Robert Bird Group

State Significant DA Report

One Sydney Harbour

Residential Building R5

Structural Engineering Report

Prepared For: Lend Lease Pty Ltd

Project No.: 13181

11th August 2016

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Report Amendment Register

Issue	Section & Page No.	Issue/Amendment	Author/ Initials		Project Engineer	Reviewer/ Initials		Date
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1.0 Introduction

This report supports a State Significant Development Application (SSD 6966) submitted to the Minister for Planning pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act). The Development Application (DA) seeks approval for construction of a residential flat building (known as Residential Building R5) 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 Residential Building R5 DA seeks approval for the construction and use of a 29 storey residential flat building comprising 151 apartments, ground floor retail, the allocation of car parking, services, plant and storage within the Stage 1B Basement (subject of a separate concurrent DA), and the construction of ancillary landscaping and temporary public domain.

Approval for the construction of Residential Building R5's core up to ground level and associated plant and services within the basement is being sought as part of the concurrent Stage 1B Basement DA and do not form part of this DA.

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 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 R5 DA Site area is located within Barangaroo South as shown in Figure 1. The DA Site is located on land generally known and identified in the approved Concept Plan as Block 4B.

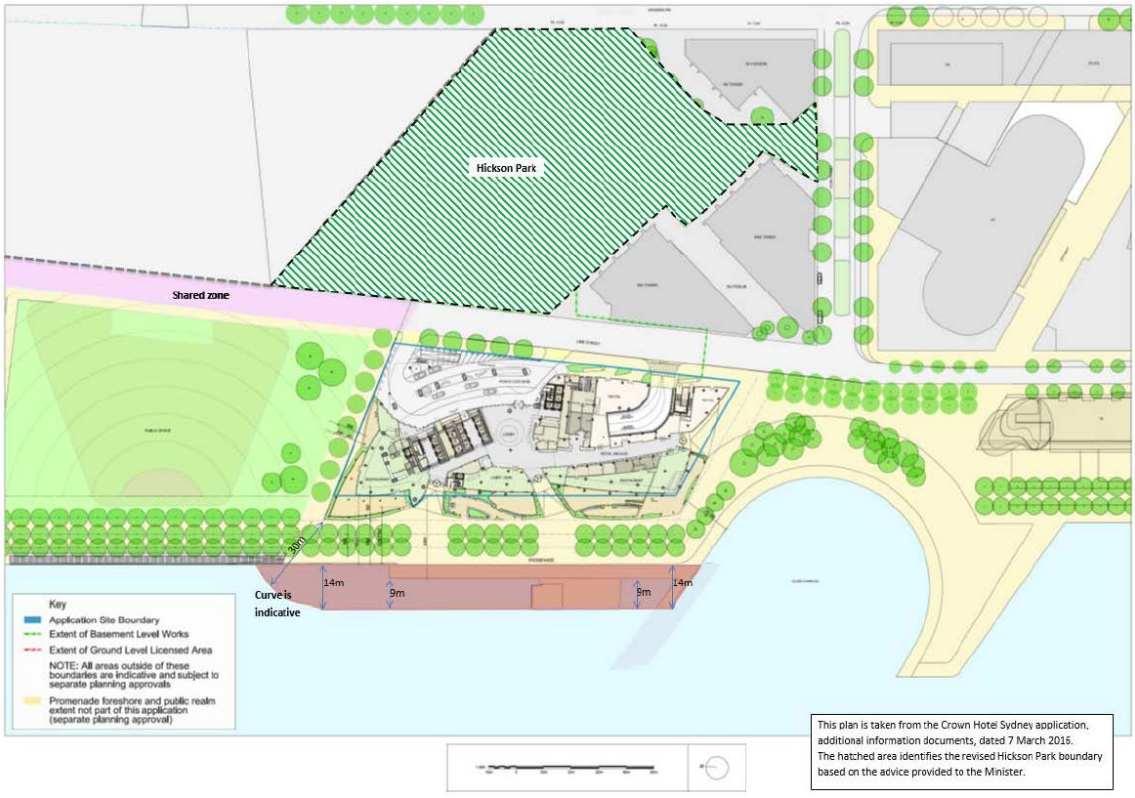

Figure 1 – Site Plan

1.3 Purpose of this Report

This report has been prepared to accompany the State Significant Development Application (SSDA) for Residential Building R5 (SSD 6966) at Barangaroo South. It addresses the relevant Secretary's Environmental Assessment Requirements for the project.

These Secretary's Environmental Assessment Requirements are discussed in the Environmental Impact Statement (EIS) that has been prepared to support the application.

1.4 Geotechnical Site Investigation

Reference is made to the Stage 1B Geotechnical Investigation and Testing Report by Coffey dated 2 June 2014. These reports are based on existing information about the site and surroundings, which provides a description of the site history, geology, and ground conditions. The reports contain sufficient information to provide confidence that an adequate foundation solution can be developed.

1.5 General Ground Conditions

The Sydney 1:100,000 Geological Sheet indicates that the site locality is underlain by Fill and Quaternary alluvium overlying Hawkesbury Sandstone. An igneous dyke (the Pittman LIV Dyke), is also shown in close proximity to the site. The depth to sandstone from existing surface level trending away from Hickson Road varies from 1m to 19m below ground across the site. A portion of the site is contaminated with hydrocarbons which will require remediation.

1.6 Groundwater

Groundwater across the site is heavily influenced by tidal fluctuations of the adjacent Darling Harbour, as confirmed by Groundwater Monitoring done by Coffey between 13 and 19 December 2013. The existing Highest Astronomical Tide (HAT) of the site is 1.175m AHD.

A design ground water level of RL 2.335m AHD is adopted for the design of the tower which includes allowances for a 0.9m rise in sea levels as stated in the NSW Coastal Planning Guideline: Adapting to Sea Level Rise and an increase in water levels associated with a 1 in 100 year weather event of 0.36m.

2.0 The Structural Scheme

2.1 General Description of Building R5

The SSD application (SSD 6966) will seek consent for the construction and use of Residential Building R5 at Barangaroo South. Residential Building R5 will be a residential building and podium. A small area of retail will be provided at ground level. Conceptual drawings including floor plans and elevations have been prepared by Lend Lease. A conceptual elevation is shown at Figure 2.

Residential Building R5 will be located above the future Stage 1B Basement, and to the east of the two other residential buildings in Block 4A, which will be the subject of separate SSDs lodged concurrently. The building's core and all associated basement services will form part of the Stage 1B Basement application, however the number and use of the car spaces and facilities within the Basement for the R5 Building will form part of the Residential Building R5 application. As such, the application will seek consent for the construction of above ground works, use of the building, the use of the car spaces and facilities within the Stage 1B Basement and fit out of basement plant and facilities spaces.

A separate application for the public domain within Stage 1B, including the park to the northwest of R5 will also be prepared. Interim public domain works will be proposed around the perimeter of the building to provide for potential construction staging.

The building will be designed within the sustainability framework for the Barangaroo Precinct.

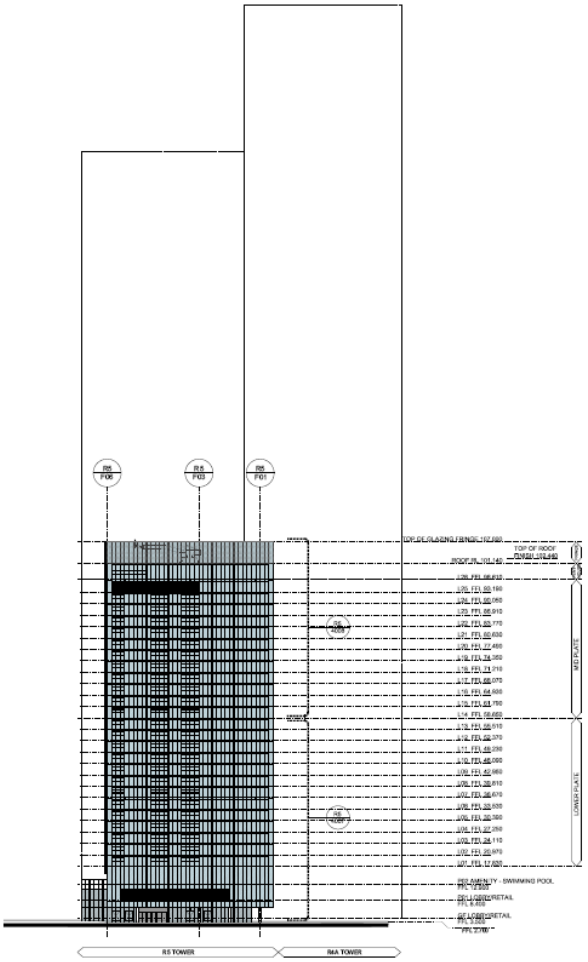

Figure 2 – Conceptual elevation of Building R5

2.2 Substructure

Foundations

The R5 Residential Building will be supported by structure within the Barangaroo South Stage 1B Basement. The basement structure is the subject of a separate application and is not covered in this report.

2.3 Superstructure

Ground Floor and Podium Levels 1 and 2 will consist of a combination of post-tensioned and conventionally reinforced slabs, spanning between band beams. These beams are supported by reinforced insitu poured walls and columns. Within the core of the tower, the lobby slab will be reinforced concrete spanning between core walls. Parts of the core lobby are to cantilever from the core walls, and will be stiffened by reinforced beams.

The residential levels of the tower will be constructed as post-tensioned flat plates, with localised folds around balcony setdowns. The plant levels will be of similar construction, with thicker slabs where required to account for increased superimposed dead and live loads. The concrete roof structure will be a post-tensioned flat plate. The pool structure will be a combination of structural steel and reinforced concrete.

2.4 Stability

Wind, seismic and structural robustness loading will be applied in accordance with the relevant sections of AS/NZS1170 and AS1170 Parts 0, 2 and 4. Structural stability will be provided by the reinforced concrete core and shear walls of the structure.

2.5 Construction Staging

The building and structural components relating to each development stage should be structurally stable under all interim conditions.

2.6 Green Star Initiatives

It is intended that Green Star initiatives relating to the R5 structure include the following where appropriate:

- Use of cement replacement and/or recycled aggregate for concrete; and
- Use of steel with recycled content.

3.0 Design Standards and Sources of Reference

3.1 General

The design and documentation of the basement and associated works shall comply with all relevant Australian Standards and the Building Code of Australia (BCA).

Standard Specifications or Codes of the British Standards Institute (BS) or the American Society for Testing and Materials (ASTM) are referenced only when a relevant Standards Australia publication does not exist.

Current editions of all codes and standards shall apply.

3.2 BCA Structural Provisions

The tower structure is classified as follows in accordance with Part B1 of the BCA.

Table 1: Classification

Australian Standard Table	**Classification**
AS 1170.0:2002 Table 3.1 Importance Level	 2 – Normal structures and structures not falling into other levels
AS 1170.0:2002 Table 3.3 Design Events for Safety Wind Earthquake	 Annual Probability of Exceedance 1:500 1:500

3.3 Codes and Standards

The following codes and standards will form the basis for the structural design:

Table 2: Codes and standards used in design

AS/NZS 1170.0	Structural design actions – General Principles
AS/NZS 1170.1	Structural design actions – Permanent, imposed, and other actions
AS/NZS 1170.2	Structural design actions – Wind actions
AS 1170.4	Structural design actions – Earthquake actions in Australia
AS 1720.1	Timber structures – Design Methods
AS 2159	Piling – design and installation
AS/NZS 2312	Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings
AS 2327.1	Composite structures – Simply supported beams
AS 3600	Concrete structures
AS 3700	Masonry structures
AS 3735	Concrete structures retaining liquids
AS 4100	Steel structures
BCA	Building Code of Australia
BS 5950-8	Structural use of steelwork in building – Code of practice for fire resistant design
BS 8102:1990	Code of practice for protection of structures against water from the ground
CIRIA 0660	Early-age thermal crack control in concrete

4.0 Loads

4.1 Self-Weight

The self-weight of structural elements is to be calculated on the basis of the following densities:

Reinforced concrete: 24.5 kN/m3

Steel: 78.5 kN/m3

4.2 Superimposed Dead Loads and Live Loads

Table 3: Superimposed dead loads and live loads used in design

Area	Superimposed Dead Load	Live Load
Balconies	2.0 kPa floor finishes	2.0 kPa
Car parking	0.5 kPa ceiling and services	3.0 kPa
Landscaping		As calculated for soil depth
Loading dock	1.5 kPa	As calculated for relevant use, 15 kPa minimum
Plant rooms	0.25 kPa ceilings 0.75 kPa floor finishes	7.5 kPa (minimum)
Residential	1.0 kPa floor finishes	2.0 kPa
Residential – Luxury	1.5 kPa floor finishes	2.0 kPa
Retail	2.5 kPa ceilings and finishes	5.0 kPa
Roads	5.0 kPa for road pavement and hard stand areas	25 kPa
Storage	0.25 kPa ceilings 0.75 kPa floor finishes	2.4 kPa per metre of storage height
Stairs	0.1 kPa services	4.0 kPa
Terraces (including trafficable roofs)	2.0 kPa floor finishes	2.0 kPa
Wintergardens	2.0 kPa floor finishes	2.0 kPa

4.3 Temporary Construction Loading

All areas located at ground level shall be designed for a temporary construction live load of 20 kPa. This may be relaxed in certain areas pending further coordination.

4.4 Wind Loads

For the structural design of components, wind loading applied to the structural elements will be assessed in accordance with AS1170 Part 2: Wind Actions. Terrain categories will be calculated based on the roughness length calculation.

The following design parameters have been assessed in accordance with AS1170.2:

Region: A2

Basic wind speeds:

Ultimate: V500 = 45 m/s

Serviceability: V25 = 37 m/s

4.5 Seismic Loading

Earthquake loading applied to the structural elements and detailing of the seismic stability system will be in accordance with AS 1170.4: 2007: Earthquake actions in Australia.

Specific seismic data is summarised as:

Importance level:	2
Annual probability of exceedance:	1:500

4.6 Earth Pressure Loading

The Barangaroo South Stage 1B site has buildings R4A, R4B and R5 within it. Shear walls provided within the towers and diaphragm walls around the perimeter of the basement will resist earth pressures transferred through the permanent suspended slabs.

Earth retaining structures shall be designed in accordance with the recommendations in the geotechnical report.

4.7 Vehicular Loads

Vehicular loads to public areas are to be designed in accordance with AS 5100.2.

4.8 Barrier Loading

Barriers, upstands and perimeter containment walls within carparks, truck docks and access driveways are to be designed in accordance with AS 1170.1 Clause 3.6 and Table 3.3.

4.9 Balustrade Loads

Balustrades are to be designed in accordance with AS/NZS1170.1.

5.0 Serviceability

5.1 Design Life

The structure is intended to be designed for a nominal 50 year design life. The BCA and Standards Australia material standards will be used as the basis for the durability specification for the structure.

Reference should be made to the relevant material standard regarding maintenance assumptions that form the basis of the design code.

5.2 Deflection Limits

The deflection criteria specified in AS 3600 as AS 1170.0 and as specified below are appropriate for the basement:

Table 4: Deflection limits

Type of Member	Deflection to be considered	Deflection limit for spans	Deflection limit for cantilevers
Beams and slabs	Total deflection	1/250	1/125
Members supporting masonry partitions	The deflection that occurs after the addition or attachment of partitions	1/500 where provision is made to minimize the effect of movement, otherwise 1/1000	1/250 where provision is made to minimize the effect of movement, otherwise 1/500
Total deflection under wind loads	H/500	-	-
Inter-storey deflection under wind load	Floor to floor/500	-	-
Inter-storey drift under earthquake load	1.5% Floor to floor	-	-

5.3 Vibration Limits

Slabs and beams shall be designed to achieve the vibration criteria in AS 2670.2.

5.4 Construction Tolerances

Construction tolerances for structural components are to be as nominated in the relevant design codes and as required for the finishes applied over those structural components.

Refer to the Perimeter Earth Retention Systems Brief by Robert Bird Group for the tolerances relevant to these elements

5.5 Concrete

Durability

The requirements of AS 3600 will be applied to all reinforced and post-tensioned concrete. For the foundations, the concrete mix and cover to reinforcement selected will be appropriate for the ground conditions.

Table 5: Concrete durability criteria

General	Exposure classification A1 to AS 3600
Pile caps and in-ground elements	Exposure classification A2 to AS 3600
Piles	In accordance with AS 2159 (Geotechnical engineer to confirm)
External elements	Exposure classification B1 to AS 5100

Crack Control

The degree of crack control to be provided in concrete elements will be in accordance with AS 3600.

5.6 Steelwork Corrosion Protection

The corrosion protection system for structural steelwork will be dependent on the location of the steel elements within the tower structure. Systems will be selected in accordance with AS/NZS 2312 as a minimum specification, and will be painted with a protective paint coating system.

5.7 Fire Resistance Levels for Structural Elements

Fire resistance levels for structural elements shall be determined in accordance with the BCA and fire engineered outcomes.

Concrete covers are to be in accordance with AS 3600 Section 5.ire resistance levels for structural elements shall be determined in accordance with the BCA and fire engineered outcomes.

Concrete covers are to be in accordance with AS 3600 Section 5.

6.0 Structural Certification

A Registered Professional Engineer shall provide structural engineering certification in accordance with the relevant Authority requirements with NPER registration.

Certification for the design and inspection of all structural elements shall be provided at the completion of the project as well as interim staged certifications at agreed milestones during construction of the project as a whole.

7.0 Conclusion

This report has been prepared to inform and accompany the R5 Residential Building state significant Development Application. It describes the structural scheme and summarises the structural design criteria at the time of the Development Application.

Our conclusion is that the project presented in the proposed R5 (SSD 6966) SSDA can be designed and constructed utilising proven design and construction techniques.

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