Stormwater Management and Civil Infrastructure Report

Barangaroo South – Stage 1B Public Domain

NA50613044

Prepared for
Lend Lease Millers Point Pty Ltd

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1 Project Appreciation

1.1 Introduction
This Stormwater Management and Civil Infrastructure Report supports a State Significant Development Application (SSD 7944) 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 public domain works within Stage 1B at Barangaroo South as described in Section 1.3.

1.2 Scope of this Report
This report has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) in respect of SSD 7944 Stage 1B Public Domain Works, specifically as outlined below:

2. Public Domain and Access
- Outline specific design features, including but not limited to:
  - footpaths and pavements, parking areas (including bicycle), roads and/or rights of carriageways
  - services where affected, utility poles and service pits
  - civil and stormwater infrastructure

6. Water Quality and Contamination
- Undertake an assessment of the potential impacts on water quality of Darling Harbour.
- Assess the impacts of the proposal on surface and groundwater quality and hydrology, for construction and operation.
- Assessment of any volumetric water licensing requirements (including those for ongoing water take following completion of the project).
- A detailed and consolidated site water balance and identification of an adequate and secure water supply for the life of the development.
- The assessment must include details of proposed erosion and sediment controls (during construction), the proposed stormwater management system (during operations), and management and mitigation measures for the containment of pollutants (e.g. fuel and sewage) and prevention of potential water quality impacts during construction and operation.
- Assess the potential for the development to intercept groundwater, including annual water volumes of groundwater proposed to be taken by the activity (including through inflow and seepage) from each groundwater source as defined by the relevant water sharing plan.
- Identification of any water licensing requirements or other approvals required under the Water Act 1912 or Water Management Act 2000.

12. Infrastructure Provision
- Detail the existing infrastructure on-site and identify possible impacts on any such infrastructure from the proposal.
- Detail the proposed infrastructure that will service the development and demonstrate that the site can be suitable serviced. This is to include lighting details and measure to mitigate light spill and potential impacts to the amenity of sensitive receivers surrounding the site, including residential and commercial premises.
- Detail measures to mitigate the impacts of the proposal on any infrastructure items, including proposed relocation.
1.3 Overview of Proposed Development

The Public Domain DA (SSD 7944) seeks approval for the all public domain works within Stage 1B of the Barangaroo South Site and the additional area of Hickson Park added in the approval of Concept Plan MOD 8. These works include typical public domain features such as street paving, street furniture, lighting and planting. Additional items such as shade/weather protection structures, outdoor seating and an amenities building are also included in the design of the public domain. Various services and infrastructure such as lighting and water supply are incorporated into the proposed works where relevant.

1.4 Site Description

Barangaroo is located on the north western edge of the Sydney Central Business District (CBD), bound 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) – Headland Park, Central Barangaroo and Barangaroo South.

The Stage 1B Public Domain Site area is located within Barangaroo South as shown in Figure 1-1. The DA Site is located on land generally known and identified in the approved Concept Plan MP06_0162 (as modified) as Blocks 4A, 4B and Y and part of the public domain area between those blocks and Block 5.

Figure 1-1 Stage 1B Public Domain Development Application (SSD 7944) Site Location Plan
1.5 Related Documents

The following reports shall be read in conjunction with this document:

1. *Barangaroo South Flood Study CS7300 (15-0132)*, Revision 1, dated March 2015 prepared by Cardno.


Project Description

2.1 Preceding and Concurrent Works

Works that will be undertaken within the Stage 1B site either prior to the commencement of or concurrent with the proposed Stage 1B Public Domain works (which are the subject of SSD 7944) include:

- Works subject to a separate development consent that were recently assessed and approved as a State Significant Development (Application No. SSD 5897), including:
  - Remediation of contaminated land within the Stage 1B site (also referred to as Block 4), which forms part of the EPA Declaration Area N21122, in accordance with a Remedial Action Plan;
  - Construction of a groundwater retention wall system around the perimeter of the Stage 1B site;
  - Carrying out remediation works within the perimeter of the groundwater retention wall to ultimately allow the EPA to revoke the Declaration Area and ensure the Stage 1B development area is suitable for the intended future uses of the land;
  - Diversion and augmentation of stormwater drainage infrastructure to the south of the proposed Block 4 groundwater retention wall and north of the existing Stage 1A basement; and
  - Bulk excavation of part of the Stage 1B development area within the groundwater retention wall.

- Works subject to a separate development consent associated with the proposed Stage 1B basement structure beneath the proposed Public Domain works (SSD 6960), including:
  - Excavation of any material outside the scope of work completed under SSD 5897 and within the extent of the proposed basement structure to approximately -14 mAH.
  - Works associated with the provision, diversion and protection of utility services to allow for construction of the proposed basement structure.
  - Construction of a four level basement structure and associated vehicular ramps within the perimeter retention wall completed under SSD 5897.
  - Trunk drainage above the ground slab and associated temporary landscaping.
  - Temporary vehicular access from Watermans Quay.

- Works associated with the proposed residential building R4A that are subject to a separate development consent that is currently being assessed (SSD 6964).

- Works associated with the proposed residential building R4B that are subject to a separate development consent that is currently being assessed (SSD 6965).

- Works associated with the proposed residential building R5 that are subject to a separate development consent that is currently being assessed (SSD 6966).

- Works associated with the Crown Sydney Hotel Resort that are subject to a separate development consent that was recently assessed and approved (SSD 6957), including:
  - Construction of a three level basement structure and associated vehicle ramps beneath the proposed Stage 1B Public Domain.
  - Construction of a five-storey podium building and 71 storey tower building.

2.2 Proposed Works

The works to be assessed under the DA that is the subject of this Stormwater Management and Civil Infrastructure Report include:

- The construction of Watermans Cove and a public pier along the foreshore between Barangaroo South Stage 1A and Central Barangaroo (Wulugul Walk).
• Public domain works associated with Hickson Park including a grassed area, tree planting and a public amenities building.

• Completion of the Barangaroo South street system including Watermans Quay and Barangaroo Avenue.

• Typical public domain features including trees and other landscape features, walkways, street paving, street furniture, stormwater drainage, lighting and wayfinding signage.

• Provision of services and infrastructure including water, power (for lighting), three-phase power (for public events) and communications to enable use of the Public Domain for a range of activities.

The scope of work is presented in the drawings listed in the following table.

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2.3 Planning Context

Approval for the proposed scope of work that is the subject of this DA is being sought from the Minister for Planning under Part 4 of the *Environmental Planning and Assessment Act 1979*. 
3 Integrated Water Management Strategy

3.1 Relevant SEARs
This section addresses the following SEAR for SSD 7944:

- A detailed and consolidated site water balance and identification of an adequate and secure water supply for the life of the development.

3.2 Overview of Barangaroo South Integrated Water Management
The objective of the Barangaroo South Integrated Water Management Strategy is to achieve a positive water balance based on exporting recycled water from the site in greater quantity than potable water is imported. This objective will be achieved through a site wide approach that focuses on:

a. Potable water demand reduction, including a commitment to achieve a reduction in potable water consumption compared to a standard practice development.
b. Water balance modelling, including:
   i. Review of potential sources of both potable and non-potable water;
   ii. Investigation of sewer mining;
   iii. Assessment of appropriate treatment measures; and
   iv. Further development of existing conceptual water balance model.

3.3 Water Balance
The proposed water balance model for Barangaroo South (Stage 1A and Stage 1B) is presented in the document titled Barangaroo Sewer, Water and Recycled Water Masterplan Report (Warren Smith & Partners, March 2015). This report outlines anticipated demands for potable and recycled water, sewage discharge to the Barangaroo South Recycled Water Treatment Plant (RWTP) and volume of sewer mining from Sydney Water’s existing system in Hickson Road. A schematic presenting anticipated water demands and sewage loadings is reproduced as Figure 3-2.

Figure 3-1 Barangaroo South Water Balance Schematic
It is noted that the projected potable and recycled water demands within Barangaroo South presented in Figure 3-2 account for residential, commercial, retail, tourism and community uses.

### 3.4 Public Domain Water Demands and Sewage Loadings

Anticipated water demands and sewage loadings associated with the proposed Stage 1B Public Domain works are summarised as follows:

- **Potable Water**
  - Water bubblers within Hickson Park, Wulugul Walk and Watermans Cove
  - Amenities building adjacent to Hickson Road
  - Irrigation of Hickson Park (alternative water supply option)

- **Recycled Water**
  - Amenities building adjacent to Hickson Road (for toilet flushing)
  - Irrigation of Hickson Park (base case water supply option, subject to satisfaction of licensing and water quality requirements). It is noted that recycled water will need to be treated to a standard required for dual reticulation end use in accordance with the *NSW Guidelines for Management of Private Recycled Water Schemes*

- **Sewage Loading**
  - Amenities building adjacent to Hickson Road (to discharge to the Barangaroo South RWTP via a connection to the proposed sewer line in the Stage 1B basement)
4 Water Licensing and Approvals

4.1 Relevant SEARs

This section addresses the following SEARs for SSD 7944:

- Assessment of any volumetric water licensing requirements (including those for ongoing water take following completion of the project).
- Identification of any water licensing requirements or other approvals required under the Water Act 1912 or Water Management Act 2000.

4.2 Water Act 1912

Under the Water Act 1912, a water licence must be obtained for extraction of groundwater via any type of bore, well, spearpoint or groundwater interception scheme for all purposes except to take water from an aquifer under a basic landholder right.

The proposed public domain works will not require any groundwater extraction works. Therefore, a license under the Water Act 1912 will not be required for the proposed scope of work under SSD 7944.

4.3 Water Management Act 2000

The Water Management Act 2000 applies to areas of New South Wales that have a water sharing plan. As the proposed works do not include any activities that are governed by a water sharing plan, a licence under the Water Management Act 2000 will not be required for the proposed works.
5 Water Quality

5.1 Relevant SEARs
This section addresses the following SEARs for SSD 7944:

- Undertake an assessment of the potential impacts on water quality of Darling Harbour.
- Assess the impacts of the proposal on surface and groundwater quality and hydrology, for construction and operation.
- Assess the potential for the development to intercept groundwater, including annual water volumes of groundwater proposed to be taken by the activity (including through inflow and seepage) from each groundwater source as defined by the relevant water sharing plan.

5.2 Background
An assessment of potential water quality impacts was prepared to accompany SSD 5897 for the Block 4 Remediation and Land Forming Works (WorleyParsons, 2013), which are currently being undertaken and will precede the proposed works to be assessed under SSD 7944.

Potential impacts of the proposed works and proposed management, mitigation and monitoring measures are generally consistent with those covered under SSD 5897. The measures implemented for the works under SSD 5897 comply with the requirements of the following:

- Water Quality Objectives in NSW (OEH)
- Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (OEH).

A summary of the broad water quality objectives that apply to the Stage 1B Public Domain are presented in the following sections.

5.3 Surface Water
This section addresses the potential water quality and hydrology impacts of surface water generated by both upstream external catchments and the extent of the Stage 1B Public Domain works.

5.3.1 Hydrology
The existing condition of the Stage 1B site is such that it is impervious and consists of an asphalt surface. The site will remain impervious as a result of the remediation and land forming works that will precede construction of the Stage 1B basement due to construction of an odour control structure over the extent of the remediation works.

The Stage 1B Public Domain works will consist of both impervious areas (e.g. road and footpath pavements) and pervious areas (e.g. grassed area within Hickson Park). As a result of the proposed public domain works, the overall impervious fraction of the site will reduce compared to the pre-development scenario. This reduction in impervious fraction will result in a reduction in the volume of surface water runoff from the site towards Darling Harbour, which will have a positive impact on surface water hydrology discharging to Darling Harbour.

5.3.2 Surface Water Quality
As discussed further in Section 8, implementation of erosion and sediment control measures will ensure that surface water runoff quality from both external and internal catchments is maintained at acceptable levels during construction. The requirements for surface water quality management are outlined in the Water and Stormwater Management Sub-Plan for the Stage 1B Public Domain works.
Surface water quality post-construction of the proposed works will be managed through implementation of a number of measures that will capture and treat surface water runoff prior to discharge to Darling Harbour. These proposed measures are discussed further in Section 6.4.3.

5.4 Groundwater

5.4.1 Existing Geological Conditions

The following subsurface conditions have been identified across the wider Barangaroo site, including the extent of the Stage 1B Public Domain:

- Hardstand consisting of concrete, asphalt and bitumen from ground level to a maximum depth of approximately 0.5 metres below ground level (bgl).
- Road base fill to a maximum depth of approximately 0.5 metres bgl.
- Fill material consisting of sandstone, building rubble, bricks, concrete and silty gravelly sand with black staining and odours up to 18 metres bgl.
- Marine Clay / Sand between 3 metres bgl and 33 metres bgl.
- Bedrock of varying quality between 1.3 metres bgl and 33 metres bgl.

5.4.2 Hydrogeology

A geotechnical assessment was undertaken by Coffey to accompany the Block 4 Remediation and Land Forming Works (SSD 5897). A summary of the findings included in this report pertaining to groundwater is presented below:

- The highest observed astronomical tide is RL 1.075 mAHD and the existing mean high spring water level is RL 0.67 mAHD. Groundwater tidal level fluctuations were recorded adjacent to the existing caisson wall and were found to be very similar to tidal movements within Darling Harbour.
- At Hickson Road, groundwater monitoring suggested that the magnitude of groundwater fluctuation is approximately one quarter of the observed normal tidal amplitude at Darling Harbour, suggesting at least a moderate tidal influence on groundwater levels across the extent of the site.

5.4.3 Groundwater Interception Works

There are no groundwater interception works proposed as part of the Stage 1B Public Domain works during either construction or operation. Construction of the Stage 1B Public Domain works will have minimal potential to intercept groundwater, as the majority of works will be undertaken above the level of the groundwater table. The construction of some stormwater pits adjacent to Watermans Cove and along Wulugul Walk will require dewatering due to the level of the groundwater table, which fluctuates due to rising and falling tides. Any sump pumps that would be required for dewatering would discharge to the on-site groundwater treatment plant.

5.4.4 Groundwater Quality

The proposed works under SSD 7944 are considered unlikely to have an impact on groundwater quality either during or after construction. The preceding remediation works and basement construction works are considered likely to have a positive impact on groundwater quality due to the removal of contaminated material that is currently impacting upon the quality of groundwater within the site.

5.4.5 Groundwater Management during Construction

No specific groundwater management controls will be required during construction of the Stage 1B Public Domain works, as no groundwater interception works are proposed.
6 Stormwater Drainage

6.1 Catchments

6.1.1 External Catchments
Delineation of catchments that drain towards Stage 1B has been undertaken based on NSW Land & Property Information contour data, detailed ground survey, site inspections and ALS data. The external catchment area draining to the Stage 1B development site is approximately 5.3 ha. The extent of external sub-catchment areas adjacent to Stage 1B is presented in drawing CD9000102 in Appendix A. Details of the catchments are as follows:

a. **Catchment A**: This catchment has a total area of approximately 2.83 ha that discharges into Gas Lane and Jenkins Street through a 600mm diameter pipe and a 750mm diameter pipe and then into an existing 1200mm diameter pipe that traverses the Stage 1B Residential development site prior to ultimately discharging directly into Darling Harbour.

b. **Catchment B**: This catchment has a total area of approximately 2.29 ha that discharges into the existing Hickson Road stormwater drainage network prior to ultimately discharging into Darling Harbour through a series of varying diameter pipes traversing the Stage 1B Residential development site.

c. **Catchment C**: This catchment has a total area of approximately 0.15 ha that discharges into the stormwater diversion works that were constructed within Hickson Road and Watermans Quay as part of the Stage 1A works.

6.1.2 Internal Catchments
Based on the current Site Concept Plan (Modification No. 8) the development site will be divided into a number of sub-catchments as a result of the location and proposed surface grading of buildings, internal roads and open space. The combined sub-catchments total approximately 2.83 ha and will ultimately discharge into Darling Harbour.

Drawing CD9000101 in Appendix A provides details of sub-catchment areas and approximate directions of flow within the Stage 1B site. The internal catchment area fronting Hickson Road that will discharge into the proposed external drainage system is approximately 0.6 ha; ultimately discharging to Darling Harbour via the proposed stormwater drainage network along Watermans Quay.

6.2 Overland Flow and Flooding

6.2.1 Historic Flood Data
Detailed ground survey and site inspections have been used to define existing overland flow paths adjacent to Barangaroo South.

City of Sydney has confirmed that there is no available historical flood data for the Barangaroo site or the external catchments to the site; however localised flooding is known to have occurred within the bounds of Hickson Road adjacent to Barangaroo South.

Anecdotal evidence is available that suggests that in March 2006, flooding of the commercial building at 30 Hickson Road (The Bond) and residential building at 38 Hickson Road occurred to a depth of approximately 20mm after over 100mm of rainfall fell in the Sydney CBD over a 24 hour period. This storm event was estimated to have had an average recurrence interval (ARI) of between 2 and 5 years.

6.2.2 Pre-Development Overland Flow Paths
Prominent overland flow paths adjacent to Stage 1B are described as follows:
i. **Catchment 1:**
   1. Overland flow splits at the intersection of Gas Lane and Jenkins Street with the majority of the flow diverting to the north between 30 Hickson Road (The Bond) and 34 Hickson Road; entering the existing Hickson Road subsurface stormwater drainage network.

ii. **Catchment 2:**
   1. North and South on Hickson Road towards an existing low point generally located in front of The Bond"; and
   2. Through the Stage 1B development site.

### 6.2.3 Impact of Proposed Development

The key changes to overland flow paths and effects on existing stormwater infrastructure as a result of the development of Stage 1B will be as follows:

a. The existing stormwater pipes for the external catchment that traverse the site are to be relocated due to the conflict with the Stage 1B basement footprint;

b. The *Sydney Harbour Foreshores and Waterways Area DCP 2005* requires that where seawalls are permitted, the top of the seawall should be 2.6 metres above the Zero Fort Denison Tide Gauge (ZFDTG), which is equivalent to 1.675 mAHD.

c. City of Sydney's *Interim Floodplain Management Policy* (May 2014) requires consideration of the potential impacts of climate change in the assessment of proposed development. Specifically, Council’s Policy requires that allowances in the *NSW Coastal Planning Guideline: Adapting to Sea Level Rise* (August 2010, recently withdrawn from publication) be met, and that an allowance of 0.9 metre sea level rise above 2009 mean sea level be considered;

d. Stage 1A has been set with a promenade height of RL 2.90. This allows for a grade to be achieved across the site from a building FFL of 3.3-3.5. It is envisaged that Stage 1B will adopt a similar strategy in order to integrate with Stage 1A; and

e. Considering existing levels on Hickson Road and the proposed building FFL within the Stage 1B site, it has been proposed to divert overland flow that would have traversed the eastern site boundary from Hickson Road into an upgraded pit and pipe network within Hickson Road and through the site. No changes to the proposed passage of overland flow to the north of the Stage 1B site are proposed.

### 6.3 External Stormwater Drainage

Detailed ground survey and site inspections have allowed for a detailed assessment of existing stormwater drainage network as documented below.

#### 6.3.1 Existing External Stormwater Network

The existing stormwater network is characterised by a series of in-ground piped stormwater systems (typically between 300mm and 1800mm in diameter) draining Hickson Road and other external catchments through the Barangaroo site and ultimately into Darling Harbour. An overview of the external stormwater drainage network prior to construction works at Barangaroo South is presented in Figure 4-1. Additional details are presented in Drawing CD9000102 (refer to Appendix A).
As part of the Stage 1A works, a concrete pipe and box culvert diversion has been constructed. This diversion has the capacity to capture and convey storm events up to the 100 year ARI event and has been adopted to alleviate flooding within Hickson Road in the vicinity of the Sussex Hotel.

### Proposed External Stormwater Strategy

As a result of the proposed Stage 1B basement works (currently being assessed under SSD 6960), works to divert external stormwater drainage around the extent of the Stage 1B works will be required. The design of these works is currently being undertaken and coordinated with Sydney Water and City of Sydney. Sydney Water has granted approval for the Stage 1B stormwater diversion works.

The proposed finished ground levels within the Stage 1B development are such that the existing overland flow paths through the site will be obstructed. Therefore, the approved design incorporates a stormwater drainage network outside the Stage 1B site including a pit and pipe network along with maintaining overland flow north along Hickson Road and through Central Barangaroo (refer to Drawing CD9000102 in Appendix A). This network will include grated surface inlet pits in Hickson Road to capture and divert overland flow around Stage 1B and ultimately into Darling Harbour. The intent of the proposed diversion works is to manage the impact of the development on the external stormwater drainage network and to ensure no net increase in flood levels along Hickson Road.

As part of the approval process, comment was sought and acceptance received from CoS regarding the proposed stormwater diversion works.

### Internal Stormwater Drainage

#### Design Criteria

The proposed stormwater drainage network within the extent of Stage 1B is proposed to be designed to provide:

a. Low flows directed through water quality measures (nominally up to a 3 month ARI event); and
b. Internal site drainage with a capacity to capture and convey all storm events up to the 100 year ARI event.

6.4.2 Design Standards

The internal stormwater drainage network will be designed generally in accordance with the following standards and guidelines:

a) Australian Rainfall and Runoff Volume 1 and 2;
b) NSW Floodplain Development Manual 2005;
c) City of Sydney, Interim Floodplain Management Policy (May 2014);
e) Any other applicable City of Sydney design standards, guidelines and policies;
f) Sydney Harbour Foreshores and Waterways Area Development Control Plan 2005;
g) AS3500 – Stormwater and Drainage Design codes;
h) AS3725 – Loads on Buried Concrete Pipes;
i) Water Sensitive Urban Design: Book 1 – Policy (Landcom, 2009), which is considered current best-practice for stormwater management in NSW and suggests the following targets for reduction of pollutant mean annual load:
- 85% for Total Suspended Solids (TSS)
- 65% for Total Phosphorus (TP)
- 45% for Total Nitrogen (TN).
j) Emi-5 Stormwater Green Stars (2 points), which recommends the following targets for stormwater quantity management and reduction of pollutant mean annual load:
- 1.5 year ARI post development peak flows not exceeding 1.5 year ARI pre-development peak flows;
- 90% reduction of GP;
- 80% reduction of TSS;
- 60% reduction of TP;
- 45% reduction of TN; and
- 90% reduction of Free Oils.

The target reductions from each of the above design requirements will be met.

6.4.3 Internal Stormwater Drainage Strategy

The drainage strategy for the Stage 1B development provides for capture and conveyance of all flows during storm events up to and including the 100 year ARI storm within the pit and pipe network for Stage 1B. The current internal drainage strategy is presented on the Siteworks drawings contained in Appendix A and is summarised below.

The Stage 1B Residential internal stormwater drainage network will connect to the existing 1800mm diameter pipe located west of Barangaroo Avenue, between Stages 1A and 1B. This network will collect flow from the proposed residential buildings (R4A, R4B and R5), public domain area, Barangaroo Avenue and Watermans Quay. Treatable flows (nominally up to a 3 month ARI event, subject to further design) will be diverted to the proposed stormwater treatment train. The existing 1800mm pipe that outlets into Darling Harbour will remain.

The stormwater treatment train for the ultimate development of Stage 1B will incorporate water sensitive urban design (WSUD) principles to remove gross pollutants, suspended solids and nutrients. The treatment train may consist of a range of measures, including (but not limited to):

- Tree pits
- Roof gardens (incorporating a bio-retention system)
- Sand filtration within areas of public open space
- Gross Pollutant Traps (e.g. Stormwater360 Enviropods or equivalent)
- Proprietary tertiary treatment measures such as cartridge filtration (e.g. Stormwater360 Stormfilter).
7 Finished Surface Levels

The current design strategy for minimum floor and ground levels within Stage 1B are driven by three factors:

> Tie-in to existing and proposed levels surrounding the development site;
> Potential worst case future water levels within Darling Harbour; and
> Capacity to convey overland flow from upstream catchments.

Main building floor levels are primarily governed by future harbour water levels. The potential worst case future HAT level is predicted to rise to RL 1.975 mAHD by the year 2100. Allowing 600mm freeboard for storm surge and wave action, it is recommended that all major pedestrian thoroughfares and accessible areas are at or above RL 2.575 mAHD.

Timber boardwalks are proposed adjacent to Watermans Cove and Darling Harbour to enable pedestrians closer access to the water, but only where the main alternative access is at or higher than RL 2.575 mAHD. These proposed timber boardwalks are currently above the existing HAT level and are likely to remain so for the design life of the structures.

As per Section 6.4, the internal roof, podium and road drainage network will be designed to cater for storm events up to the 100 year ARI event.

The development of Stage 1A includes a sea wall with a minimum height of 2.5mAHD, graduating incrementally to a nominal site ground level of 3.4mAHD. This minimum height is:

- Greater than the current 1 in 100 year design still water level for Sydney Harbour (1.435 mAHD) plus an additional 0.9m to accommodate mean sea level rise (2.335mAHD);
- 825mm above the top of seawall level nominated in the Sydney Harbour Foreshores and Waterways Area DCP 2005 (1.675mAHD); and
- Able to be incrementally increased in the future to respond to actual demonstrated sea level changes.

It is recommended that ground levels within the Stage 1B Public Domain should be set at a minimum of RL3.35, though an appropriate relationship with existing buildings and ground levels in Stage 1A must also be achieved.
8 Erosion and Sediment Control

This section addresses the following SEAR for SSD 7944:

- The assessment must include details of proposed erosion and sediment controls (during construction), the proposed stormwater management system (during operations), and management and mitigation measures for the containment of pollutants (e.g. fuel and sewage) and prevention of potential water quality impacts during construction and operation.

As part of the works, erosion and sedimentation controls shall be designed, installed and maintained throughout the duration of construction works in accordance with Managing Urban Stormwater - Soils & Construction Volume 1 (Landcom, 2004).

It is noted that the majority of erosion and sediment control measures required for the construction of the Stage 1B basement will be established as part of the works to be completed under SSD 5897 and will be maintained through the duration of the construction of the Stage 1B public domain works. The requirements for erosion and sediment control measures are outlined in the Water and Stormwater Management Sub-Plan for the Stage 1B Public Domain works.

Prior to any earthworks commencing on site, all erosion and sediment control measures will need to be implemented in accordance with the above specifications. These measures shall generally include, as necessary:

- Installation of A-Class hoarding around the perimeter of the site;
- Installation of truck wash down facilities at each point of exit from the site;
- Installation of sediment fencing around disturbed areas, including any stockpiled topsoil;
- Placement of geotextile bags filled with sand and/or gravel around and along existing and proposed catch drains and stormwater drainage pits;
- Installation of water monitoring facilities within Darling Harbour.

In order to minimise the volume of polluted stormwater runoff generated by site works, stormwater within and adjacent to the site will generally be managed by diverting clean rainfall and runoff from any disturbed areas. Measures that will be implemented to prevent the ingress of surface water runoff into excavation areas include bunds, silt fences and drainage diversions. Proposed drainage diversion works are discussed in Section 6.3.2 and detailed on Drawing CD9000102 included in Appendix A.

The preferred hierarchy for management of water onsite is as follows:

- Minimising the volume of contaminated water during the works wherever possible by directing surface water away from excavations, depressions, pits and stockpiles by the construction of drainage works such as bunds and diversion drains. Sediment basin(s) may be employed as deemed necessary for the collection of surface water for maintenance of water quality and/or re-use;
- Recycling water, where possible, by reusing on site as dust suppression or for other site operations including wheel washing and truck washing subject to suitable treatment measures; and
- Discharging to the adjacent stormwater drainage network via overland flow or formal reticulation or to sewer, with or without treatment, will be as per regulatory guidelines and in accordance with the licensed discharge for the works.

Surface and ground water management structures will be frequently monitored in accordance with a site specific Water and Stormwater Management Sub-Plan.

Overall water quality shall be assessed with harbour monitoring. Final locations of harbour monitors will be to future detail.
Lendlease commits to the preparation of a detailed Water and Stormwater Management Plan that addresses water quality and water monitoring requirements for the duration of construction works associated with the development of Stage 1B. The Water and Stormwater Management Plan will include construction phase control measures to be implemented for Stage 1B and will be incorporated into an overarching site specific Environmental, Construction and Site Management Plan.

The Water and Stormwater Management Plan will address the following:

**Water Monitoring**

a. Criteria for nominating areas and different sources of site water as clean or contaminated;

b. Water monitoring protocols and decision criteria for whether site water will be directed to stormwater, a waste water treatment plant, to sewer or to a liquid waste facility;

c. Water discharge criteria and monitoring frequency for relevant parameters;

**Stormwater and Sediment Controls**

a. A detailed description of measures for stormwater and sediment control for specific locations on the site; and

b. Silt curtain arrangements for the protection of Darling Harbour as a secondary protection control.
10 Roads and Walkways

10.1 Relevant SEARs
This section addresses the following SEAR for SSD 7944:

2. Public Domain and Access

- Outline specific design features, including but not limited to:
  - footpaths and pavements, parking areas (including bicycle), roads and/or rights of carriageways
  - civil and stormwater infrastructure

10.2 General
The proposed road layout is based upon the Concept Plan included in the approval of MOD 8 (approved 28 June 2016) and is consistent with the established design standards and planning framework. Roads and associated footway areas have been designed so not to preclude future dedication to City of Sydney.

10.3 Design Standards
The road and walkway network has been designed generally in accordance with the following standards and guidelines:

- City of Sydney standards, policies and guidelines
- Austroads Guidelines
- Australian Standards including:
  - AS2890.1 – Parking facilities: Off-street parking
  - AS2890.2 – Parking facilities: Off-street commercial vehicle facilities
  - AS1742 – Manual of uniform traffic control devices
  - AS1428 – Design for access and mobility

10.4 Design Vehicle
Table 10-1 summarises the design vehicles for which the roads within Stage 1B have been designed:

<table>
<thead>
<tr>
<th>Interim Arrangement (prior to development of Central Barangaroo)</th>
<th>Ultimate Arrangement (upon completion of Central Barangaroo development)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.5 m truck access along Watermans Quay and Barangaroo Avenue south of Watermans Quay;</td>
<td>12.5 m truck access along Watermans Quay and Barangaroo Avenue</td>
</tr>
<tr>
<td>9.8 m garbage truck to access the Stage 1B basement and Crown basement; and</td>
<td>9.8 m garbage truck to access the Stage 1B basement and Crown basement</td>
</tr>
<tr>
<td>Passenger vehicles to the northern end of Barangaroo Avenue.</td>
<td></td>
</tr>
</tbody>
</table>

Design turning paths were modelled using Austroads 2013 vehicle templates in the AutoTURN software package to determine where local increases in pavement width were required to ensure the design vehicle could negotiate turns and bends safely with adequate clearances.

Where necessary, ‘No Stopping’ signs will be provided to ensure that required turning areas are free of parked vehicles.
10.5 Road Geometry and Width

Road geometry design has been undertaken in accordance with the approved Concept Plan. A summary of the road type characteristics are described in Table 10-2.

Table 10-2 Summary of Roads Characteristics

<table>
<thead>
<tr>
<th>Road Name</th>
<th>Road Pavement Width</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watermans Quay</td>
<td>11.5m</td>
<td>• Northern footpath 4 metres wide</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Southern footpath generally 7.5 metres wide, except at taxi bay.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Taxi bay on southern side of Watermans Quay 2.1 metres wide.</td>
</tr>
<tr>
<td>Barangaroo Avenue</td>
<td>7.0m</td>
<td>• Eastern footpath 5.15 metres wide</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Western footpath (adjacent to approved Crown Hotel) 3.85 metres wide.</td>
</tr>
</tbody>
</table>

Typical road sections are presented on Drawings CD5000101 and CD5000102 included in Appendix A.

10.6 Road and Walkway Grading

Due to the relatively flat nature of the site, roads have generally been designed using a ‘sawtooth’ grading system with a series of localised sags and crests. Typically, road cross fall has been maintained at 3%.

10.7 Road and Walkway Pavements

The northern half of Watermans Quay will be constructed on in-situ material, between the existing Stage 1A basement and the proposed Stage 1B basement structures. The southern half of Watermans Quay will be constructed over the existing Stage 1A basement.

The majority of Barangaroo Avenue will be constructed over the proposed Crown Hotel basement structure. There will be a section of Barangaroo Avenue approximately 50 metres long that will be constructed above in-situ material.

Road pavement designs have been prepared and presented in Table 10-3.

Table 10-3 Road Pavement Design for Watermans Quay and Barangaroo Avenue

<table>
<thead>
<tr>
<th>Pavement Material</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wearing Course - Asphaltic Concrete (AC10)</td>
<td>30mm</td>
</tr>
<tr>
<td>Base Course – Asphaltic Concrete (AC14)</td>
<td>55mm</td>
</tr>
<tr>
<td>Base Course – Asphaltic Concrete (AC14)</td>
<td>55mm</td>
</tr>
<tr>
<td>Primer Seal</td>
<td>10mm</td>
</tr>
<tr>
<td>Base Course (DGB20)</td>
<td>200mm</td>
</tr>
<tr>
<td>Sub Base (cement stabilised sand with 4% by mass cementitious content)</td>
<td>variable thickness</td>
</tr>
</tbody>
</table>

10.8 Intersections

There will be two intersections within and adjacent to the Stage 1B site:

- Hickson Road / Watermans Quay (signalised)
- Watermans Quay / Barangaroo Avenue (unsignalised)

The primary vehicular access to the site will be via the intersection at Hickson Road and Watermans Quay.
Vehicular access between the Stage 1A and 1B sites will be via a continuation of Barangaroo Avenue through the Stage 1B site. Barangaroo Avenue will be approximately aligned in a north-south direction and will continue to the northern site boundary. Signage will be put in place to indicate that Barangaroo Avenue will be a no through road until such time as continuation of the road alignment through the Central Barangaroo development site is constructed. In addition, a temporary vehicular crossing will be provided on the eastern side of Barangaroo Avenue to allow vehicles to make a three-point turn at the northern boundary and to minimise disruption of traffic exiting the Crown porte cochere as much as possible.

10.9 Footpaths

Footpaths within the Watermans Quay and Barangaroo Avenue road reserves will be provided in accordance with Council’s standard drawings with no provision for shared paths. Footpaths will generally be designed with 1 to 2.5% crossfall.
11 Utility Service Provision

11.1 Relevant SEARs
This section addresses the following SEARs for SSD 7944:

2. Public Domain and Access
   - Outline specific design features, including but not limited to:
     - services where affected, utility poles and service pits

12. Infrastructure Provision
   - Detail the existing infrastructure on-site and identify possible impacts on any such infrastructure from the proposal.
   - Detail the proposed infrastructure that will service the development and demonstrate that the site can be suitable serviced. This is to include lighting details and measure to mitigate light spill and potential impacts to the amenity of sensitive receivers surrounding the site, including residential and commercial premises.
   - Detail measures to mitigate the impacts of the proposal on any infrastructure items, including proposed relocation.

11.2 General
Approval for the provision of utility services to the Stage 1B development site has been sought and is currently being assessed under the Stage 1B Basement SSDA (SSD 6960). Infrastructure that will be constructed as part of the Stage 1B development will include potable water, recycled water, sewerage, chilled water (for heating, ventilation and air conditioning), natural gas, electrical and telecommunications. Detailed design of all infrastructure services is currently being undertaken.

The following sections provide an overview of the proposed infrastructure that will service the Stage 1B Public Domain works. Further details regarding existing and proposed utility services that will service the Stage 1B development are contained in the report titled Stormwater Management and Infrastructure Servicing Strategy (Cardno, August 2015), which was lodged under SSD 6960.

11.3 Proposed Utility Services
Approval for provision of the following utility services is being sought under the Stage 1B Public Domain DA (SSD 7944).

11.3.1 Potable Water
Minor water reticulation lines will be required to service public domain areas including the proposed amenities building adjacent to Hickson Road and bubblers along Wulugul Walk. Connections for these will be provided from the proposed 250mm diameter ring main that will be constructed within the Stage 1B site.

Final details, routing and location of assets are to be agreed with Sydney Water during detailed design development.

11.3.2 Recycled Water
Dual reticulation quality recycled water, compliant with the NSW Guidelines for Management of Private Recycled Water Schemes will be supplied for irrigation of Public Domain areas. The design and operation of the irrigation system will require a risk assessment of safe use of recycled water to be undertaken.

Recycled water will be supplied for sub-surface irrigation of Hickson Park and the proposed tree planters across the extent of the Stage 1B Public Domain works. The irrigation strategy for the public domain open space areas will be resolve during design development.
Recycled water will also be connected to the proposed Amenities Building for toilet flushing and other non-potable uses.

Connections to the existing recycled water mains within Stage 1A or planned recycled water mains within Stage 1B would be made to supply recycled water to the Stage 1B Public Domain. Final routing and location of connection points would be resolved during detailed design.

### 11.3.3 Chilled Water
No chilled water services will be required to service the proposed Stage 1B Public Domain works.

### 11.3.4 Sewerage
A sewerage connection will be required from the proposed amenities building adjacent to Hickson Road. Provision for a main sewer line from Central Barangaroo has been made adjacent to the eastern wall of the proposed Stage 1B basement. The preferred servicing option would be to provide a connection to this line, which would discharge to the Barangaroo RWTP.

### 11.3.5 Natural Gas
No gas services will be required to service the proposed Stage 1B Public Domain works.

### 11.3.6 Electricity and Lighting
Anticipated electricity loads associated with development of the Stage 1B Public Domain include the following:
- Performing spaces
- Temporary event areas
- Wireless access points
- Information kiosks
- Street lighting within Watermans Quay and Barangaroo Avenue
- Path and feature lighting within Hickson Park, Watermans Cove and Wulugul Walk
- Security cameras
- Irrigation infrastructure

Within the Stage 1B site, private embedded network cabling and substations will be established to service the building and other site loads. The electricity reticulation system will be provided through conduits and pits located at ground plane level within the streets and walkways. Distribution boards will be positioned on the ground plane for the supply of general power and lighting. These boards will be located within suitable rooms or cupboards and made accessible to authorised personnel only.

Final locations and integration of power supplies into the public domain will be identified through design development.

All electrical works will comply with the requirement of the following:
- National Construction Code (formerly Building Code of Australia)
- Relevant Australian Standards

### 11.3.7 Telecommunications
As part of the Stage 1B Public Domain works, communications lines will be extended from the future Stage 1B basement and will utilise risers within the proposed residential tower buildings on the ground plane, extending into a pit and pipe network along the street and walkways within the Stage 1B public domain.

Communications conduits will be installed underneath the footpaths adjacent to electricity conduits and will provide service to security cameras that will be installed throughout the Stage 1B Public Domain.
Wireless Access Points (WAPs) will be distributed throughout the public domain to enable basic data connectivity to the general public. The WAPs will be collocated with lighting poles and suitable architectural structural elements where appropriate.

No additional mobile phone augmentation is expected for the Stage 1B Public Domain in addition to works that will be installed for the Stage 1B Basement.

Communications works shall comply with the requirements of the following:

- National Construction Code (formerly Building Code of Australia)
- Relevant Australian Standards
- Governing Statutory Authorities
- Vendor specific guidelines

11.4 Existing and Planned Utility Services

The following sections describe both existing utility services and planned utility services that are subject to separate development approvals.

11.4.1 Potable Water
To service the Stage 1B site and the Crown Hotel development, connection will be made to the existing 300mm diameter watermain in Hickson Road. From this connection, a 250mm diameter potable water main will be constructed along the internal road network. The new main will generally be located as follows:

- Under the roadway on the northern side of Watermans Quay.
- Under the footpath on the eastern side of Barangaroo Avenue (above the proposed Crown Hotel basement, and on in-situ material between the existing Stage 1A basement and the proposed Crown Hotel basement).
- Under Hickson Park (above the proposed Crown Hotel and Stage 1B basement structures)

The proposed alignment of the proposed potable water main is presented on the Services Coordination drawings contained in Appendix A.

11.4.2 Recycled Water
The recycled water supply to Stage 1B and the Crown Hotel developments will be drawn from the central Recycled Water Treatment Plant (RWTP) that is located in the Stage 1A basement. The RWTP is currently operational and treats wastewater from the Barangaroo South development as well as a sewer mining connection from an existing Sydney Water sewerage line in Hickson Road.

Recycled water will be treated in accordance with Australian Recycled Water guidelines and reticulated throughout the Stage 1A and 1B developments for non-potable uses including landscape irrigation and toilet flushing.

Recycled water mains are generally to be located within the Stage 1B basement (subject to a license from Sydney Water and to the requirements of NSW Guidelines for Management of Private Recycled Water Schemes), reticulating to customer recycled water meters that will be located within the basement. The recycled water mains for Stage 1B will be extended from the existing termination point within the Stage 1A basement.

Indicative pipework associated with the proposed recycled water network within Stage 1B is presented on the Services Coordination drawings contained in Appendix A.

11.4.3 Chilled Water
A centralised chilled water plant and harbour heat rejection system have been constructed as part of Stage 1A works to provide reticulated chilled water to the Barangaroo South buildings, including the Stage 1B and Crown Hotel developments. Chilled water will be reticulated throughout the Barangaroo South development within a privately owned pipe network.
11.4.4 Sewerage

Provision of wastewater services connections to the Stage 1B and the Crown Hotel developments has been addressed through the Site Servicing Strategy as agreed with Sydney Water.

Sewerage from Stage 1B and the Crown Hotel development will discharge to the central RWTP located in the Stage 1A basement.

11.4.5 Natural Gas

The proposed gas servicing strategy for Stage 1B is currently being developed with Jemena, the gas asset owner and manager for the area. Jemena has confirmed that there is adequate capacity to service the Stage 1B development from the existing 110mm low pressure gas main in Hickson Road.

There is currently a combined servicing strategy being considered by Jemena for the supply of gas to Stage 1B and the Crown Hotel development:

- Construction of a new low pressure gas ring main within Hickson Road adjacent to the Stage 1B site to service the development,
- Construction of a high pressure connection from Hickson Road to the eastern site boundary, with a private network of low pressure mains to be constructed within the Crown Hotel basement to service the Crown Hotel development

The preferred option for the supply of gas to Stage 1B is currently being negotiated with Jemena.

A separate high pressure gas customer service would supply the Crown hotel site and would be provided under a separate application.

11.4.6 Electricity

The electrical services that will be required for Stage 1B can be broadly separated into three categories:

- Common infrastructure, including high voltage infrastructure that will be privately owned and operated.
- Basement
- Podium, including Public Domain

The scope of electrical services that will service Stage 1B include low voltage reticulation, main switchboards and distribution boards, standby power, energy metering, earthing and lighting protection, lighting and controls, exit and emergency escape lighting and small power reticulation.

Electricity infrastructure, which will consist of a 33kV network with substations located in the Stage 1A and Stage 1B basements, will be owned and operated by Lendlease as a private embedded network. This will be configured in a triplex configuration and will provide a similar level of redundancy to the 11kV CBD system.

The substations within the Stage 1A site (currently under operation) and Stage 1B site (planned future works, subject to a separate application) will have sufficient capacity to service the anticipated load for the Stage 1B Public Domain works.

11.4.7 Telecommunications

The scope of communications services that will ultimately be provided for Stage 1B and the Crown Hotel development (subject to separate applications) includes lead-in telecommunications service provider infrastructure, distribution, an Integrated Communications Network (ICN), Master Antenna Television System (MATV) and in-building (i.e. basement) mobile coverage / distributed antenna system.

A single lead-in connection will be provided to the Stage 1B site indicatively from Hickson Road. Allowance will be made for a primary telecommunications provider with spare capacity for up to two additional future service providers. Private fibre services may be interfaced directly to Barangaroo South Stage 1A. These works will all be subject to separate future applications.
Reticulation within the site will generally be in dedicated carrier cable trays at a high level in the Stage 1B basement to individual building node rooms. These works will be subject to approval under the Stage 1B Basement DA (SSD 6960).
12 Conclusion

This report supports a State Significant Development Application (SSD 7944) submitted to the Minister for Planning pursuant to Part 4 of the *Environmental Planning and Assessment Act 1979*. The Development Application (DA) seeks approval for construction of the Stage 1B Public Domain and associated works at Barangaroo South.

The completed design of proposed stormwater management measures will result in no adverse impact on surrounding neighbours or public spaces due to adjusted overland flow paths around the Barangaroo South development. Details are to be developed and integrated into the ground plane design and detailed in the design development phase.

The internal drainage system will capture and convey storm events up to and including the 100 year ARI event to Darling Harbour whilst also providing water quality treatment through a comprehensive treatment train.

The climate change induced sea level rise predicted for 2100 poses a risk to the effectiveness of the existing local stormwater drainage system in the Barangaroo area. However, the proposed diversion seeks to improve the capacity and allow for future climate change-driven increases in harbour water levels.

All required utility services to support the development, at a level of technology and innovation required for Barangaroo South, will be provided. Lendlease will enter into the necessary arrangements and obtain the necessary approvals for water supply, electrical supply, communications, sewer and stormwater connections from the relevant authorities, as required.
APPENDIX A
STAGE 1B PUBLIC DOMAIN CIVIL DRAWINGS
BARANGAROO SOUTH
STAGE 1B - PUBLIC DOMAIN WORKS

DRAWING No. DESCRIPTION

CD0000100 COVER SHEET
CD0000102 GENERAL ARRANGEMENT PLAN
CD0000110 SITEWORKS PLAN SHEET 1
CD0000111 SITEWORKS PLAN SHEET 2
CD0000112 SITEWORKS PLAN SHEET 3
CD0000130 PAVEMENT, SIGNAGE AND LINEMARKING SHEET 1
CD0000131 PAVEMENT, SIGNAGE AND LINEMARKING SHEET 2
CD0000132 PAVEMENT, SIGNAGE AND LINEMARKING SHEET 3
CD1000101 SERVICE COORDINATION PLAN SHEET 1
CD1000102 SERVICE COORDINATION PLAN SHEET 2
CD1000103 SERVICE COORDINATION PLAN SHEET 3
CD5000101 TYPICAL CROSS SECTIONS SHEET 1
CD5000102 TYPICAL CROSS SECTIONS SHEET 2
CD5000103 TYPICAL CROSS SECTIONS SHEET 3
CD9000101 INTERNAL CATCHMENT PLAN
CD9000102 EXTERNAL CATCHMENT PLAN