operator (operating under a precinct waste management agreement) occurring daily as part of the same collection for the large commercial buildings.

The final management requirements will be subject to design development.

5.3.3 Waste Management Responsibility

The following measures outline the general responsibilities associated with waste management at the Barangaroo South development;

- The responsibility for cleaning the waste storage area will be on the building manager;
- Removal of waste to the central waste storage rooms is the responsibility of building management;
- Labelling of the bins will be the responsibility of the building manager. This includes adequate signage identifying the waste and recycling area, and instructions outlining how to use the waste management system and what materials are acceptable for recycling;
- Transfer of bins from the storage area to the collection truck will be carried out by the waste collection contractors. After emptying the bins the contractors will return them immediately to the waste storage room within the premises;

- The final allocation of responsibilities will be subject to design development.

6 Conclusion

The purpose of this Waste Management Plan is to inform and accompany the Project Application for R8 & R9 Residential Buildings for Barangaroo South under Part 3A of the Environmental Planning and Assessment Act (EP&A Act).

The Waste Management Plan concludes that waste management practices can be implemented under the proposal to achieve a significant reduction in waste going to landfill during construction and operation, and that adequate storage and handling facilities for the project waste streams from the R8 & R9 development are catered for within the central basement facility below.

Appendix 03 - Noise & Vibration Management Plan

WILKINSON MURRAY

19 April 2013

WM Project Number: 10232-C4
Our Ref: CG 210413 bconst

Con Giannoulis
Lend Lease (Millers Point) Pty Limited
Level 4, 30 The Bond
30 Hickson Road
Millers Point NSW 2000

Dear Con

Barangaroo South - Commercial Building C4 Westpac Group Fitout

Construction Noise and Vibration Review

This letter has been prepared by Wilkinson Murray Pty Ltd for Lend Lease (Millers Point) Pty Ltd to support an application that is to be made pursuant to application for the Westpac integrated fitout for Building C4 from a noise and vibration perspective.

Wilkinson Murray has prepared assessments of construction noise and vibration for the Basement, C3, C4 and C5 buildings. In relation to the fitout works for the C4 building it is noted that the fitout works will be conducted with the facade of the building installed and material access will be from the basement.

Therefore any noise and vibration generated by the Westpac fitout activities will be adequately contained within the basement and facade of the C4 building. Therefore there will be no significant noise or vibration contribution to overall construction levels at surrounding sensitive receivers..

Yours faithfully
WILKINSON MURRAY

Brian Clarke
Senior Associate

ACOUSTICS AND AIR

BARANGAROO SOUTH

CONSTRUCTION OF COMMERCIAL BUILDING C4
MP10_0025 - PLANNING APPLICATION 75W
CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

REPORT NO. 10232-C4
VERSION D

WILKINSON MURRAY

BARANGAROO SOUTH

CONSTRUCTION OF COMMERCIAL BUILDING C4
MP10_0025 - PLANNING APPLICATION 75W
CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

REPORT NO. 10232-C4
VERSION D

SEPTEMBER 2011

PREPARED FOR

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TABLE OF CONTENTS

1 INTRODUCTION

1.1 Scope of Commission

This report has been prepared to support an Application made pursuant to section 75W of the Environmental Planning and Assessment Act 1979 to modify Project Approval granted by the Minister for Planning in respect of MP10_0025 for the C4 commercial building within Barangaroo South. The C4 Project Application was approved by the Minister for Planning under section 75J of the EP&A Act on 3 March 2011.

A previous assessment of construction noise and vibration for Barangaroo South basement works has been conducted by Wilkinson Murray (Sydney) Pty Limited (WMSPL). That assessment is detailed in Report 10232 Version B. This report relies in part on the work contained in that previous report

1.2 .The Approved C4 Project Application

The approved C4 Project Application approves for the construction and use of a 42 storey commercial building and allocation of car parking spaces from the Bulk Excavation and Basement Car Parking Project Application, within the area of land known generally as Block 2 at Barangaroo South. More specifically, consent was granted for development including:

- Piling and associated earthworks and remediation;
- Construction and use of a commercial building with a maximum of 98,514m2;
- Operation and use of 168 car parking spaces and 36 loading spaces;
- 690 bicycle parking spaces (127 to be located temporarily on grade in the landscaped forecourt adjacent to Hickson Road and 563 in the basement car park); and
- Construction of certain public domain works.

1.3 Overview of Proposed Modification

The proposed modification seeks to modify the following elements of the approved C4 building:

- Mix of the uses within the building;
- Total GFA;
- Shape of floorplates of the podium and the tower elements of the building;
- Facade details;
- Roof treatment; and
- Basement layout.

1.4 Site Location

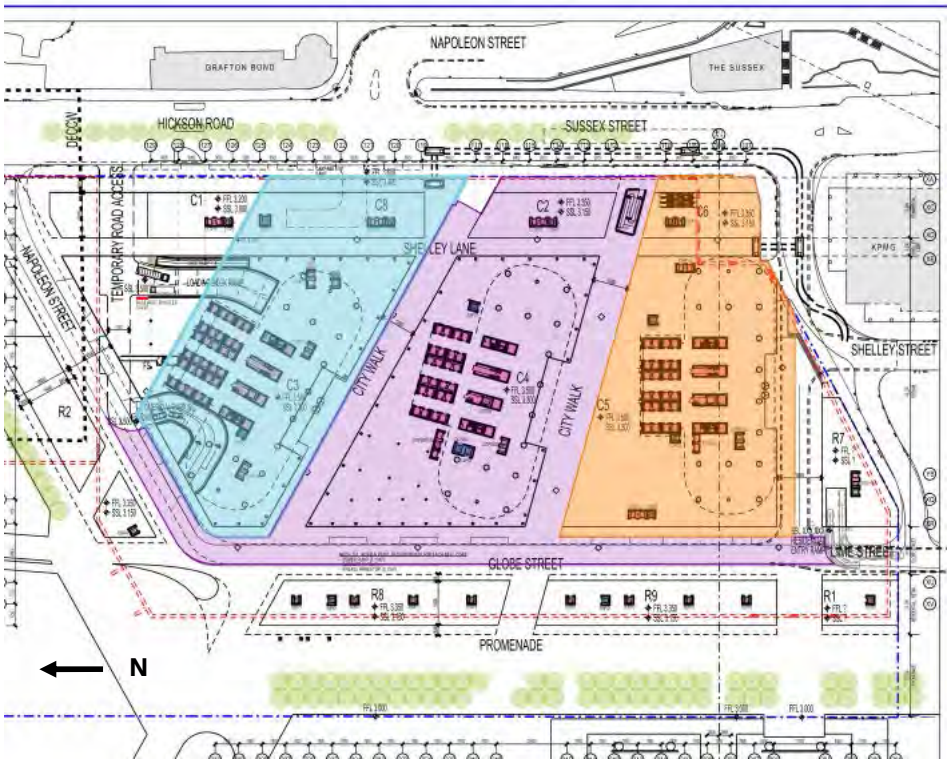
Barangaroo is located on the north western edge of the Sydney Central Business District, bounded by Sydney Harbour to the west and north, the historic precinct of Millers Point (for the

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 Stage 2 and Barangaroo South.

The Project Application Site extends over land generally known and identified in the approved Concept Plan as Block 2 which comprises Lot 5 in DP 876514.

Figure 1-1 C4 Commercial Building Project Site Location Plan



2 2DESCRIPTION OF PROJECT

2.1 Project Summary

This Project Application seeks approval for the:construction of a 43 storey building with a maximum RL of 180.0 AHD, comprising:

- commercial office floor space; and
- retail floor space (inclusive of the childcare and basement supermarket).
- provision of approximately car spaces, bicycle parking spaces and associated facilities within the Barangaroo South Basement Car Park (to be constructed as part of a

separate Project Application approval),

- construction of the surrounding ancillary public domain including:
    - access streets; and
    - Temporary Landscaping of areas.

Note that the provision of car spaces, bicycle facilities and associated facilities will be delivered as part of PA1 and constructed as part of the bulk excavation and construction of a basement car park for Barangaroo South.

2.2 Construction Hours

The proposed construction hours are between 7.00am and 6.00pm Monday – Friday and between 7.00am and 5.00pm on Saturdays. No work will be undertaken on Sundays or Public Holidays.

It is noted that the proposed hours for Saturdays are outside OEH's standard hours of construction being 8.00am and 1.00pm. However, this extended period of construction hours will enable the major noise and vibration generating activities to be carried out in a more efficient manner, thereby shortening the period over which sensitive receptors will be exposed.

2.3 Hoardings / Site Fences

As part of the previous works for PA1, the construction site would be secured by a combination of hoardings and fencing that will remain as part of these works. The proposed location and construction of hoardings/site fences is described in Table 2-1.

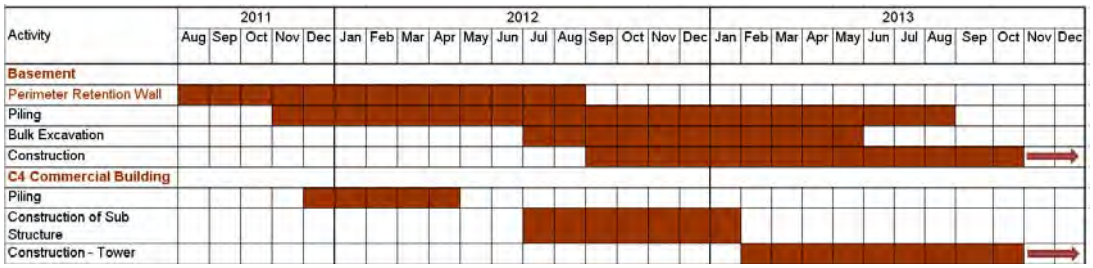
Table 2-1 Proposed construction hoardings / site fences

Frontage	Proposed Fencing
Hickson Road	A Class B painted hoarding along Hickson Road extending north from the Margaret Street intersection. Vehicle gates will be located at the northern end of Stage 1 for access to and from site, to coincide with existing crossovers associated with the former Port use. This area will be secured by gatemen and stop/go personnel to control pedestrian and vehicle traffic.
Shelly Street	Shelley Street will be protected by Class A 2.4m painted plywood hoarding.
Western Frontage	Class A 2.4m painted plywood hoarding or chain wire that bounds the site mesh/barbed fence will be erected along the Western Frontage to maintain the public thoroughfare through to King Street Wharf.
Northern Frontage	Class A painted hoarding of minimum 2.4m height.

2.4 Construction Activities

The expected works associated with the C4 development are shown in Figure 2-1. However, the activities "Excavation" and "Construction Sub-structure" listed under "C4 Commercial Building" will be delivered as part of the Basement project, and are not specifically addressed in this report.

Figure 2-1 Expected Construction Program



It is important that the cumulative noise impacts from all site construction activities in the area are considered. Other construction activities that may occur concurrently include the Headland Park works and Excavation and Basement Car Parking works. For this reason, in addition to the identified Piling, Tower Construction and Finishes and Fitout stages of construction, noise assessments for this report consider Piling in conjunction with concurrent Basement works, and simultaneous Tower Construction and Fitout.

The Headland Park works are covered by MP10_0047 and likely to be carried out by a contractor separately commissioned by the Barangaroo Delivery Authority. This report also considers the cumulative effect of these works and C4 construction.

2.5 Construction Traffic

Construction traffic generated by the construction of C4 will combine with traffic from basement works. The following Table 2-1

Table 2-1 Estimated Construction Generation

Milestone Number	Milestone Description	Total Deliveries / Day / Qtr
Oct 11 - Dec 11	PRW / Stage 1 Piling	51
Jan 12 - Mar 12	PRW / Stage 1 Piling & Anchor Ex	66
April 12 - June 12	Stage 1 Piling & Anchors & Bulk Ex	**230**
July 12 - Sept 12	Stage 2 Piling / Bulk Ex / Detailed Ex / C4 Core	186
Oct 12 - Dec 12	Stage 2 Piling / Bulk Ex / Detailed Ex / C4 Core / Ground Slab	227
Jan 13 - Mar 13	Stage 2 Piling / Detail Ex / SOG / C4 Core	209
April 13 - June 13	Stage 2 Piling / SOG / C4 & C3 Core / Sea Water intake	148
July 13 - Sept 13	Mez & GF Structure / C3 & C4 Core / C4 Low rise	187
Oct 13 - Dec 13	Basement GF Structure / C4 / C3	189
Jan 14 - Mar 14	C4 Mid/highrise / LGR infra Rough in / Facade	154
April 14 - June 14	C4 Structure complete / C4 Fitout / Basement services	**159**
July 14 - Sept 14	C4 Facade / Finishes / Fitout / Services	129
Oct 14 - Dec 14	C4 Facade / Finishes / Fitout / Services	142
Jan 15 - Mar 15	C4 Facade / Finishes / Fitout / Services / External works	139
April 15 - June 15	C4 Facade / Finishes / Fitout / Services	96

Maximum movements are estimated to be in the order of 230 trucks per day during basement works whilst the maximum trucks generated by the combined construction of the basement and C4 tower will be in the order of 159 trucks per day

3 AMBIENT NOISE LEVELS AND SURROUNDING RECEIVERS

WMSPL was involved in a previous study at Barangaroo Stage 1 for Lend Lease Millers Point Pty Ltd. That study was for a construction noise and vibration assessment for the Bulk Excavation and Basement Car Parking Stage. As part of that study, all residential and commercial receivers that may be affected by construction noise and vibration were identified. These receivers are applicable for this current study relating to the Construction of Building C4 and are detailed in Table 3-1.

Table 3-1 Surrounding Receivers

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

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. Additional ambient noise data that has been utilised consists of noise logging conducted by Arup as described in the Operational Acoustic Assessment report prepared by Arup and entitled ***" Lend Lease (Millers Point) Pty Limited Barangaroo Stage 1 - PA 1 Bulk Excavation and Basement Car Parking (MP10-0023) Acoustic Report - Planning Application"***

The noise monitoring locations are described in Table 3-2 and 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 - Representative of Temporary Passenger Terminal	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, Millers Point	31 August – 9 September	WM
6	18 Merriman St, Dawes Point	31 August – 6 September	WM
7	25 Edward St, Balmain East	31 August – 9 September	WM
8	Adjacent to 3 Darling Island Rd, Darling Island	31 August – 9 September	WM

Figure 3-1 Aerial showing Noise Monitoring Locations

*Source: Land and Property Management Authority

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

In the case of noise logging conducted by ARUP, the data was reviewed by WM and is considered suitable to use for assessment purposes. The details of the noise measurement equipment and calibration can be referred to within the ARUP 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. 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.

Detailed results for each monitoring location are shown in graphical form in Appendix A. The graphs show measured values of L_{Aeq}, L_{A90}, L_{A10} and L_{A1} for each 15-minute monitoring period.

Table 3-3 summarises the noise results, for daytime, evening and night time periods as defined in the OEH's *Construction Noise Guidelines* (*CNG*). 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. The summary values are:

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

Table 3-3 Summary of Measured Noise Levels

Noise Logging Site	RBL (dBA)				$L_{Aeq,period}$ (dBA)			
	Daytime 7-6pm	Evening 6-10pm	Night Time 10pm-7am	Saturday 7am-5pm	Daytime 7-6pm	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 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 OEH procedures.

Results of noise logging are presented in Appendix A.

4 CONSTRUCTION NOISE AND VIBRATION CRITERIA

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

- *Interim Construction Noise Guideline*; and,
- *Assessing Vibration: A Technical Guideline*.

4.1 Construction Noise Criteria

The OEH 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 as defined by the CNG. The standard hours are:

- Monday to Friday 7.00am to 6.00pm
- Saturday 8.00am to 1.00pm

Outside the standard hours, the criterion would be background + 5dBA.

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 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Noise affected RBL + 10dBA	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured Lea,(15min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. 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.
	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.
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 $L_{Aeq,15\ min}$ construction noise management levels 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.

Table 4-2 Site Specific Construction Noise Management Levels

Location	Construction Noise Management Level, L_{Aeq} - dBA				Maximum Construction Noise Level, L_{Aeq} - dBA
	Day	Evening	Night	Saturday (extended)	
1 – Hickson Road Residences	63	58	54	55	75
3 – The Sussex Hotel	70	64	54	62	75
5 – High Street Residences	57	49	46	50	75
6 – Dawes Point Residences	56	49	45	51	75
7 – Balmain East Residences	59	50	45	51	75
8 – Darling Island Residences	57	49	44	55	75
All Commercial Properties	70				
Schools / Preschools	55*				
Parks / Outdoor Play Areas	65				

* The external noise goal of 55dBA is based on a 10dB reduction through an open window.

4.2 Construction Vibration Criteria

4.2.1 Human Comfort

Criteria for assessment of the effects of vibration on human comfort are set out in British Standard 6472-1992. Methods and criteria in that Standard are used to set "preferred" and "maximum" vibration levels in the document "*Assessing Vibration: A Technical Guideline*" (2006) produced by the NSW OEH.

Acceptable values of human exposure to continuous vibration, such as that associated with underground drilling, are dependent on the time of day and the activity taking place in the occupied space (e.g. workshop, office, residence or a vibration-critical area). Guidance on preferred values for continuous vibration is set out in Table 4-3.

Table 4-3 Criteria for Exposure to Continuous Vibration

Place	Time	Peak Particle Velocity (mm/s)	
		Preferred	Maximum
Critical working areas (e.g. hospital operating theatres precision laboratories)	Day or night time	0.14	0.28
Residences	Daytime	0.28	0.56
	Night time	0.20	0.40
Offices	Day or night time	0.56	1.1
Workshops	Day or night time	1.1	2.2

In the case of intermittent vibration, which is caused by plant such as rockbreakers, the criteria are expressed as a Vibration Dose Value (VDV) which is presented in Table 4-4.

Table 4-4 Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime		Night Time	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Calculation of VDV requires knowledge of the number of events in the relevant time period.

4.2.2 Building Damage

In terms of the most recent relevant vibration damage objectives, Australian Standard AS 2187: Part 2-2006 "Explosives – Storage and Use – Part 2: Use of Explosives" recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2" as they "are applicable to Australian conditions".

The British Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

The recommended limits (guide values) from BS7385 for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 4-5.

Table 4-5 Transient Vibration Guide Values - Minimal Risk of Cosmetic Damage

Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50mm/s at 4 Hz and above	N/A
Unreinforced or light framed structures Residential or light commercial type buildings	15mm/s at 4 Hz increasing to 20mm/s at 15 Hz	20mm/s at 15 Hz increasing to 50mm/s at 40 Hz and above

The standard states that the guide values in Table 4-5 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

Note that rockbreaking/hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures (e.g. residences) and where these activities occur it may therefore be appropriate to reduce the transient values by 50%.

The British Standard goes on to state that "*Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity*". In addition, a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.

In addition to the British Standard, for the case of nearby heritage buildings, guidance for structural damage is derived from the German Standard DIN 4150 – 3 "Structural Vibration Part 3 – Effects of Vibration on Structures". Table 4-6 details the recommendations for heritage buildings.

Table 4-6 DIN 4150 recommended vibration level for Heritage Buildings

Frequency Range of Predominant Pulse	1-10 Hz	10 to 15 Hz	40 to 50 Hz
Peak component particle velocity	3 mm/s	3 to 8 mm/s	8-10 mm/s

5 CONSTRUCTION EQUIPMENT NOISE SOURCE LEVELS

Sound Power Levels (SWLs) for typical construction plant are identified in Table 5-1. These SWLs have recently 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 Typical Construction Plant Sound Levels – dBA

Plant	Sound Power Level	Sound Pressure Level at 7m
Bulldozer	114	94
Pug Mill – Remediation Plant	100	75
Excavator	108	82
Rotary Hoe	109	84
Mobile Crane	104	79
Concrete Truck	109	84
Angle Grinder	109	84
Concrete Pump – 120 mm diameter / 50 bar	112	87
Bentonite Plant	104	79
Sheet Metal Forming (Grinding, Hammer)	105	80
Concrete Crushing and Screening Plant	116	91
Concrete Saw	116	91
Crawler Cranes	98	73
Ground Water Pump	106	81
Mobile Crane	98	73
Rotary Boring Drill Rig	107	82
Site Cranes	104	79
Dump Truck	108	83
Front End Loader	112	87
Excavator	107	82
Hammer Hydraulic	122	97
Auger Vibro Pile	110	85
Bored Pile Rig	112	87
Sheet Piling - Vibrating	108	83
Concrete Saw	113	88
Compressor	100	75
Bobcat	103	78
Hand Tools	90	65
Jackhammer	105	80

6 CONSTRUCTION NOISE ASSESSMENT

Assessment of likely noise at surrounding commercial and residential receivers has been assessed for the site during excavation and general construction.

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.

The model includes the effect of the 2.4 metre noise barriers around the site as recommended in our previous PA1 Basement construction noise assessment.

Modelling has been conducted for the construction scenarios described in Section 2.4. The five scenarios considered are summarised in Table 6-1.

Table 6-1 Construction Scenarios for C4

Scenario	Description	Works
A1	C4 Auger Piling	4 auger piling rigs and 2 truck movements are assumed to operate in 15minutes.
A2	C4 Sheet Piling	In the event that vibratory impact sheet piling for C4 occurs in isolation. 1 piling rig operating for 4 weeks
B	C4 Building Construction	This scenario includes concreting and lifting. 2 concrete pumps, 2 forklifts, 4 compressors, 2 cranes, a boom truck and lift are assumed to operate in 15minutes. Also concrete trucks and normal delivery trucks assumed to be 12 movements in 15minutes.
C	C4 Facade	In the event that the construction of the façade occurs in isolation. Forklift and power tools assumed. 4 truck movements in 15minutes assumed.
D	Scenarios B + C	Represents periods where both Scenarios B and C occur concurrently.
E	Scenario A + Basement PA1 earthworks + piling	Represents periods where the piling for C4 and earthwork and vibratory piling for PA1 occur concurrently.

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

Area Noise Sources – General construction equipment that is distributed across the work site has been modelled as an area source based on proposed equipment numbers and total noise levels.

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.

Under the OEH's *Industrial Noise Policy*, certain noise sources, notably rockbreakers and other impact activities, attract a "modifying factor" penalty of 5 dBA because they are understood to be particularly annoying. Where these sources are determined to be the principal contributor to overall noise levels, a 5 dB penalty is applied to the predicted noise level at a receiver. However, no noise sources associated with stage C4 require the application of modifying factors.

6.1 Predicted Construction Noise Levels

Predicted noise levels at surrounding receivers are presented as follows:

- Table 6-2 Residential Receivers
- Table 6-3 Commercial Receivers
- Table 6-4 Schools and Pre Schools

In addition, daytime noise contour plots of the site and surrounds for Scenarios A-D are presented in Figures 6-1 to 6-4.

In scenario E, noise levels in the evening and night periods are presented. There is no proposed C4 construction work in these hours – the levels shown are due entirely to basement works that are also included in this Scenario. These have been addressed in a previous report and are presented for completeness. The identified exceedances in these periods are not within the scope of this assessment and have been addressed in the previous PA1 basement construction noise assessment.

Table 6-2 Predicted Noise Levels at Residential Receivers – $L_{Aeq(15\ min)}$

Location	Predicted Noise Day / Night dBA		Day			Evening			Night			Saturday (Extended)		
			Criteria dBA	Exceedance dBA	Compliance	Criteria dBA	Exceedance dBA	Compliance	Criteria dBA	Exceedance dBA	Compliance	Criteria dBA	Exceedance dBA	Compliance
Scenario A1 - Piling														
1 – Hickson Road Residences	57		63	-	Yes							55	2	No
3 – The Sussex Hotel	55		70	-	Yes							62	-	Yes
5 – High Street Residences	45		57	-	Yes							50	-	Yes
6 – Dawes Point Residences	40	NA	56	-	Yes				NA			51	-	Yes
7 – Balmain East Residences	40		59	-	Yes							51	-	Yes
8 – Darling Island Residences	46		57	-	Yes							55	-	Yes
9 – Sydney Wharf Residences	48		57	-	Yes							55	-	Yes
Scenario A2 - Sheet Piling														
1 – Hickson Road Residences	54		63	-	Yes							55		Yes
3 – The Sussex Hotel	52		70	-	Yes							62		Yes
5 – High Street Residences	43		57	-	Yes							50		Yes
6 – Dawes Point Residences	33	NA	56	-	Yes				NA			51		Yes
7 – Balmain East Residences	33		59	-	Yes							51		Yes
8 – Darling Island Residences	39		57	-	Yes							55		Yes
9 – Sydney Wharf Residences	43		57	-	Yes							55		Yes
Scenario B - C4 Building Construction														
1 – Hickson Road Residences	59	NA	63	-	Yes				NA			55	4	No
3 – The Sussex Hotel	61		70	-	Yes							62	-	Yes
5 – High Street Residences	49		57	-	Yes							50	-	Yes

Location	Predicted Noise Day / Night dBA		Day Criteria dBA	Day Exceedance dBA	Day Compliance	Evening Criteria dBA	Evening Exceedance dBA	Evening Compliance	Night Criteria dBA	Night Exceedance dBA	Night Compliance	Saturday (Extended) Criteria dBA	Saturday (Extended) Exceedance dBA	Saturday (Extended) Compliance
6 – Dawes Point Residences	45		56	-	Yes							51	-	Yes
7 – Balmain East Residences	45		59	-	Yes							51	-	Yes
8 – Darling Island Residences	51		57	-	Yes							55	-	Yes
9 – Sydney Wharf Residences	52		57	-	Yes							55	-	Yes
Scenario C - C4 Facade														
1 – Hickson Road Residences	52		63	-	Yes							55	-	Yes
3 – The Sussex Hotel	53		70	-	Yes							62	-	Yes
5 – High Street Residences	42		57	-	Yes							50	-	Yes
6 – Dawes Point Residences	37	NA	56	-	Yes			**NA**				51	-	Yes
7 – Balmain East Residences	36		59	-	Yes							51	-	Yes
8 – Darling Island Residences	43		57	-	Yes							55	-	Yes
9 – Sydney Wharf Residences	45		57	-	Yes							55	-	Yes
Scenario D - Scenarios B + C														
1 – Hickson Road Residences	60		63	-	Yes							55	**5**	**No**
3 – The Sussex Hotel	61		70	-	Yes							62	-	Yes
5 – High Street Residences	50		57	-	Yes							50	-	Yes
6 – Dawes Point Residences	46	NA	56	-	Yes			**NA**				51	-	Yes
7 – Balmain East Residences	45		59	-	Yes							51	-	Yes
8 – Darling Island Residences	51		57	-	Yes							55	-	Yes
9 – Sydney Wharf Residences	53		57	-	Yes							55	-	Yes

Table 6-2 (Continued) Predicted Noise Levels at Residential Receivers – $L_{Aeq(15\ min)}$

Location	Predicted Noise Day / Night dBA		Day			Evening			Night			Saturday (Extended)		
			Criteria dBA	Exceedance dBA	Compliance	Criteria dBA	Exceedance dBA	Compliance	Criteria dBA	Exceedance dBA	Compliance	Criteria dBA	Exceedance dBA	Compliance
Scenario E - Scenario A + Basement PA1 earthworks + piling														
1 – Hickson Road Residences	65	53	63	**2**	**No**	58	-	Yes	54	-	Yes	55	**10**	**No**
3 – The Sussex Hotel	62	44	70	-	Yes	64	-	Yes	54	-	Yes	62	-	Yes
5 – High Street Residences	53	49	57	-	Yes	49	-	Yes	46	**3**	**No**	50	**3**	**No**
6 – Dawes Point Residences	50	43	56	-	Yes	49	-	Yes	45	-	Yes	51	-	Yes
7 – Balmain East Residences	49	42	59	-	Yes	50	-	Yes	45	-	Yes	51	-	Yes
8 – Darling Island Residences	53	44	57	-	Yes	49	-	Yes	44	-	Yes	55	-	Yes
9 – Sydney Wharf Residences	55	42	57	-	Yes	49	-	Yes	44	-	Yes	55	-	Yes

Note: Activities during the evening and night attributed to basement and carpark works only.

Table 6-3 Predicted Noise Levels at Commercial Receivers - $L_{Aeq(15\ min)}$

Location	Predicted Noise Day/Night dBA		Day			Evening			Night			Saturday (Extended)		
			Criteria dBA	Exceedance dBA	Compliance	Criteria dBA	Exceedance dBA	Compliance	Criteria dBA	Exceedance dBA	Compliance	Criteria dBA	Exceedance dBA	Compliance
Scenario A1 - Piling														
Lime Street, (King Street Wharf)	51	NA	70	-	Yes							70	-	Yes
30 Hickson Rd	55		70	-	Yes							70	-	Yes
Shelly Street	59		70	-	Yes				NA			70	-	Yes
Temporary Cruise Terminal	45		70	-	Yes							70	-	Yes
Scenario A2 – Sheet Piling														
Lime Street, (King Street Wharf)	51	NA	70	-	Yes							70	-	Yes
30 Hickson Rd	45		70	-	Yes							70	-	Yes
Shelly Street	55		70	-	Yes				NA			70	-	Yes
Temporary Cruise Terminal	51		70	-	Yes							70	-	Yes
Scenario B - C4 Building Construction														
Lime Street, (King Street Wharf)	56	NA	70	-	Yes							70	-	Yes
30 Hickson Rd	59		70	-	Yes							70	-	Yes
Shelly Street	63		70	-	Yes				NA			70	-	Yes
Temporary Cruise Terminal	52		70	-	Yes							70	-	Yes

Table 6-3 Predicted Noise Levels at Commercial Receivers - $L_{Aeq(15\ min)}$

Location	Predicted Noise Day/Night dBA		Day			Evening			Night			Saturday (Extended)		
			Criteria dBA	Exceedance dBA	Compliance	Criteria dBA	Exceedance dBA	Compliance	Criteria dBA	Exceedance dBA	Compliance	Criteria dBA	Exceedance dBA	Compliance
Scenario C - C4 Facade														
Lime Street, (King Street Wharf)	48	NA	70	-	Yes							70	-	Yes
30 Hickson Rd	51		70	-	Yes				NA			70	-	Yes
Shelly Street	54		70	-	Yes							70	-	Yes
Temporary Cruise Terminal	45		70	-	Yes							70	-	Yes
Scenario D - Scenarios B + C														
Lime Street, (King Street Wharf)	60	NA	70	-	Yes							70	-	Yes
30 Hickson Rd	56		70	-	Yes				NA			70	-	Yes
Shelly Street	63		70	-	Yes							70	-	Yes
Temporary Cruise Terminal	52		70	-	Yes							70	-	Yes
Scenario E - Scenario A + Basement PA1 earthworks + piling														
Lime Street, (King Street Wharf)	61	51	70	-	Yes	70	-	Yes	70	-	Yes	70	-	Yes
30 Hickson Rd	58	43	70	-	Yes	70	-	Yes	70	-	Yes	70	-	Yes
Shelly Street	63	44	70	-	Yes	70	-	Yes	70	-	Yes	70	-	Yes
Temporary Cruise Terminal	58	57	70	-	Yes	70	-	Yes	70	-	Yes	70	-	Yes

Note: Activities during the evening and night attributed to basement and carpark works only.

Table 6-3 Predicted Noise Levels at School Receivers - $L_{Aeq(15\ min)}$

Note: For Scenario E, activities during the evening and night attributed to basement and carpark works only.

Location	Predicted Noise Day/ Night dBA		Day Playground			Day Internal Noise		
			Criteria dBA	Exceedance dBA	Compliance	Criteria dBA	Exceedance dBA	Compliance
Scenario A1 - Piling								
Billabond Child Care	51		65	-	Yes	55	-	Yes
KU Lance Preschool	45		65	-	Yes	55	-	Yes
Scenario A2 – Sheet Piling								
Billabond Child Care	45		65	-	Yes	55		Yes
KU Lance Preschool	43		65	-	Yes	55		Yes
Scenario B - C4 Building Construction								
30 Hickson Road	56		65	-	Yes	55	**Marginal - 1**	**No**
KU Lance Preschool	45		65	-	Yes	55	-	Yes
Scenario C - C4 Facade								
30 Hickson Rd	48		65	-	Yes	55	-	Yes
KU Lance Preschool	42		65	-	Yes	55	-	Yes
Scenario D - Scenarios B + C								
Billabond Child Care	56		65	-	Yes	55	**Marginal - 1**	**No**
KU Lance Preschool	50		65	-	Yes	55	-	Yes
Scenario E - Scenario A + Basement PA1 earthworks + piling								
Billabond Child Care	61	-	65		Yes	55	**6**	**No**
KU Lance Preschool	53	-	65		Yes	55	-	Yes

Note: Premises unlikely to be used during the evening, and not at night.

Figure 6-1 Construction Scenario A Daytime $L_{Aeq(15\ minutes)}$ Noise Contours

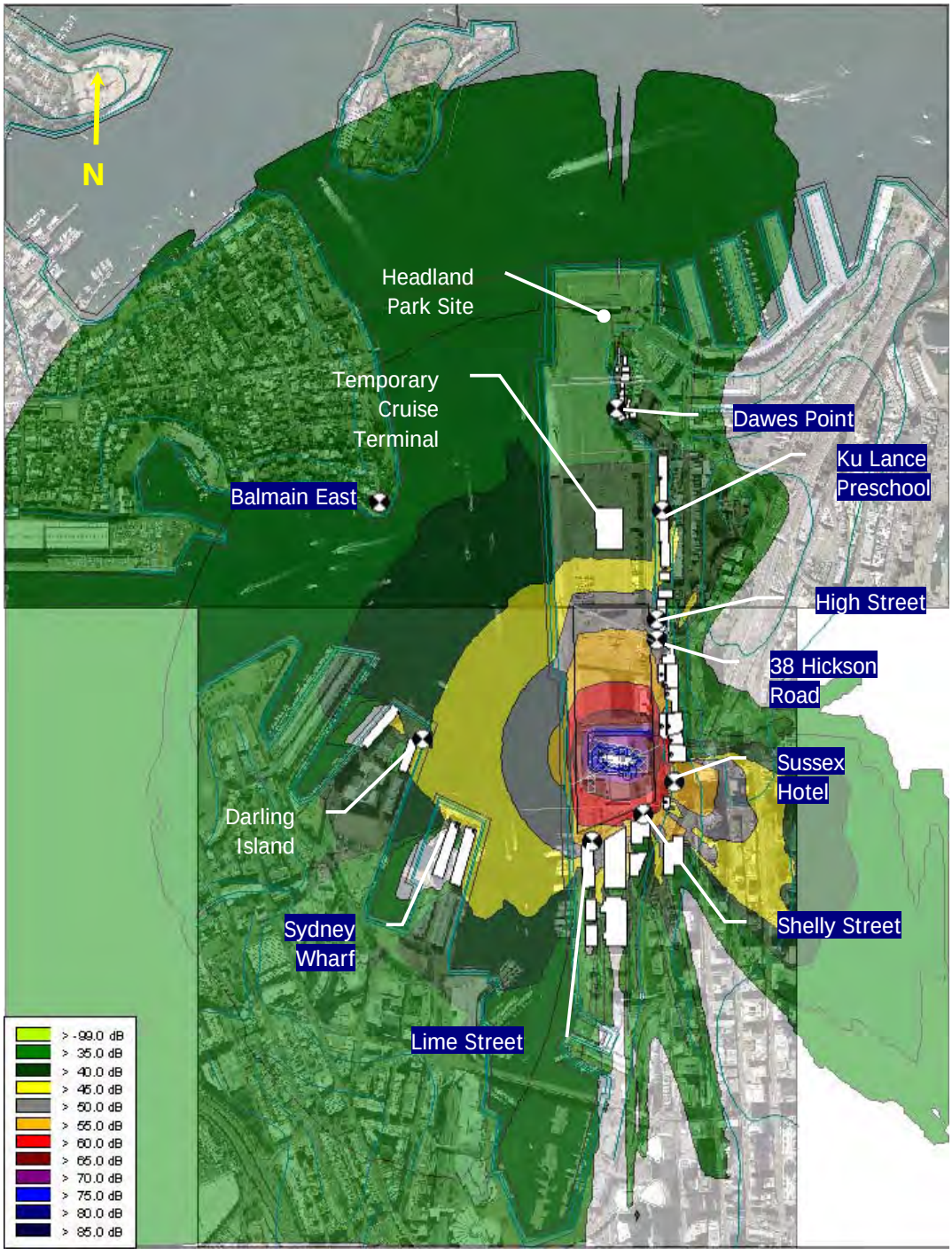


Figure 6-2 Construction Scenario B Daytime $L_{Aeq(15\ minutes)}$ Noise Contours

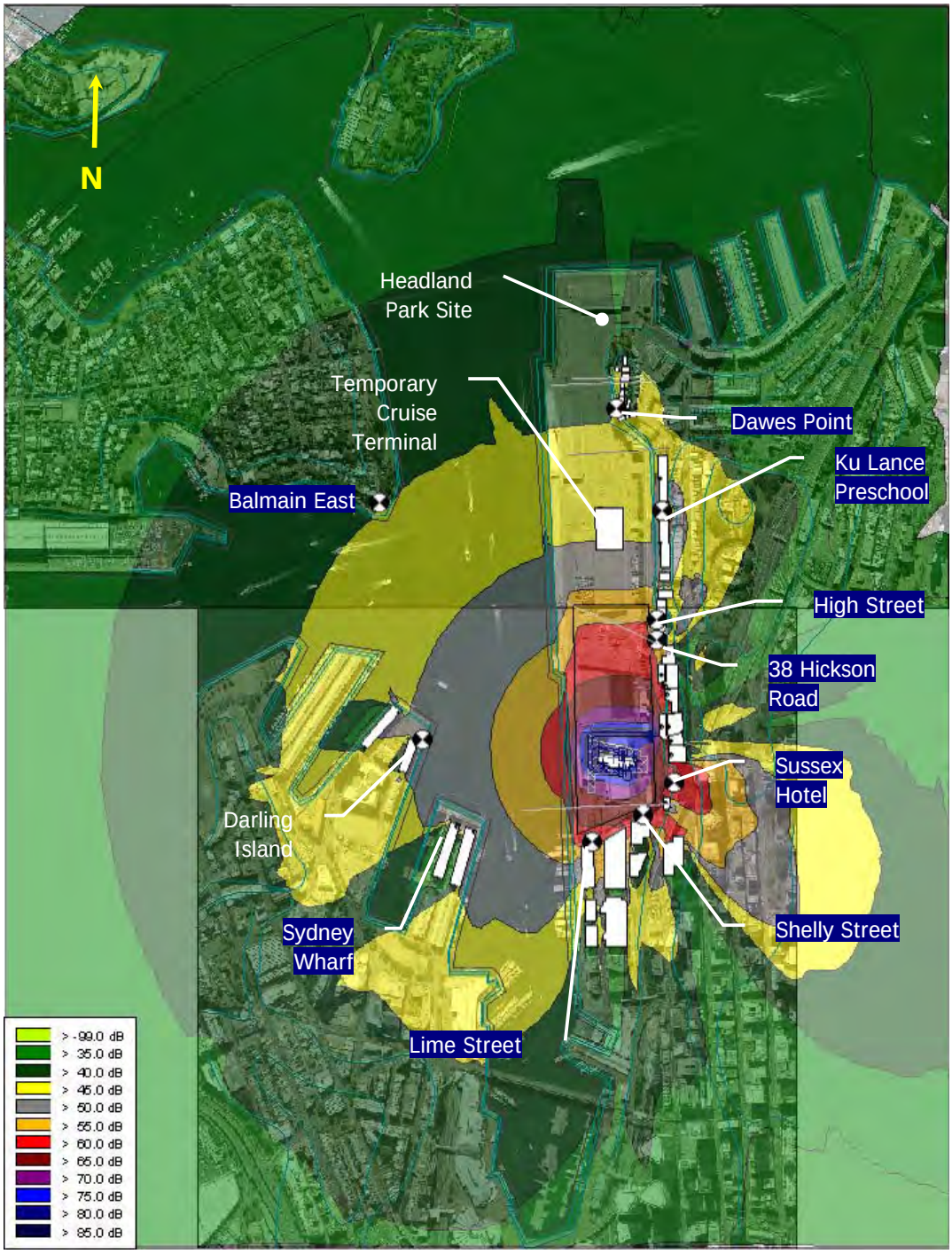


Figure 6-3 Construction Scenario C Daytime $L_{Aeq(15\ minutes)}$ Noise Contours

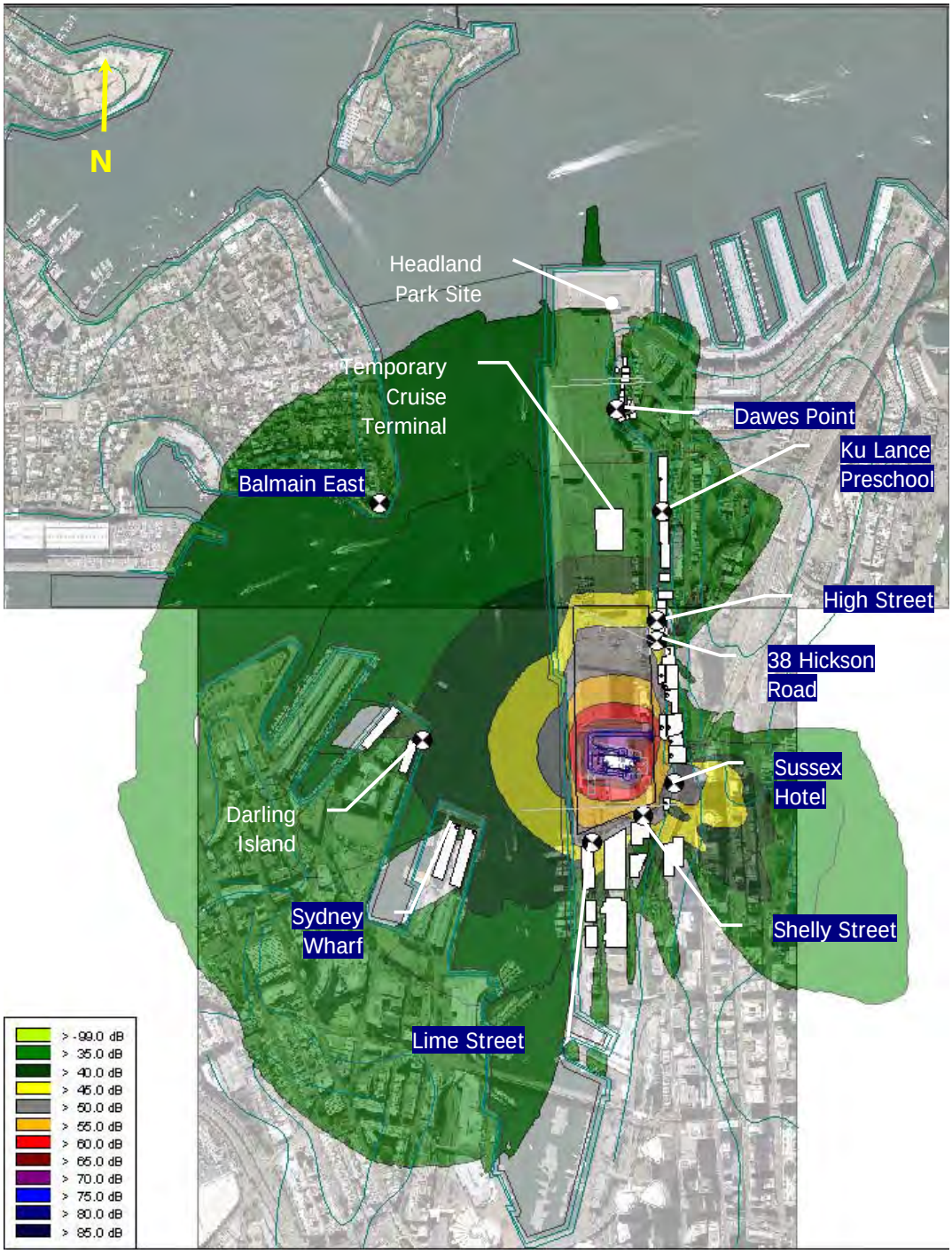
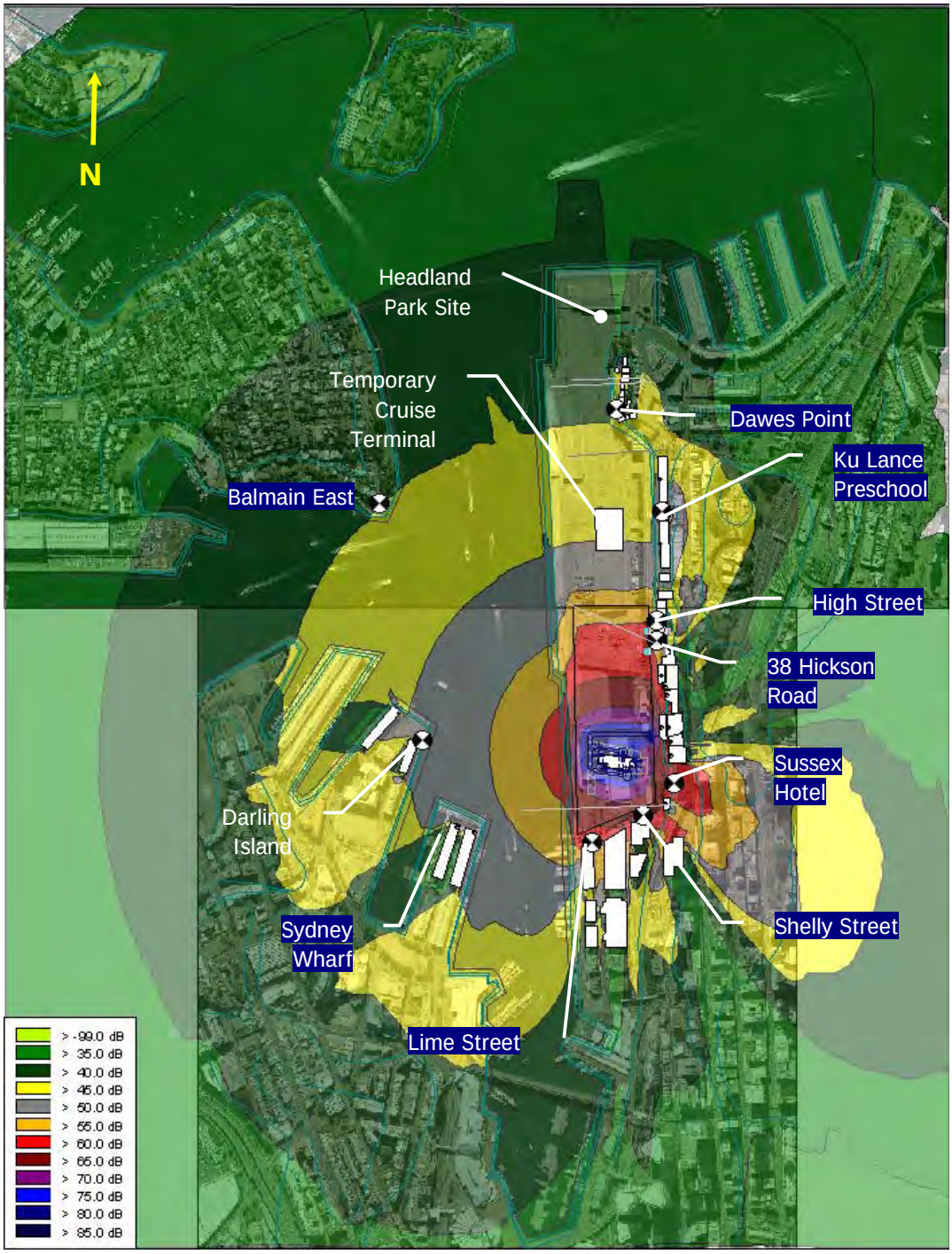


Figure 6-4 Construction Scenario D Daytime $L_{Aeq(15\ minutes)}$ Noise Contours



6.2 Discussions of Results

6.2.1 Residential Receivers

During normal operating hours, the only predicted exceedance of relevant noise criteria is an exceedance of 2 dBA at the Hickson Road residences, under Scenario E. This is due to noise from the basement works, which in this scenario is significantly higher than that from C4 works.

During extended Saturday operating hours, exceedances of up to 4dBA are predicted at the same residences due to C4 works alone, and up to 10dBA due to combined noise from C4 and basement works.

It is noted that all construction noise levels are well below the maximum construction noise level of 75 dBA.

Selection of noise control kits for some louder plant would reduce these noise levels to some extent, and could potentially eliminate exceedances during normal working hours.

6.2.2 Commercial Receivers

Compliance with the 70 dBA noise objective is indicated at all surrounding commercial premises.

These premises are generally of modern construction and do not have operable windows, such that a facade reduction of at least 20 dBA can be expected. As a result, maximum internal noise levels in the order of 40 to 45dBA dBA are predicted. This is consistent with the maximum noise levels recommended in Australian Standard 2107 for general office areas,

Commercial receivers which have operable windows would be subjected to construction noise levels at least 10 dBA higher if windows were open. Therefore, where internal noise levels exceed 45 dBA, windows may need to be closed during intensive periods of construction.

In the case of restaurants and cafes at the northern end of Lime Street and the Shelley Street precinct, maximum internal construction noise levels up to 50 to 53dBA are predicted. The provision of plywood hoardings has been previously recommended on the southern site boundary to improve the acoustic amenity of outdoor eating areas. These barriers have been included in our predictions.

6.2.3 Preschools

At preschools, external noise levels are predicted to comply with the 65 dBA noise objective for active recreation areas. A marginal exceedance of internal noise objectives of 1 dBA is predicted at the Billabond Child care Centre when windows are open. This exceedance is not considered acoustically significant.

For Scenario E, when the cumulative construction noise from basement works is included, an exceedance of 6 dBA is indicated at this Centre. It can be concluded that it is noise from the basement works that is the main contributor if this exceedance. To achieve the recommended criterion, windows may need to be closed during intensive periods of construction.

6.2.4 Temporary Cruise Ship Passenger Terminal

The temporary cruise ship passenger terminal has been approved by the Barangaroo Delivery Authority (under Part 5 of the Environmental Planning and Assessment Act 1979) to operate adjacent to Gate 5 on the site of Barangaroo until 2012. Based on information provided by Sydney Ports, there are approximately 130 ship days per year when a ship will be docked at Wharf 5.

Maximum noise levels of up to 58 dBA are predicted during construction scenario E, when works for C4 and the basement and carparking stages could occur concurrently. At these noise levels, effective communication will be achieved in the terminal at distance of at least 2 m between persons using a normal voice effort. Lower construction noise levels are predicted for all other scenarios.

6.3 Extended Hours of Operation

It is proposed to undertake activities outside OEH normal hours of construction. This will enable the activities to be carried out in a more efficient manner, thereby shortening the construction period during which receptors are exposed to construction-related noise and vibration impacts.

These works will be undertaken during hours that are consistent with the City of Sydney Council's preferred hours for construction. These hours include Saturday afternoon up to 5pm, which recognises the urban nature of the city environment. This differs from the OEH guideline which covers the entire range of environments in NSW.

Section 2.2 discusses proposed hours of operation in more detail.

Some activities are required to be undertaken outside normal construction hours, for example dewatering and treatment of groundwater, dust suppression, attendance to environmental protection structures, and other site and maintenance activities. These have been included in the noise assessment and where appropriate localised treatment will be implemented on site.

It is noted that the subject site is located within a commercial precinct where there is significant other local activity during the construction periods, and also bearing in mind the site's previous use permitted 24 hour per day operation of the port facilities. It is also noted that fewer impacts on commercial receivers are expected during these times, as some of these buildings would have reduced occupation during these periods.

It is recommended that for Saturday operations consideration be given to, where feasible, planning construction activities so that the loudest activities occur during standard construction hours. In addition, the use of equipment over defined periods with periods of respite is provided is recommended to be included in the Environmental Management Plan.

6.4 Cumulative Noise Impact with Headland Park Works

The predicted construction noise levels due to the works associated with stage C4 are more than 10dB below those predicted construction noise from Headland Park Construction Works at Balmain East and Dawes Point Residences (based on predictions conducted by Acoustic Logic Consultancy Pty Ltd for the Barangaroo Delivery Authority BDA). As such the impact of C4 construction noise on theses receivers is considered negligible.

In the case of the Cruise Passenger Terminal there are no construction predictions presented in the Acoustic Logic Consultancy (ALC) report. Therefore the noise levels presented for the Universal Music Australia premises have been taken to be indicative of likely Headland Park construction noise levels at the terminal during the "Receipt of fill for Stage 1" period.

External noise levels of 69-75 dBA at the passenger terminal have been determined from ALC predictions by adding a 20 dBA façade correction to the predicted internal noise levels presented in the ALC assessment for Universal Music Australia.

Assuming the previously recommended 2.4 metre barrier is installed on the northern side of the passenger terminal by the BDA, Headland Park construction noise can be expected to be reduced by about 10 dBA, resulting in a noise level of 59 – 65 dBA. This combined with C4 and PA1 noise of 54 dBA will result in cumulative noise levels in the order of 60 -65 dBA. In this context, South Baranagaroo construction noise is not considered to be a significant contributor to overall construction noise at the Passenger Terminal.

7 CONSTRUCTION VIBRATION ASSESSMENT

Construction, demolition and excavation activities have the potential to generate significant levels of vibration. However, as mentioned previously, the works associated with C4 will not involve plant that will generate significant vibration levels. The main plant that could generate vibration would be:

- bored piling; and
- general earthmoving plant such as excavators, truck etc (no rock breaker or rollers).

Given the above, and the fact that the distance from the works to the nearest receiver (minimum of 85m), the impact is considered to be negligible and no further assessment necessary.

8 CONSTRUCTION NOISE AND VIBRATION MANAGEMENT MEASURES

8.1 Construction Noise and Vibration Mitigation Measures

Without mitigation, noise levels from some construction activities have been predicted to exceed the noise management levels nominated in the guidelines at some surrounding receivers. Therefore, noise control measures have been recommended to ensure that noise is reduced where feasible.

A range of possible approaches to reducing the impact of construction noise is described below. It is proposed that these strategies be applied to the areas of potential exceedance identified in the preceding section.

- *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 OEH guidelines.
- *Site Noise Planning* - Where practical, 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 the street frontages with minimum 17mm thick structural plywood or similar. (The site would be surrounded by hoardings erected in accordance with the City of Sydney Guidelines.) This recommendation has been made for the PA1 basement application and has been included in modelling.

8.2 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 appraised of progress of the works, and to forewarn potentially affected groups (e.g. by letterbox drop, meetings with surrounding residences, 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 Leases' *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.

8.3 Noise and Vibration Management Plan

A Noise and Vibration Management Plan has been prepared for the PA1 Basement stage works. This plan will be incorporated into Lend Lease's Environmental Management Plan.

This plan details the mitigation, monitoring and community liaison measures. The plan will be updated to incorporate any additional measures that emerge as the project design evolves and work methodologies become better defined.

Areas that should be 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;
- Community consultation and complaint handling.

9 CONSTRUCTION TRAFFIC

9.1 Traffic Noise Criteria

Criteria for assessment of road traffic noise are set out in the NSW Government's *NSW Road Noise Policy (RNP)*. Table 9-1 sets out the assessment criteria for residences to be applied to particular types of project, road category and land use.

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

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

Table 9-1 Traffic noise criteria extracted from the NSW *RNP*

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

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

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

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

The proposed haulage routes are located to the west of the site boundary thereby avoiding the passby by haulage trucks of residences on Hickson Road. It has been determined that the road on which residences are located that will be subjected to the most traffic generated by the proposed activities will be those on Hickson Road and Sussex Street. The main southern haulage truck route for off-site disposal would be along Sussex Street to the Western Distributor and/ or Cross City Tunnel/Eastern Distributor.

Some trucks may also be travel north via Napoleon Street, Kent Street and onto the Harbour

Bridge.

The results of noise logging at Location 3 at Sussex Street have been processed to determine a existing daytime traffic noise level of $L_{Aeq(15\ hrs)}$ 66.7 dBA. It should be noted that existing traffic noise in relevant areas already exceeds the "base" noise criteria in Table 9-1. As any increase in traffic volumes associated with this project would be temporary in nature, the 2dBA allowance goal applies.

A review of the basement and C4 traffic data for the basement works indicated that a maximum of 230 Truck Loads per day (460 movements) is envisaged during "Piling and Anchors and Bulk Excavation". Following a tapering down of basement truck movements the highest truck flow will occur during "C4 Structure complete / C4 Fitout/ Basement services" stage when 318 Truck Movements per day on average will occur.

Table 9-2 details predicted future noise levels due to the two truck movement scenarios.

Table 9-2 Predicted Daytime Traffic Noise Levels at Sussex Street - $L_{Aeq,15hr}$

Truck Movements per day along Sussex Street	Existing Traffic Noise Level - dBA	Truck Noise Contribution - dBA	Total Noise Level -dBA	Predicted Noise Increase dBA
159	66.7	59.5	67.5	0.8
230	66.7	61.1	67.8	1.1

As the existing noise levels at residences along Sussex Street already exceed traffic objectives of the RNP the additional traffic should not increase traffic noise levels by more than 2 dBA. Review of the above prediction indicates that noise levels due to truck noise comply with the applicable noise criteria. Therefore the impact of construction traffic noise is considered acoustically acceptable.

10 SUMMARY OF RECOMMENDATIONS

Based on our investigations of the project the following findings have been determined.

10.1 Noise Criteria

Noise objectives for construction have been established based on OEH procedures. These criteria should be adopted as objectives to work towards in minimising any noise impact at surrounding residences.

Table 10-1 presents applicable noise criteria at residential receivers in the vicinity of the site.

Table 10-1 Site Specific Construction Noise Management Levels – dBA

Location	Construction Noise Management Level, L_{Aeq} – dBA				Maximum Construction Noise Level, L_{Aeq} - dBA
	Day	Evening	Night	Saturday (extended)	
1 – Hickson Road Residences	63	58	54	55	75
3 – The Sussex Hotel	70	64	54	62	75
5 – High Street Residences	57	49	46	50	75
6 – Dawes Point Residences	56	49	45	51	75
7 – Balmain East Residences	59	50	45	51	75
8 – Darling Island Residences	57	49	44	55	75
All Commercial Properties	70				
Schools / Preschools	55*				
Parks / Outdoor Play Areas	65				

Note: * The external noise goal of 55dBA is based on a 10dB reduction through an open window.

10.2 Construction Noise

It has been determined that noise from construction activities during the day period will potentially exceed established construction noise management goals, particularly during the proposed extended Saturday construction period. Therefore, the planning and management of construction activities must take into account the sensitivities of surrounding residents so as to minimise the impact of construction activities at these receivers.

The control of construction noise and vibration should form a part of the Construction Environmental Management Plan that would detail reasonable and feasible management measures and community consultation that would be employed.

The following measures are recommended.

- The noise barriers recommended in the PA1 basement stage should be maintained on site when C4 construction works occur.
- Plant with noise control kits should be installed where practicable.
- An audit of plant should be conducted to select equipment that generates the lowest practical commercially available noise levels.

- Construction activities should be planned so that respite is provide to residences when noise activities occur. This is particular important during extended Saturday hours.
- An effective complaints and community consultation program should be implemented. This program should inform the project manager about appropriate mitigation measures to protect the acoustic amenity of surrounding residences.

11 CONCLUSION

A noise and vibration assessment has been conducted of the proposed construction activities associated with the construction of the Commercial Building C4 to determine the potential for noise and vibration impact at surrounding receivers.

Where applicable, this assessment supersedes the previous construction noise assessment provided with the original Project Application.

The assessment allows the area of risk to be identified, and appropriately responsive measures to be adopted to mitigate or minimise any potential noise and vibration issues.

Management and mitigation measures to reduce noise impact at receivers have been identified which include:

- maintaining barriers between the site and the Temporary Passenger Terminal as well as the southern and western boundaries of the site;
- maintaining localised noise treatment of fixed plant and selection of quiet plant where practical;
- provision of respite from noise producing activities during extended hours operations where practicable; and
- effective community consultation and complaints management.

The impact from traffic along the road network is not considered to be acoustically significant due to the fact the majority of trucks will haul spoil within the boundaries of the site rather than using the public road network.

A noise and vibration management plan has been prepared to assist Lend Lease in managing the environmental issues associated with this project.

Vibration associated with on-site construction activities is considered to be negligible.

Version	Status	Date	Prepared by	Checked by
A	Draft	14 October 2010	Sam Demasi	Brian Clarke
B	Final	3 November 2010	Brian Clarke	Rob Bullen
D	Final	13 September 2011	Brian Clarke	Rob Bullen

APPENDIX A

GLOSSARY OF TERMS

GLOSSARY OF TERMS

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

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

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

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

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

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

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

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

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

- Appendix 04 - Stakeholder Engagement - Statement of Commitment

STAKEHOLDER ENGAGEMENT - STATEMENT OF COMMITMENT

Lend Lease recognises the importance of positive relationships with our stakeholders and seeks to proactively engage with them in the communities in which we operate.

This statement of commitment covers project level stakeholder engagement, meaning our interactions with individuals and/or groups that have an interest in or are affected by our projects.

Objective

Our objective is to:

- Ensure that our business has a positive impact on communities and other stakeholders

Approach

Our approach is to:

- Be proactive in our engagement in order to understand the needs of our stakeholders and be in a position to respond to these needs and meet them wherever possible
- Provide accurate, up to date and accessible information to our stakeholders as early as possible and at regular intervals throughout the project
- Be open, honest, fair and realistic in all dealings with our stakeholders
- To treat the communities in which we work with respect
- Recognise diversity and seek to inform all stakeholders in the decisions affecting them in a way so that they can understand the nature of our operations and ensure that they have an opportunity to be engaged

Delivering Stakeholder Engagement

Our commitment is that we will:

- Assess the requirement for a stakeholder Engagement Strategy on all projects
- As required, prepare a Stakeholder Engagement Strategy and Action Plan outlining who our stakeholders are and how we will engage with them on projects
- Strive to add value (where appropriate) to the communities in which we operate by developing initiatives that positively contribute to the community and surrounding environment; in consultation with all relevant stakeholders
- Treat our stakeholders, in particular our neighbours with respect and take reasonable steps to minimise impacts where possible

- Be aware of, and acknowledge, any engagement undertaken prior to our involvement in the project; and work with our client to seek solutions that balance the needs of all stakeholders

- Provide training for all employees involved in stakeholder engagement processes and include relevant information in subcontractor inductions

- Ensure that all public concerns and complaints are documented, acted upon promptly and resolved, where possible, with outcomes communicated back to the relevant affected groups

- Ensure that all subcontractors and consultants are aware of and adhere to our Statement of Commitment

Monitoring and Reviewing

In order to evaluate and review the success of Stakeholder Engagement, each project will have as part of the regular Project Reviews process:

- An assessment of how stakeholders have been engaged in accordance with the project's stakeholder engagement plan and how stakeholder's feedback has been integrated into the project's development

- A review of comments expressed by stakeholders (via customer feedback and complaints process) and how they have been genuinely acted upon/responded to within agreed periods

Consultation Strategy – Barangaroo South				
Key Stakeholders	**Relationships/rationale**	**Aim of Engagement**	**Strategy**	**Timeline**
Local Residents e.g.: - **Kent St. Residents Group** - **Millers Point Resident Action Group** - **Walsh Bay Precinct Committee** - **Pyrmont** - **Hickson Road** - **Millers Point Estates Action Board – Housing NSW** **Local Businesses e.g.** - **Hickson Road** - **Walsh Bay** - **Kent Street** - **Kent street Wharf**	Neighbours and surrounding community living in local area. Local businesses in surrounding area	• Inform community of proposed design and gain feedback • Develop positive relationships • Provide regular updates on proposal	• Participated in large scale Community Forums organised by the Barangaroo Delivery Authority • Smaller community forums run by Lend Lease for local and surrounding residents that may have been impacted by or have an interest in the development. Providing updates on proposed plans and progress of planning submissions • Provide fact sheets with details of the proposed plans • Provide feedback forms to gain feedback and understand the concerns of the community • Leverage existing and develop relationships with the local resident and business groups attending existing meetings or forums to provide updates on proposed plans and progress on planning submissions. • Provide notifications to local residents and groups when planning submissions are taking place	• During planning phase • Ongoing Project/Precinct stages

			• Provision of email address for enquiries • Developing a contact management system (incl.) - Contacts database for registering, managing and reporting complaints & enquiries - Provision of a 1300 number for enquiries and complaints - Provision of a Barangaroo South community relations team to manage complaints/enquiries, feedback and engage with the community	
Councils & Chamber of Commerce e.g. - **City Of Sydney** - **Sydney Cove Rotary** - **Rocks Chamber of Commerce**	Local Councils and Chambers of Commerce	• Develop positive relationships • Provide regular updates on the proposal and the proposed timeline of commencing	• Regular briefing meetings with key representatives • Provide presentations to all key staff on proposed development • Notification prior to planning submissions taking place	• During planning phase • Ongoing Project/Precinct stages
Agencies/Utilities e.g. - **Sydney Ports** - **Sydney Water** - **NSW Maritime** - **Sydney Ferries**	Key agencies with an interest in the project	• Ensure agencies are kept updated on the progress of the proposal and pending works • Develop positive relationships • Promote positive messages about the project	• Provide updates on key works and upcoming construction activities via: - 1-1 meeting where required - Website - Letters - Newsletters • Participation in Technical Working Groups	• During planning phase • Ongoing Project/Precinct stages
Government Departments e.g. - **Department of Environment, Climate Change and Water (DEEC-W)** - **Housing NSW** - **RTA**	Government departments with an interest or role in the project	• Provide regular updates on the proposal and the proposed timeline of commencing • Joint initiatives and projects	• Provide updates on proposal and upcoming construction activities that may interface with these agencies • Offer regular meetings to ensure agencies are briefed on the project • Ensure these stakeholders are kept up to date with status of pending works • Advise of potential impacts and mitigation measures being implemented • Notification prior to works commencing & links to complaints management system	• During planning phase • Ongoing Project/Precinct stages
Local Educational Institutions e.g. - **Fort Street Public School** - **Observatory Hill Environmental & Education Centre**	Local Schools and educational institutions	• Use this landmark project as an educational opportunity • Encourage schools and universities to become involved in the project • Ensure the positive project	• Provide updates on proposal and upcoming construction activities via: - 1-1 meeting where required - Website - Letters - Newsletters • Engage with local school to organise opportunities to involve children in activities i.e. photography, art and student	• During planning phase • Ongoing Project/Precinct stages

		messages get out to the educational community	based traineeships. Organise site tours to be provided as part of educational development.	
General Public	People commuting/working in the area, pedestrians who use Hickson Road, general road users and cyclists.	• Provision of information & upcoming traffic changes & transport links • Minimise disruption and complaints • Maintain safety on and around the site • Promote positive messages about the project	• Provide up to date information on works, access and transport impacts via: - Site signage - Factsheets • Establish information channels for stakeholders including: - 1300 information line - Website - Email address - Community Relations Tea, to manage enquiries and feedback	• During planning phase • Ongoing Project/Precinct stages
Local Cultural Groups & Facilities e.g. - **Sydney Theatre Company** - **Australian Theatre for Young People** - **Bangara Dance Company**	Cultural groups & organisations within the local community	• Provision of information on upcoming traffic changes and any modifications to key transport links • Develop positive relationships	• Provide updates on proposal and upcoming construction activities via: - 1-1 meeting where required - Invitation to Community Forums - Letters - Factsheets	• During planning phase • Ongoing Project/Precinct stages
Interest & Action Groups e.g. - **Barangaroo Community Action Group (BAG)** - **Friends of Barangaroo** - **Millers Point Resident Action Group** - **Kent Street Residents Group**	Local interest and action groups with an interest or stake in the project	• Be open and transparent with project information • Minimise disruption and complaints by being responsive to concerns	• Provide updates on proposal via: - 1-1 meeting or community forum where required - Letters - Factsheets • Address concerns and feedback in a timely and comprehensive manner	• During planning phase • Ongoing Project/Precinct stages
Media	Key public opinion influencers regarding this project	• Be open and transparent with project information as appropriate • Facilitate a positive working relationship with media	• Provide updates on proposal and upcoming construction activities • Respond to media enquiries where appropriate • Ensure project spokesperson is available for comment when required	• During planning phase • Ongoing Project/Precinct stages