Appendix F Technical Paper: Traffic and Transport Impact Assessment

Transport for NSW

Barangaroo Ferry Hub

Traffic and Transport Impact Assessment

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1 Introduction

Arup has been appointed by Transport for NSW (TfNSW) to study the transport and access impacts of the proposed Barangaroo Ferry Hub. The proposal includes construction and operation of three new ferry wharves and ancillary landside ferry facilities (refer Chapter 5 for further detail). This study examines the construction and operational impacts of the proposal and their connectivity with the wider study area.

Table 1 lists the Secretary's environmental assessment requirements relevant to the traffic and transport for the proposal and where they are addressed in this section.

Table 1 – Secretary's environmental assessment requirements relevant to traffic and transport

Secretary's environmental assessment requirements	**Where addressed in report**

2. Transportation and Operation
• An assessment and modelling of the traffic and transport impacts of the development during construction and operation including consideration of:
  ○ estimated ferry arrivals and departures and impacts on the waterway (weekdays, weekends and public holidays);
  ○ access route identification;
  ○ estimated ferry passenger numbers (weekdays, weekends, public holidays and per year);
  ○ hours of operation;
  ○ estimated vehicle trips, type and frequency associated with ferry operations and maintenance;
  ○ vehicle access; and
  ○ car parking and bicycle parking requirements.
  ○ truck movements on the foreshore for the delivery of materials during construction, the cumulative impact of all projects within the vicinity including Barangaroo.
• Impacts on cyclist and pedestrian access and safety, including consideration of opportunities to integrate cycling and pedestrian elements with the public domain.
	Sections 6.1 and 6.2

5. Navigation and Safety • A review of existing boating activities in the area and an assessment of the impacts of the development on water-based traffic and the existing users of Sydney Harbour and nearby ferry operations at King Street Wharf, Sydney Aquarium and Pyrmont Bay. • Consideration of measures to ensure the safety of any recreational users of Sydney Harbour.	Sections 6.2.3 and 6.2.5
15. Construction Impacts • Identify measures to ameliorate potential construction impacts, including to vehicular, pedestrian and maritime access, noise and vibration, air quality, erosion and sediment control, water quality and waste management.	Section 6.1

2 Strategic Context

2.1 Policy Documents

The following relevant policy documents were reviewed in order to provide context for the traffic and transport aspects of the proposal.

2.1.1 Barangaroo Integrated Transport Plan

In August 2012, the Barangaroo Delivery Authority (BDA) released the *Barangaroo Integrated Transport Plan* (NSW Government, 2012a) which was prepared by a taskforce chaired by TNSW and included the City of Sydney, BDA, Lend Lease and other Government agencies. Key actions of the plan relating to ferry usage included:

- Continue existing ferry services in the short term to King Street Ferry Wharf, similar to current Parramatta River and Darling Harbour/Balmain East services, providing for an initial 4 per cent of Barangaroo commuters plus visitors to other parts of the northern Central Business District (CBD).
- Commence detailed planning for a ferry interchange at Barangaroo to enable growth in ferry patronage and convenient access to the western parts of the CBD for ferry passengers, as well as relieving congestion pressure at Circular Quay.

2.1.2 NSW Long Term Transport Master Plan

The *NSW Long Term Transport Master Plan* (NSW Government, 2012b) released in December 2012 by the NSW Government outlines a 20 year plan for the direction of transport services across NSW. The Master Plan presents an integrated approach to transport planning and identifies the roles different modes of transport would play in meeting the future transport and access needs of the State.

The Master Plan includes 220 short, medium and long term goals that are focused on commitments to the transport system in NSW. Accompanying the Master Plan are seven modal delivery plans, including a ferry modal delivery plan. Actions for Sydney's ferries are highlighted as a key component of the Master Plan with the Barangaroo Ferry Hub presented as part of the network that would accommodate new routes and destinations. The Master Plan confirms that the proposal is an integral component of Sydney's transport network, supporting the commercial development of Barangaroo, connecting ferry customers to the western and central parts of the CBD and relieving pressure from Circular Quay.

2.1.3 Sydney's Ferry Future

Sydney's Ferry Future (TfNSW, 2013c) outlines the strategy for ferry services over the next 20 years. The document outlines the NSW Government's plan to construct a ferry hub at Barangaroo to replace the

Darling Harbour King Street Ferry Wharf. The new ferry hub would serve the commercial development at Barangaroo and connect ferry customers to the western and central parts of the CBD. The ferry hub would also relieve capacity at Circular Quay. The future ferry network presented in the document is shown below in Figure 1.

2.1.4 Sydney City Centre Access Strategy

The *Sydney City Centre Access Strategy* (TfNSW, 2013a) released in December 2013, is the State's detailed plan to deliver a fully integrated transport network in Sydney's city centre. An action of the strategy is to construct a new ferry terminal at Barangaroo that would service the development at this site and connect ferry customers to the western and central parts of the city centre. The new Wynyard Walk pedestrian link would connect Barangaroo and Wynyard. Additional components of the strategy of particular relevance to the proposal are new bus routes serving Barangaroo and Wynyard Walk.

2.1.5 Sydney's Light Rail Future

Sydney's Light Rail Future (TfNSW, 2012b) describes the CBD and South East Light Rail project which will be a new light rail line extending from Circular Quay through George Street to Central Station and to the University of NSW via Anzac Parade and Alison Road. A stop is proposed on George Street at Wynyard Station which will provide accessibility between light rail and the Barangaroo Ferry Hub via Wynyard Walk and surface footpaths.

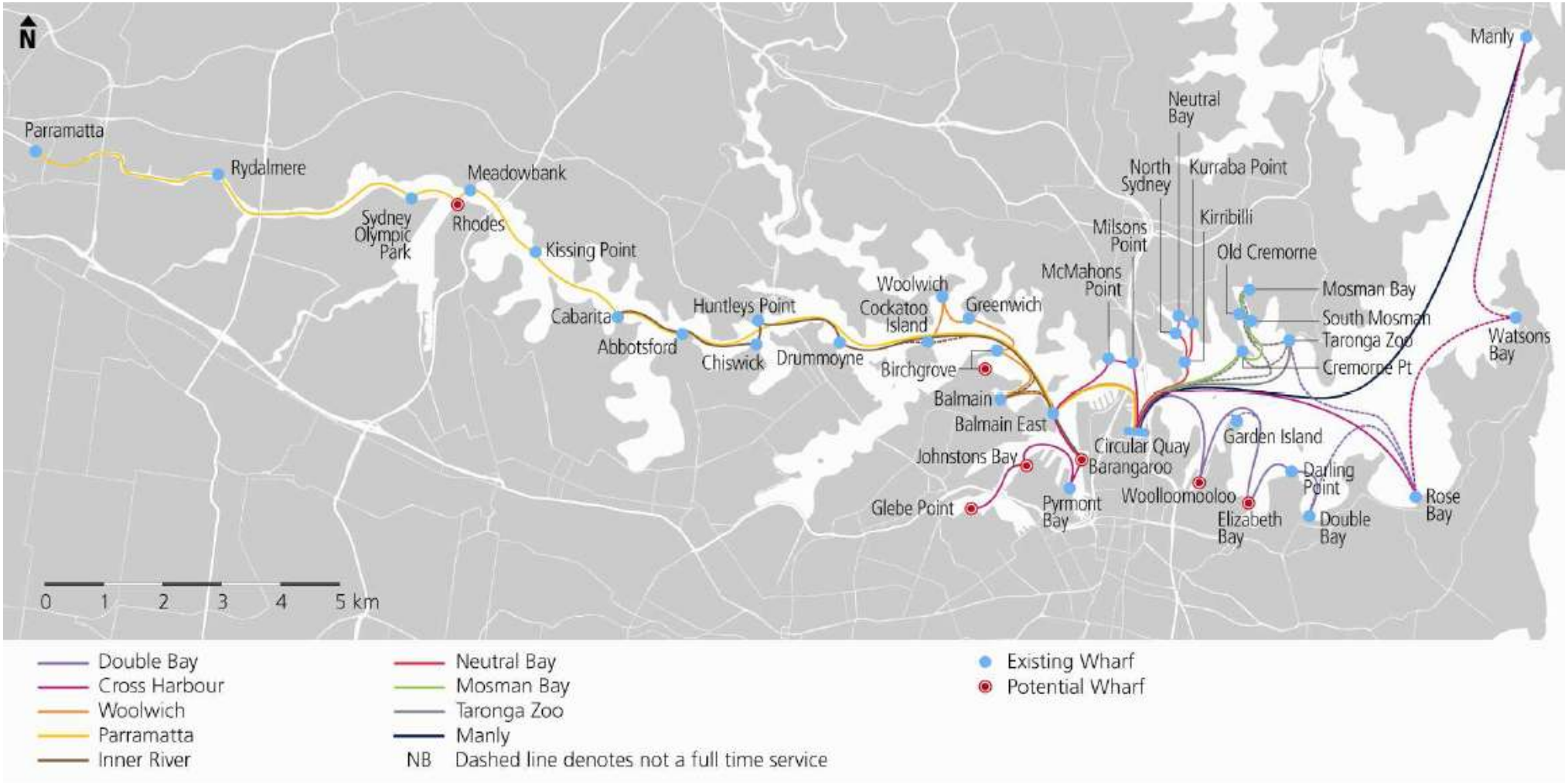

Figure 1 – Long Term Ferry Network for Sydney Harbour (TfNSW, 2013a)

2.2 Background Documents

The following relevant background documents which have been previously prepared were reviewed in order to provide context for the proposal.

2.2.1 Barangaroo Ferry Interchange Options Analysis

In January 2012, TfNSW undertook an options analysis of the Barangaroo Ferry Hub and related interchange requirements. The *Barangaroo Ferry Interchange Options Analysis* (TfNSW, 2012a) study supported the urban design for the adjacent Transport Place and associated Wynyard Walk projects, with the intention to 'future proof' the required space to accommodate the transport interchange functions for the Barangaroo Ferry Hub. As a result of the study, two options were identified to be considered further, both of which allowed for the construction of three new wharves. A third option was also developed independently by Sydney Ferries and Roads and Maritime Services (Roads and Maritime, 2012). All three options were then considered in a navigational issues workshop in June 2012. This is discussed further in Section 5.2.4 below.

2.2.2 Barangaroo Ferry Interchange – Navigational Issues

The *Barangaroo Ferry Interchange – Navigational Issues* (Roads and Maritime, 2012) report documents the results of a workshop attended by a group of 14 experts from Roads and Maritime, Sydney Port Corporation, TfNSW, Sydney Ferries, Captain Cook Cruises and Blue Line Cruises which considered the navigational issues of the two options posed in the *Barangaroo Ferry Interchange Options Analysis* (TfNSW, 2012a) and a third option developed independently by Sydney Ferries and Roads and Maritime. Critical points of the report included the following:

- The area around the proposed hub has multi-directional vessel traffic and recreational vessels. The introduction of new wharves would increase vessel numbers and introduce additional traffic movements which would need further consideration and a vessel traffic management plan.
- The line of approach at the wharves is significantly different to those at Circular Quay which have an aligned approach.
- Wharf orientation should be slanted between 30° and 45° from perpendicular (oriented northwest-southeast) to improve approach lines and reduce encroachment into the adjacent navigation channel.
- The current channel width of 130 metres should be maintained.
- Optimum wharf projection is 65 metres.

It is noted that the report also identified the need for further navigational assessment beyond previously undertaken. Further navigational assessment is discussed in Section 6.2.5.

2.2.3 Barangaroo Pedestrian Precinct Demand

The *Barangaroo Pedestrian Precinct Demand Report* was developed for Lend Lease (in conjunction with the BDA) in 2013 (Arup, 2013). The strategy provides expected weekday, weekend, and event populations across the Barangaroo development site for a full build scenario. This includes an estimation of the anticipated foot traffic along major pedestrian routes over different time periods.

The outcomes of the analysis suggests that volumes of pedestrians using Barangaroo South would be comparable to existing movements along some of the key pedestrian corridors in the Sydney CBD. The strategy identified high pedestrian activity at all times of the day travelling along the corridor between the Barangaroo Ferry Hub and Wynyard Station – with more than 4,000 movements forecast in the AM peak hour.

3 Surrounding Planned Developments

The following planned or under construction developments have a direct or indirect relationship with the proposed Barangaroo Ferry Hub:

- Barangaroo precinct
- Wynyard Walk
- Wynyard Station Upgrade
- CBD and South East Light Rail (CSELR).

The surrounding planned and under construction developments are shown in Figure 2.

3.1.1 Barangaroo precinct

Barangaroo is a 22 hectare mixed-use development west of the Sydney CBD. The Barangaroo precinct was historically used for shipping and stevedoring however the NSW Government is now transforming the space into a public, residential and commercial precinct over the next decade. Based on the most recent development approval for Barangaroo, the precinct is expected to accommodate up to 23,000 office workers, 2500 residents and attract up to 33,000 visitors per day when complete.

The precinct is divided into three sections:

- Barangaroo South – a major new business, tourism, residential and retail precinct opening onto a public waterfront promenade. This is the area in which the Barangaroo Ferry Hub would be located.
- Central Barangaroo – a cultural and civic focal point for recreation, relaxation, events, festivals, entertainment and leisure activities as well as recreational, residential, retail and commercial facilities.
- Headland Park – a six hectare open space precinct designed to complement the neighbouring headlands of Sydney Harbour.

The Barangaroo development is shown in Figure 2 on the following page.

In February 2010, an amendment to the original Barangaroo Concept Plan was proposed (MP06_0162 MOD 4). The modification proposed several amendments including a hotel development, additional ground floor space and height. Other changes included approximately 300 m^2 of transport related office space. The modification also facilitates the future provision of ferry wharves and provides an indicative location for these at the southern end of the site. The construction of the wharves and the provision of associated waterside infrastructure were proposed to be undertaken by others. These are now the subject of an EIS.

The BDA is a State Government-owned agency established to manage and develop Barangaroo on behalf of the State Government. Lend Lease is currently developing Barangaroo South, where construction commenced in 2011. The first commercial tower is expected to open in the middle of 2015. The proposed Barangaroo Ferry Hub would support the mixed use development of Barangaroo and the western parts of the CBD.

3.1.2 Wynyard Walk

Once completed, Wynyard Walk will provide a direct pedestrian link between Barangaroo and Wynyard Station. Wynyard Walk is expected to be open during 2016, coinciding with the opening of the proposal.

Key features of the Wynyard Walk project include:

- A new western entrance to Wynyard Station (Clarence Street portal) to provide direct access to Wynyard Walk, the Kent Street tunnel and the station concourse.
- A new 3.5 metre high by nine metre wide underground pedestrian link from Wynyard Station to the intersection of Kent and Napoleon Streets (approximately 180 metres long).
- A new paved pedestrian plaza at the intersection of Kent and Napoleon Streets that would include landscaping, street furniture, lighting and public art.
- A pedestrian bridge over Sussex Street.

Wynyard Walk would allow people to access the Barangaroo Ferry Hub from Wynyard Station in approximately six minutes and would accommodate up to 20,000 pedestrians per hour (bi-directional).

3.1.3 Wynyard Station Upgrade

In May 2014, the NSW Government announced a $100 million upgrade of Wynyard Station. The upgraded station would feature premium fixtures and finishes, a wider concourse and ticket gates, and less clutter on the concourse and platforms to improve customer experience and make it easier for customers to move in and around the station. The upgrade would be supported by improved operational reliability through upgraded services and removal of redundant services.

TfNSW has engaged the Novo Rail Alliance to design and deliver early works for the station upgrade. Subject to planning approvals, major construction for the Wynyard Station Upgrade project would start in 2015 and is expected to finish in 2016.

3.1.4 CBD and South East Light Rail

The CSELR project would commence construction of a new light rail line in late 2014 and is expected to take five or six years to complete. The light rail line extends from Circular Quay through George Street to Central Station and to the University of NSW via Anzac Parade and Alison Road. A stop is proposed on George Street at Wynyard Station which would provide accessibility between light rail and the Barangaroo Ferry Hub via Wynyard Walk and surface footpaths.

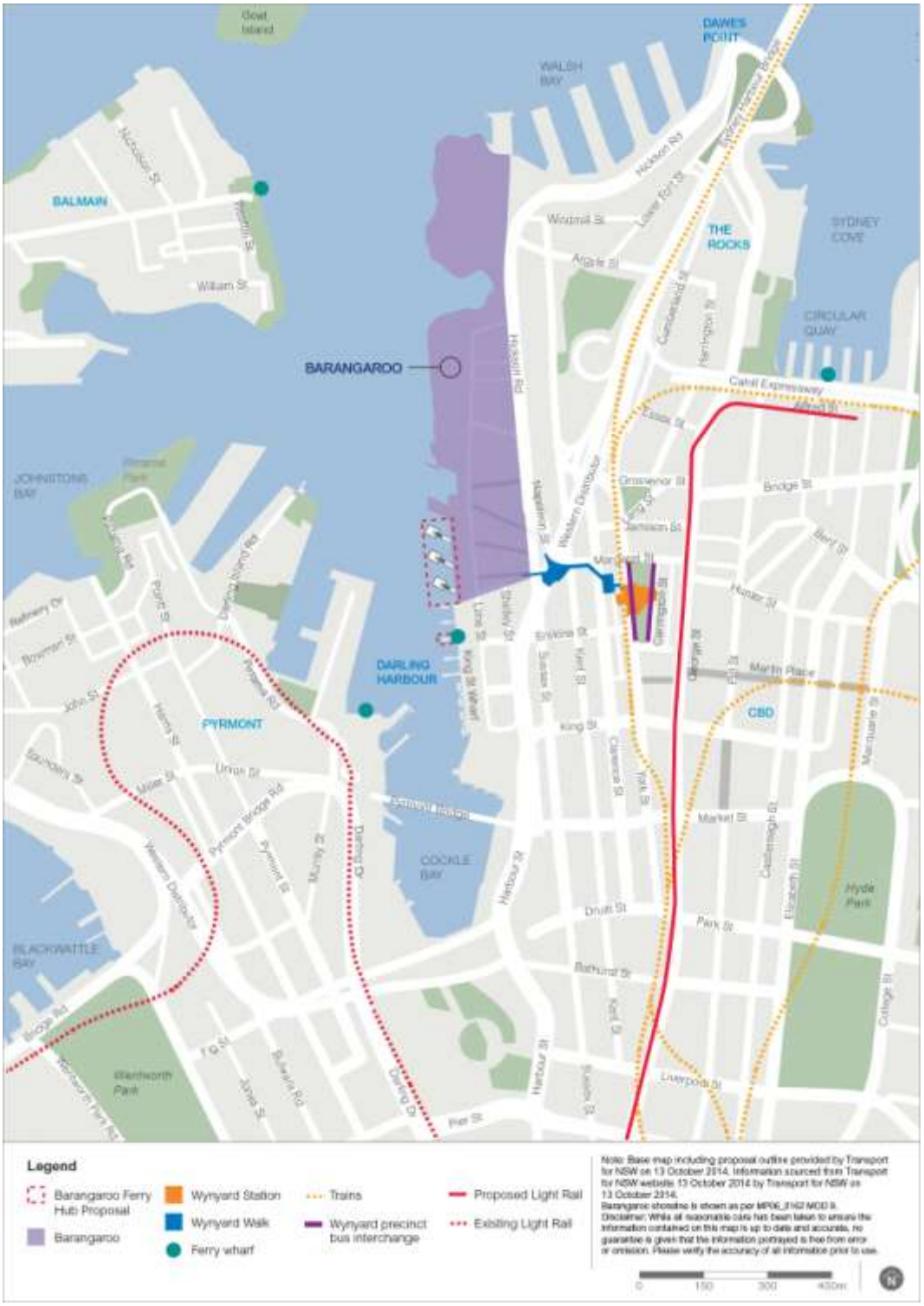

Figure 2 – Existing and planned public transport network

4 Existing environment

4.1 Waterways

Darling Harbour is one of Sydney's busiest marine transport hubs. It is currently used by a variety of small leisure craft, ferries and commercial vessels, currently without restrictions on access. The waterway to the north and north-west of the proposal area is used by commercial vessels accessing White Bay and Johnston Bay, as well as ferries and leisure craft. The outer edge of the Darling Harbour waterway is largely occupied by commercial vessel berths. Access to these berths is through the entrance to Darling Harbour which is about 130 metres wide.

The nearest berth to the proposal area is the King Street Wharf 1. This wharf has two berthing faces (north and south). The northern berth is occupied by Captain Cook Cruises under a lease arrangement with Roads and Maritime. The King Street Wharf wave baffle is located on the northern side of the King Street Wharf 1.

Sydney Ferries services, including Darling Harbour and Parramatta River services, currently operate from King Street Ferry Wharf on weekdays and weekends, with a total of 86 services per day during weekdays and 91 services per day on Saturdays and 94 services on Sundays. During the weekday morning peak and on the weekends there are up to eight ferry services per hour using King Street Ferry Wharf. There are also many charter cruise companies operating from Darling Harbour providing scheduled and unscheduled cruises.

4.2 Road Network

The primary roads currently serving the Barangaroo development site include Sussex Street, Hickson Road, Napoleon Street, Lime Street and Shelley Street, as shown in Figure 3 . Lime Street is the closest vehicular traffic route to the proposal. Lime Street is a two lane local road that connects to King Street at the south and Shelley Street to the east. This arrangement would remain following the opening of Barangaroo.

Hickson Road (between Erskine Street and Lower Fort Street) and Napoleon Street (between Hickson Road and Kent Street) come under the control of BDA. City of Sydney Council manages all other roads in the precinct. The nearest State Roads under the control of Roads and Maritime Services are King Street and the Western Distributor.

Figure 3 – Existing Road Network

4.3 Traffic Volumes

Traffic counts were undertaken in the Barangaroo precinct in July 2013 and are presented in Figure 4 and Figure 5. These counts indicate Sussex Street (in the vicinity of the proposal) carries more than 1100 vehicles in both the AM and PM commuter peak hours. During the morning peak hour (8 am to 9 am), more than 800 vehicles were recorded travelling north on Shelley Street south of Erskine Street.

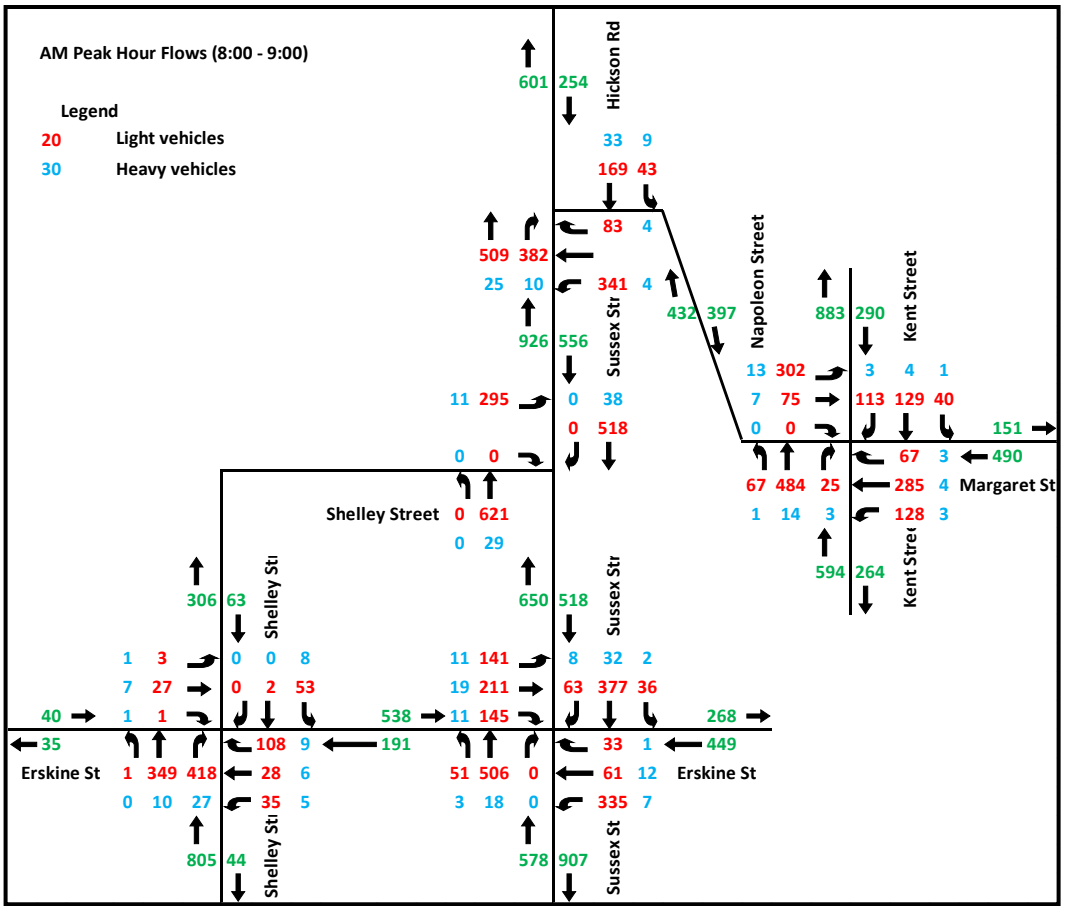

Figure 4 – AM Peak Hour Traffic Flows, July 2013

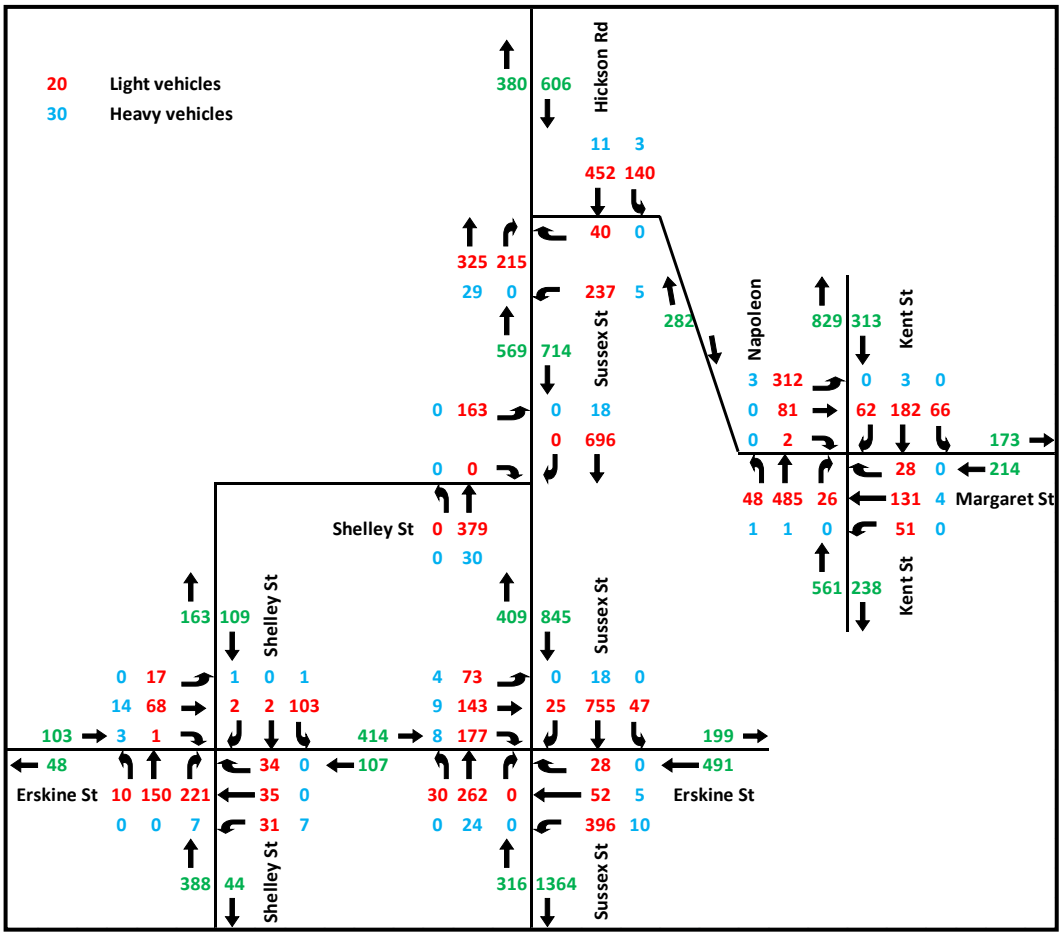

Figure 5 – PM Peak Hour Traffic Flows, July 2013

Planned development in the precinct includes Barangaroo South, Central Barangaroo and Headland Park. These developments will have a high reliance on public transport for access with vehicle movements restricted by the level of car parking provided. The additional vehicle trips generated by development in the precinct are shown in Table 2. These vehicle movements will be focused on Hickson Road and Napoleon Road for access to basement car parking areas. There will be minor traffic increases on local roads in the King Street Wharf precinct associated with local access and taxi circulation.

Table 2 – Additional Vehicle Trips Generated by Barangaroo

Development	**Vehicles per hour**	
	AM peak hour	**PM peak hour**
Barangaroo South	450	375
Central Barangaroo	150	200
Headland Park	15	120
Total	615	675

4.4 Parking

On-street parking in the precinct is currently limited to time restricted parking, ranging from five minutes up to 10 hours. There are approximately 14 loading bays for vehicles on the western side of Lime Street between 7 am and 6 pm Monday to Friday and 7 am-10 am Saturday, with 4 hour parking restrictions in place outside these times. All day car parking is available in a number of off-street car parking areas in close proximity to the proposal. The closest public parking is available at 1 Shelley Street and 275 Kent Street. Limited additional public parking will be provided in Barangaroo South for visitors.

4.5 Public Transport

The current and existing public transport services in and around the proposal area are shown on Figure 2. All existing public transport services would be maintained during construction of the Barangaroo Ferry Hub.

4.5.1 Ferries

The closest public ferry wharf to the proposal is King Street Ferry Wharf. Based on the current ferry timetable, ferries operate at King Street Ferry Wharf between 6.30 am and 11.30 pm on weekdays and 8.30 am to 11.30 pm on weekends and public holidays. Up to eight services per hour operate from this wharf in the peak direction; with fewer services in off-peak periods (refer to Table 3).

4.5.2 Rail

Wynyard Station is the closest railway station to the proposal, located approximately 400 metres walking distance from the proposal. Wynyard is served by the T1 - North Shore Northern and Western line, T2 - Airport Inner West and South line and T3 - Bankstown line, making the station highly accessible for passengers from most parts of the Sydney metropolitan area.

4.5.3 Light Rail

The existing light rail route extends from Central Station via Hay Street to Darling Harbour and then follows the freight rail corridor through Pyrmont, Glebe and Leichhardt to Dulwich Hill. The planned CBD and South East Light Rail project would be a new light rail line extending from Circular Quay through George Street to Central Station and to the University of NSW via Anzac Parade and Alison Road. A stop is proposed on George Street at Wynyard Station which would provide accessibility between light rail and the Barangaroo Ferry Hub via Wynyard Walk and surface footpaths.

4.5.4 Bus

Two bus routes currently directly service the Barangaroo precinct, those being routes 412 (King Street Wharf and Campsie via Lewisham) and 413 (King Street Wharf and Campsie via Dulwich Hill). These services operate at 15 minute frequencies during the morning and evening peak hours.

A significant number of bus routes operate along Clarence Street and York Street serving Wynyard Station. These bus routes largely service the North Shore, Northern Beaches and North-West Sydney.

The Sydney City Centre Access Strategy proposes new bus services along Hickson Road to service Barangaroo. Bus stop locations have not yet been determined.

4.6 Taxis

A formal taxi rank is currently provided at the northern end of Shelley Street, with capacity for up to seven taxis queued at any one time. There is also a secure taxi rank at the northern end of Lime Street which operates between 10 pm and 4 am on Friday and Saturday nights. Barangaroo South would supplement these taxi ranks with new ranks proposed on Hickson Road and Globe Street.

4.7 Pedestrian Network

Figure 6 shows the current pedestrian network in and around the proposal area.

The roads in the vicinity of the Barangaroo Ferry Hub generally provide controlled pedestrian crossings on all legs of signalised intersections. Footpaths are provided on both sides of all streets in the area. A number of physical barriers in the precinct may deter people from travelling west towards Barangaroo. These include:

- Busy traffic along York Street
- Severance caused by the Bradfield Highway between Argyle Street and Grosvenor Street
- Hickson Road cliff face
- Steep topography from Wynyard station to Barangaroo
- Western Distributor’s elevated structures.

There is a significant level difference between Wynyard Station and the proposal site. Wynyard Walk (currently under construction) will improve connectivity for pedestrians by providing a grade separated link where pedestrians may bypass on-street delays, travelling between Wynyard and the Barangaroo waterfront in about six minutes.

Currently the foreshore adjacent to Barangaroo is closed to pedestrian movements for construction of the Barangaroo South buildings and public domain. The foreshore is planned to reopen in March 2015. The proposal area adjoins the northern edge of the King Street Wharf promenade. The

King Street Wharf promenade is a busy pedestrian thoroughfare providing access to waterfront properties and the commercial and public ferry wharves at King Street Wharf. Access to the foreshore and the northern end of the King Street Wharf promenade is from Lime Street and connections from the south including Darling Harbour foreshore walk and Pyrmont Bridge.

Once constructed, Barangaroo South would comprise a series of pedestrian connections and roads. A pedestrian promenade is to be developed along the length of the Barangaroo foreshore edge – providing a continuous connection from Darling Harbour north to Headland Park site. As shown in Figure 6, two new pedestrian bridges would cross Sussex Street connecting between Wynyard Walk and Barangaroo. Wynyard Walk Bridge provides a direct connection from Wynyard Walk to Transport Place. A second bridge known as City Walk Bridge would connect into the heart of Barangaroo South.

Figure 6– Pedestrian Network (planned and existing)

4.8 Bicycle Network

The cycling network surrounding the proposal is comprised of a number of different routes, described below.

- **Kent Street** (bi-directional separated cycleway)

Kent Street provides the predominant north-south cycling route through the CBD. It is largely utilised by cyclists travelling from the southern and eastern suburbs through the CBD, linking with the Harbour Bridge cycleway. Construction of stage two of the cycleway, connecting Druitt Street to Liverpool Street, is currently underway.

- **Sydney Harbour Bridge** (bi-directional separated cycleway)

The Sydney Harbour Bridge cycleway provides access for cyclists arriving from the northern suburbs of Sydney. The cycleway connects with the Kent Street cycleway via a link through Observatory Hill Park.

- **Pyrmont Bridge** (shared pathway)

The Pyrmont Bridge share pedestrian/cycle path provides a key link for cyclists arriving from the western suburbs and inner west. The path continues to the start of the King Street cycleway at the intersection of King Street and Sussex Street.

- **Hickson Road** (bicycle shoulder lane)

The on-road cycleway along Hickson Road runs adjacent to the Barangaroo site and provides access to the Rocks and Circular Quay. The route is largely utilised by recreational cyclists, with users generally accessing the cycleway from other routes.

- **Darling Harbour / Shelley Street** (shared pathway / mixed traffic)

A popular route for cyclists travelling to the north CBD area via the inner west, eastern and southern suburbs is via the Darling Harbour precinct and through to Shelley Street. This route is attractive for cyclists as it provides a direct route to the Barangaroo precinct with minimal interaction with vehicles along trafficable routes.

With an Opal card, cyclists may take their bikes onto the ferry at no additional cost (with paper tickets during peak hours, taking a bicycle on a ferry requires an additional child ticket).

5 Proposal Overview

5.1 Description

The proposal comprises the construction and operation of a ferry hub and would include:

- Establishment of a construction work area and temporary construction compound.
- Construction of three new ferry wharves and ancillary landside ferry facilities.
- Potential demolition of King Street Wharf wave baffle.
- Site clean-up and opening of the new wharves.
- Operation of the wharves including ferry layover, pump out facilities and facilities for minor maintenance activities.
- Eventual decommissioning and removal of the public transport elements of King Street Ferry Wharf such as ticket vending machines and signage.
- Operation of the Barangaroo Ferry Hub.

Landside ancillary facilities included as part of the proposal are likely to include way finding signage and ticketing (including Opal card facilities).

Initially, two of the three wharves would be constructed. The third wharf would be constructed in the future when the demand for ferry services necessitates. These features are illustrated in Figure 7.

Figure 7 – Barangaroo Ferry Hub Key Proposal Features

5.2 Proposed configuration

It is anticipated that each wharf would be self-supporting and would comprise:

- A prefabricated steel covered pontoon about 38 metres long and 22 metres wide, which includes:
  - two berthing faces on each pontoon
  - ancillary facilities on each wharf to provide for passenger safety, comfort and security and to display ferry service information
  - a roof structure which incorporates a glazed roof light, with a ceiling height of about 3.5 metres above the pontoon surface and 4.5 metres above sea level and an overall roof height of up to about 6.5 metres above sea level.
- A fixed covered link structure to connect the gangway to the land (comprising two ramps and a landing) up to about 30 metres long, between about 13 metres to 37 metres wide. The link structure would be level with the built quay line (+RL 2.9m at northern wharf and +RL 2.5m at southern wharf) and ramps down to around +RL 1.9m for each wharf.
- A prefabricated aluminium gangway about 15 metres long and 10 metres wide between the link structure and the pontoon.
- Mini pontoons and walkways for crew access to vessels in layover (on both sides of each wharf).
- Ticket barriers, wayfinding signage , public announcement system (PA system) and Opal ticketing infrastructure.
- About 30 piles per wharf (including steel pontoon restraint piles, steel support piles, crash barrier piles and potentially fender piles).
- Ferry crash barrier comprising cross beam attached to the crash barrier piles. On the southern side this would be installed adjacent to the sea wall, on the northern side this would be in front of the link structure.
- Connection of power, telecommunication and data communications and potable water services (including fire hydrant services).
- A sewage pump-out facility comprising pump, filters, reels, valves, electrical and control facilities. It is anticipated that the pump-out facilities would be located in an enclosed space on the link structure and be about 3 metres by 2 metres by 1.5 metres in size.
- A small gateline ‘kiosk’ (office) would also be located on the link structure for staff activities (no ticket sales), together with a bin store.

During detailed design and navigational safety planning, the need for fender piles would also be considered, and may potentially require up to eight additional piles per wharf.

Design elements including surface treatments and transition features will be designed to be compatible with Barangaroo South and the design of the ferry wharves.

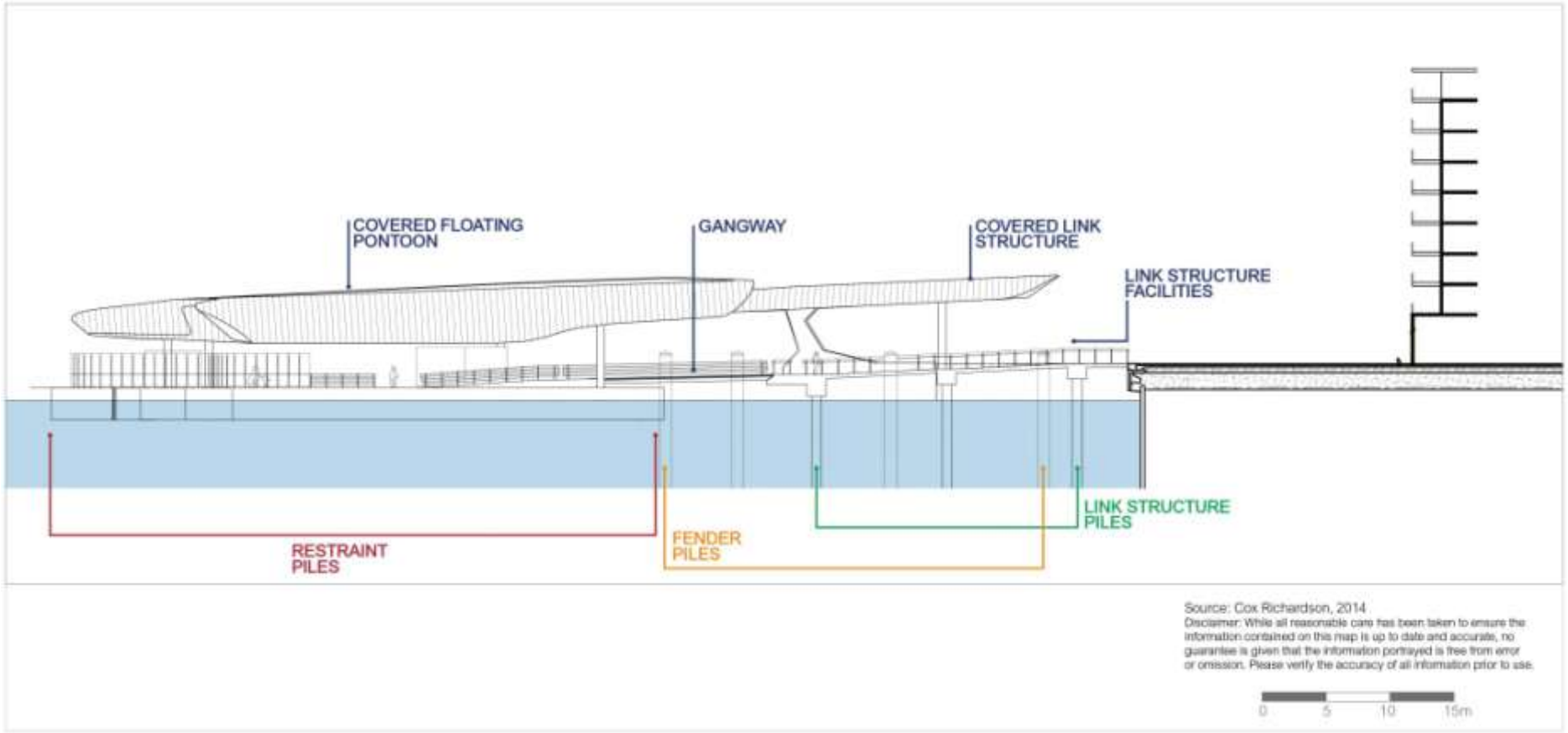

Figure 8 – Typical Wharf Configuration Source: Preliminary Concept Design

5.3 Construction Methodology

Construction of the wharves is expected to be carried out as follows:

a) Establishment of construction work area and a temporary construction compound

The construction work area would be established by installing hoarding along the foreshore at the location of the proposed wharves, erecting construction signage identifying the work area, and installing silt curtains around the perimeter of the site within the waterway. Silt curtains would contain any accidental spills, as well as the potential disturbance of harbour sediments from construction and demolition activities such as vessels manoeuvring and piling.

It is anticipated that the temporary construction compound within the work area would be located on the Barangaroo foreshore and adjacent to the location of the Barangaroo Ferry Hub proposal. The temporary construction compound would measure about six metres wide and 70 metres long (420 square metres in area). Depending on Barangaroo South construction activities and hoarding locations, access along the Barangaroo foreshore would be reduced to about 12 metres in width due to the location of the temporary construction compound. This would provide sufficient space to enable two wheelchair users to pass each other in opposite directions. Pedestrian detours are unlikely to be required during the construction of the proposal as site clean-up would be within the proposal area and the installation of ancillary landside facilities would be isolated.

The establishment of the temporary construction compound would involve the installation of relocatable site sheds, temporary toilets and bunding to prevent accidental spills entering the waterway. Construction equipment (e.g. construction materials and tool boxes) would be stored within the compound. Based on similar projects within Sydney Harbour, the size of the temporary construction compound would be sufficient for these items. The final position and layout would be subject to detailed design.

The majority of construction plant, equipment, materials and personnel would access the construction work area via Sydney Harbour, including components fabricated off-site (including pontoons, gangways and rooves), being transported by boat and/or barge from the construction contractor’s main off-site facilities to the proposal area.

A 130 metre wide navigation channel would be maintained throughout the works wherever possible to minimise disturbance to vessel movements and safety of vessels travelling to and from Darling Harbour during construction. There may be instances where some movement of plant occurs within the navigation channel such as during the positioning of construction barge(s) and when barge equipment needs to be moored in close proximity to the work area. Any encroachment into the navigation area would be for short periods of time and would be managed in accordance with the Harbour Master and/or Sydney Ports requirements.

b) Construction of three new ferry wharves and ancillary landside ferry facilities

For each wharf, the majority of the components such as the piles, pontoon and gangway would be fabricated off-site and transported to the construction site via barges. These components would generally arrive at the site at the time of installation. In-situ work is likely to be required for the link structure.

The piles for each wharf would be installed using a combination of screwing, vibrating and hammering techniques from a barge using a crane with a piling rig attachment. It is not anticipated that piling works would happen concurrently. Once the piles are installed, concrete trucks would pour the concrete to build the link structure and to fill the piles. Intricate lifting and placement of components of each wharf would be carried out using a barge mounted crane. This method would be used to install the gangway and pontoon components. It is anticipated that specific components of work for each wharf may need to be undertaken out-of-hours (i.e. during the evening and night time periods). Piling and intricate lifts typically need to be undertaken during calm environmental conditions (e.g. still water and minimal wind) to enable accurate pile installation. Calm conditions are also required to provide safe conditions for the construction crew. Out-of-hours activities, if required, would normally be up to two months in total during the early stages of construction.

Further detail on these activities is provided below:

Installation of piles

About 30 piles (including steel pontoon restraint piles, steel support piles, crash barrier piles and potentially fender piles) would be installed into bedrock for each wharf. These piles would be transported by barge to the site from the off-site facility.

Constructing pile foundation systems in bedrock consists of three components:

- Phase 1 Pitching, vibrating and drilling piles into sediment and rock during calm water conditions
- Phase 2 Hammering piles to refusal during calm water conditions
- Phase 3 Cutting, levelling and plugging of piles with concrete.

As noted above, Phase 1 and Phase 2 require calm water conditions so that the floating barge used for the piling can remain still for the piles to be installed accurately and to also provide safe conditions for the construction crew. The waterway is usually calmer during the night and early morning with wind and wind chop increasing throughout the day. Accordingly, the conditions required for piling usually occur during the night and early morning. As such, the proposal may require night works over around two months to complete the installation of piles. This timeframe provides some allowance for construction to be programmed to minimise the number of consecutive nights that impact on the same receptors and unfavourable conditions from weather, seas, swell, wind, and boat wash.

Phase 1

Each pile would be lifted from the barge and put into place (pitching) using a barge mounted crane, taking up to three hours. A vibrating hammer attached to the crane would be used to stabilise the pile within the sediment layer prior to drilling, taking around one hour.

Drilling into sediment and rock would take about three hours per pile plus setup time and pack up time (with continuous noise from the diesel generator and large electric motors only occurring during drilling of the pile). A barge mounted crane with drill rig attachment would attach to the pile using a helmet fitting. The drill rig would screw the pile into the bedrock to a depth of up to about three metres.

Phase 2

The piles are hammered to refusal using the barge mounted crane with hammer attachment. Hammering of piles would take place at least one day after the drilling of piles. It is anticipated that each pile would be hammered for about one minute (about 10 hits with the hammer within one minute). For each pile this activity is likely to occur five times over a period of one hour. There are about 30 piles to be hammered for each wharf.

Phase 3

About one third and up to about a half of the steel piles would be filled with concrete. Large structural piles would require concreting and different finishing. Some smaller piles would be cut to level and have caps installed. The method applied to each pile would be decided during construction.

c) Construction of pontoon, gangway and ancillary facilities for each wharf

Following the completion of piling activities, the link structure and gangway would be constructed. Most of the structure (e.g. beams, headstocks and rooves) would be pre-fabricated/pre-cast then transported to site from the off-site facility. Temporary walkways would be installed down each side of the structure. For each wharf, in-situ works would include concrete pours (involving about 48 concrete trucks per wharf) to construct the link structure and to fill the piles. Concrete would be transported to site either by land or the Harbour depending on construction planning.

Intricate lifting and placement of components of the new wharf such as the gangway and rooves would be carried out using a barge mounted crane. This activity needs to be undertaken during calm environmental conditions (i.e. still water and minimal wind). Intricate lifts and placement can take up to about six hours per gangway and up to about four days per roof. For lifting and placement to be completed while the environmental conditions are appropriate, intricate lifting and placement may need to be undertaken during the night-time/early morning period between about 11 pm and 7 am.

The pontoon structures would be constructed at an off-site facility and floated into place. Prior to its placement, piles on one side would be completed. Following placement, the remaining piles would be completed. Each pontoon would be attached to its associated gangway.

Once the structural elements are in place, electrical power and communication lines, and sewer and water pipes would be installed and connected to the existing services at the land/water interface which are to be constructed by Lend Lease. Fit out of the Barangaroo Ferry Hub, including the installation of pump-out, and minor modifications to the wharves would also occur at this stage of the construction program.

Ancillary landside facilities such as Opal card ticketing facilities, wayfinding signage and bicycle racks would also be installed at this stage. This involves installation of ticket machines, customer information facilities and signage. TfNSW would be aiming to provide for a minimum of 20 bicycle rack spaces (10 Urails) near the interchange entrance for ferry customers. These may be provided along the promenade and would be designed and located to integrate with the other street furniture (trees, rubbish bins and benches) to be developed by Lend Lease. Final bicycle rack numbers, design and location would be subject to discussions with BDA/Lend Lease.

It is expected that the fit out of the Barangaroo Ferry Hub and the installation of the landside facilities would take up to about two months.

d) **Potential demolition of King Street Wharf wave baffle**

The King Street Wharf wave baffle is a Roads and Maritime asset. The potential demolition of the wave baffle is being discussed with Roads and Maritime. If the demolition of the wave baffle proceeds, it would make available additional space to enable full utilisation of the southern berthing face of the southernmost wharf.

The King Street Wharf wave baffle is irregular in shape and about 40 metres long, eight metres wide at the eastern end and six metres wide at the western end. It is comprised of a timber deck supported by timber girders, steel wash barrier substructure and about 26 concrete piles, 25 timber fender piles and a single steel pile at the western end of the jetty.

If demolished, the following works would be involved:

- Removal of all timber decking, supporting timber girders, underlying wash barrier steel substructure using hand tools and barge mounted crane. It expected that this phase of demolition would take up to about one month.
- Removal of the piles using a vibratory hammer to extract the piles. The hammer would be placed over the pile using a barge mounted crane. If the pile is unable to be pulled out, it would be cut level to the harbour bed to remain in situ. Divers would cut the pile at seabed level using appropriate underwater equipment. It expected that this phase of demolition would take up to about one month.
- Moving all of the materials to the off-site facility by barge.

The components of the wave baffle would be reused, where possible, or eventually be removed to a licensed waste management facility for recycling or disposal.

e) **Site clean-up and commissioning of the new wharves**

The site would be cleaned up and brought to its intended state. Controls and temporary structures would be removed in order to open the wharves for operation. A safety assessment of the structure would be carried out to identify any risks and rectify any safety hazards resulting from the construction before opening areas to the public.

Following the removal of construction controls and site clean-up the wharves would be commissioned for operation, which is expected to take about two weeks to complete. Minor adjustments may occur at this time.

f) **Decommissioning and removal of the public transport elements of King Street Ferry Wharf**

When the existing King Street Ferry Wharf services are relocated to the Barangaroo Ferry Hub, the public transport elements of King Street Ferry Wharf would be decommissioned. This would involve the removal of components such as ticket vending machines and signage no longer required. Where possible, these components would be reused or eventually transferred to a licensed waste management facility for recycling or disposal.

6 Assessment of Impacts

6.1 Construction Impacts

Construction would normally be undertaken during the following standard work times:

- 7 am to 6 pm Monday to Friday
- 8 am to 1 pm Saturday.

It is anticipated that the construction workforce would comprise a maximum of approximately 15 people on site at any one time. It is expected that there would be about 60 people over the duration of the construction period for the first two wharves.

6.1.1 Maritime Transport

The majority of construction plant, equipment, materials and personnel would access the construction site via Sydney Harbour, travelling by boat and/or barge from the construction contractor's main office facilities (off-site facility) to the proposal area.

The 130 metre wide navigation channel would be maintained throughout the work wherever possible to minimise disturbance to vessel movements and safety of vessels travelling to and from Darling Harbour during construction. The proposal would generate minor increases in water traffic during the construction period.

Water-borne construction plant may also be operated and docked within the proposal area during the construction period. Some minor detours may be required during this time, however this is unlikely to have a significant impact to other users of the waterway and access to other ferry wharves would not be restricted.

Weekends and special event periods (i.e. New Years Eve, Vivid and Australia Day) are expected to attract the most recreational and unchartered commercial vessel movements.

Due to the proximity of the proposal to King Street Wharf 1, a management plan with appropriate measures would be prepared to manage vessel manoeuvring during construction work.

6.1.2 Vehicular Traffic

Construction of the proposal would require a small number of light and heavy vehicles to transport materials to and from the construction compound located on the foreshore. It is anticipated that the busiest period for land based vehicle access would be for concrete pours associated with the link structures after piling has been completed. Up to 10 concrete trucks per day would access the site during concrete pours (about one vehicle per hour). The expected traffic impact is considered to be minimal in the context of existing and expected traffic volumes on Lime Street during the construction period.

During the construction period, some occupation at the Barangaroo South commercial space would have commenced. It is anticipated that traffic would be able to access the basement car park from Hickson Road with only minimal circulation traffic along Lime Street. Access to the construction compound may be from Lime Street via a gateway (if possible). The estimated construction vehicle movements could be easily accommodated by the surrounding road network with ample capacity, and therefore the proposal would result in negligible road network impacts.

6.1.2.1 Construction vehicle routes

The anticipated traffic routes that construction vehicles would utilise are summarised below and presented in Figure 9 and Figure 10. These routes provide access primarily for concrete trucks from the batching plants. With the majority of activity being associated with the concrete pours, the impact is considered low and could be easily accommodated on the surrounding road network.

From the north and north-west:

- Harbour Bridge – Western Distributor – Bathurst Street – Liverpool Street – Harbour Street – Shelley Street – Erskine Street – Lime Street(inbound).
- Lime Street – Erskine Street - Hickson Road – Napoleon Street – Kent Street – Western Distributor – Harbour Bridge (outbound).

This southbound vehicle activity would occur during peak hours as there is no access for general traffic from the Harbour Bridge to York Street between 6.30 am – 9.30 am (Monday – Friday).

From the west:

- Pyrmont Bridge Road – Western Distributor – Sussex Street – Erskine Street – Lime Street (inbound).
- Lime Street – Erskine Street – Sussex Street – Western Distributor – Pyrmont Bridge Road (outbound).

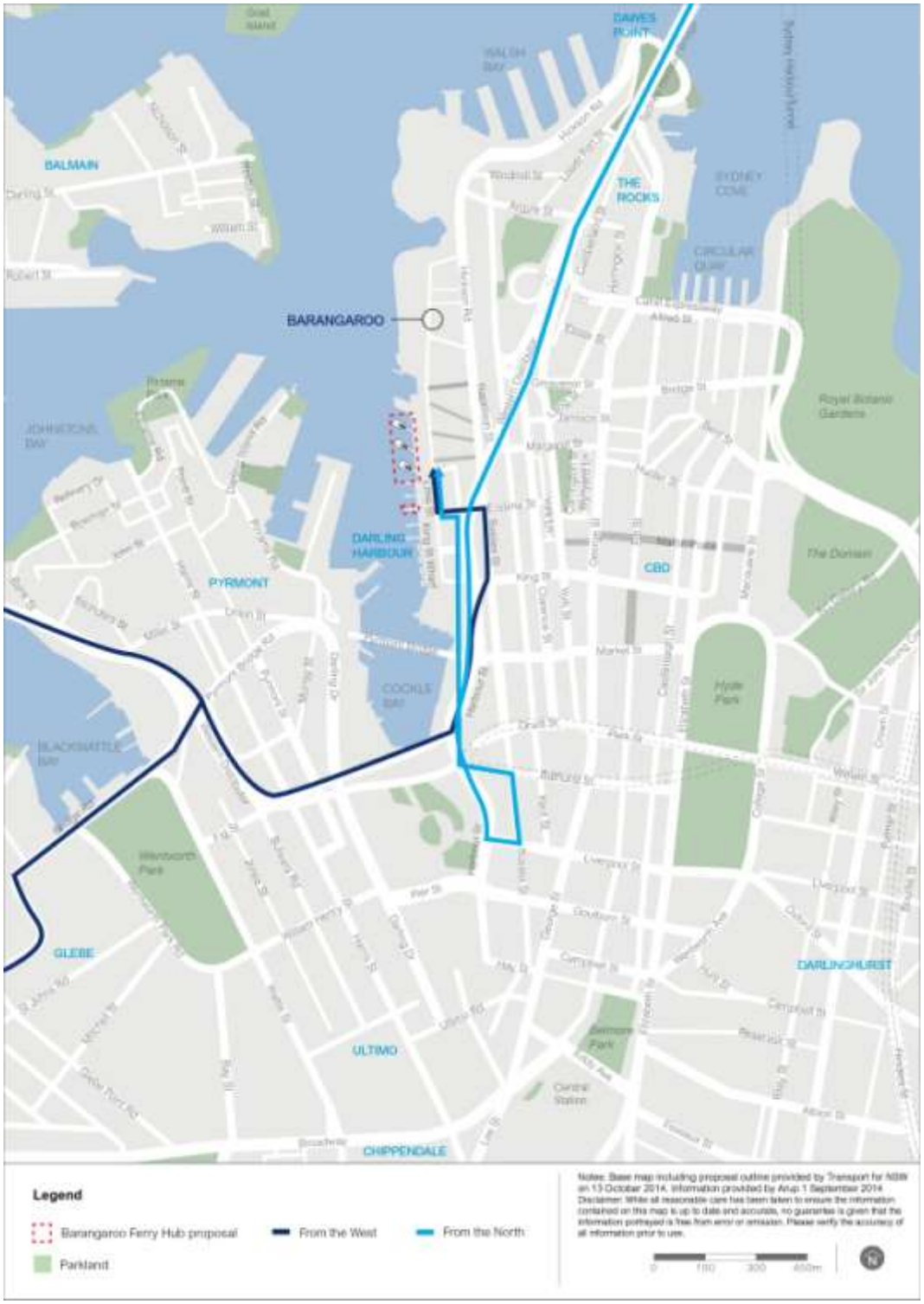

Figure 9 – Inbound Traffic Routes to the Construction Site

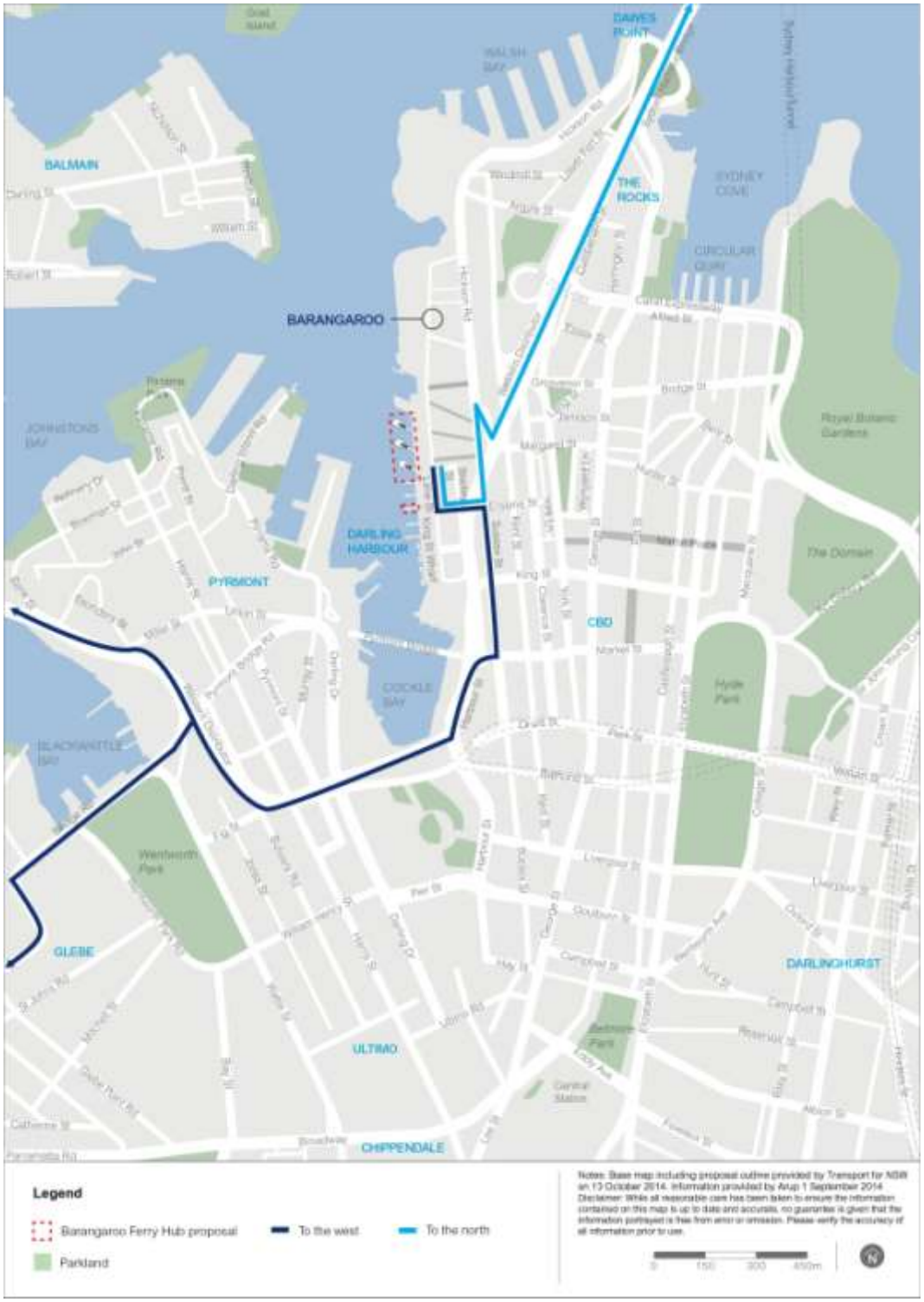

Figure 10 – Outbound Traffic Routes from the Construction Site

6.1.3 Parking

The construction activity is specialised and would be undertaken by a relatively small team of workers. The construction workers would be encouraged to use public transport for daily access to the site. In this manner, the proposal would be treated like any other CBD construction project. The constrained parking environment surrounding the site, coupled with the relatively high cost of all day parking, would ensure that the majority of construction workers arrive to the site via public transport. A small number would arrive by boat accompanying equipment and supplies.

A small number of construction related vehicles may need to use existing parking spaces on Lime Street, where load and size restricts vehicles from using the construction compound. Potential impacts are expected to be minor, with no changes anticipated to the existing loading zones and time-restricted parking areas on Lime Street.

6.1.4 Pedestrian

Currently the foreshore adjacent to Barangaroo is closed to allow for construction of a range of works for the project. When reopened in March 2015, it would again be used by pedestrians during day time hours for active and passive recreation. A construction compound, about 180 square metres, would be set up for construction activities associated with the proposal, which would reduce pedestrian access on the foreshore between the proposal area and Barangaroo South. There is expected to be sufficient space between the proposal and Barangaroo South to remain compliant with disability access requirements between the compound and Barangaroo South.

6.2 Operational Impacts

This section presents details regarding the expected ferry movements, frequency and patronage of the Barangaroo Ferry Hub based on the construction of the initial two ferry wharves.

TfNSW is seeking planning approval for a third ferry wharf at Barangaroo to enable it to respond to any unexpected growth or change in demand for ferry services to the CBD and in particularly Barangaroo. This approval would also enable TfNSW flexibility to respond to changes in the network that might arise from upgrades to the Circular Quay Ferry Terminal.

At the year of opening (2016), the proposed Barangaroo Ferry Hub is expected to have service throughput of up to 11 vessels per hour during weekday peak periods and 14 vessels per hour all day Saturday and Sunday. Patronage throughput is expected to increase, requiring an increase in ferry services of up to 15 vessels per hour during the weekday peak and 14 vessels per hour for weekend services by 2026 as shown in Table 3. The full vessel throughput as outlined in Table 3 is expected to be accommodated within the two ferry wharves planned to be constructed initially.

Operating hours would be between 5 am and 12 am Monday to Friday and between 7 am and 12 am Saturday, Sunday and public holidays.

Table 3 – Peak hour ferry services to Barangaroo

Services	AM Peak 1-hr			Weekend Peak 1-hr		
	Existing	**2016**	**2026**	**Existing**	**2016**	**2026**
Parramatta River Services (F3)	5	5	7	5	6	6
Darling Harbour Services (F4)	2	6	8	3	8	8
Totals	**7**	**11**	**15**	**8**	**14**	**14**

In addition to these regular services, there could also be occasions when special event ferry services or other commercial ferry services would be required to service Barangaroo. This would increase the number of services during the peak one hour period, particularly during weekends and public holidays. It is expected that the two wharves planned to be constructed would cater for special event ferry services. Commercial ferry services would have the opportunity to use facilities at King Street Ferry Wharf and at Barangaroo (during periods where spare capacity exists) under the provisions of TfNSW's Wharf Access Policy.

Initially there would be four berths available, two at each wharf. The periods providing more frequent services are at risk of interruption and not having a berth immediately available. This includes Saturdays and Sundays and possibly during events. These are also the periods where recreational and unchartered commercial vessels are likely to have the most movements, increasing the risk of congestion in the waterway.

The proposal would eventually transfer all public transport ferry trips from King Street Ferry Wharf to the proposed Barangaroo Ferry Hub, thereby

releasing capacity at the King Street Ferry Wharf for private and commercial operations.

The proposal would assist in meeting future demand for public transport generated from the Barangaroo precinct and complement future planned infrastructure improvements in the vicinity of the site.

6.2.1 Forecast Patronage

Forecast ferry patronage at the Barangaroo Ferry Hub was calculated for the 2016 opening year and 2026 forecast year, based on the Sydney Ferries network outlined in Sydney's Ferry Future (TfNSW, 2013c). Ferry operation plans for the two forecasted years (2016 and 2026) have been specified by TfNSW and modelled by the Bureau of Transport Statistics using the Sydney travel model and the Sydney ferry demand model.

Weekday ferry patronage

Based on ferry patronage survey results for King Street Ferry Wharf (650) there is expected to be a substantial growth in demand by 2016 (year of opening) with a projected patronage level of around 3000 in the weekday morning (AM) peak period. Estimated increases in ferry patronage from the year of opening (2016) to 2026 show a predicted growth in patronage to about 5,000 trips during the morning (AM) peak period on weekdays. This growth is based on strong passenger demand along the Parramatta River and up to 26,000 jobs within the Barangaroo precinct by full occupation.

It is noted that whilst the existing King Street Wharf is nearing capacity in terms of the number of vessels that are able to berth at the facility, there is some existing spare capacity on the ferries themselves. Once Barangaroo has opened, this spare capacity on the ferries is expected to be filled together with creating additional demand which would result in the need for increased services and bigger pontoons to accommodate the resulting loads. The facility has been designed to fully accommodate the AM peak estimated passenger demand through 2026.

Weekend, public holidays and special events ferry patronage

The proposed Barangaroo Ferry Hub may be required to operate outside of the operating hours detailed above during special events such as New Years Eve, Vivid and Australia Day. The timetabling of services at the proposed Barangaroo Ferry Hub may also require adjustment to accommodate other events that take place in the Sydney metropolitan area.

Weekend, public holiday and special events patronage is likely to be greater than weekday commuter peak period patronage as a result of greater use of the Sydney Ferries network for recreation, leisure activities and events. Patronage is contingent on numerous variables including weather, type of events and ticking arrangements (e.g. $2.50 Sundays with Opal), which are less easily defined than weekday commuter activities. As such the maximum passenger capacity per hour has been calculated as a representative for maximum weekend and public holiday patronage.

The maximum ferry passenger capacity passenger per hour that can be accommodated at the Barangaroo Ferry Hub is limited by the type of vessel and berth availability. The maximum ferry passenger capacity per hour which can be utilised on weekends and public holidays from year of opening (2016) is described in Table 4.

Table 4 – Barangaroo Ferry Hub maximum passenger capacity (weekends)

Services	Capacity	Vessels per hour	Maximum passenger capacity per hour
Parramatta River Services	230	6	1380
Cross Harbour Services	400	8	3200
Total	**630**	**14**	**4580**

6.2.2 Special event management

The location and prominence of Barangaroo will mean it is a focal point for significant pedestrian movements for events within the precinct itself, as well as those around the wider Sydney CBD. Special events would generate demand greater than normal operating conditions.

The extent and arrival profile of event demand that uses the Barangaroo Ferry Hub will be dependent on:

- the mode share for ferries
- day and time of the week
- the type, location, and size of the event.

During special events such as New Years Eve, Vivid and Australia Day, temporary arrangements would be made to ensure efficiency and safety of larger than normal number of passengers. This may include, but not be limited to, the following:

- Erection of temporary wayfinding signage
- Erection of temporary marshalling infrastructure such as removable bollards
- Erection of temporary Opal/ticketing facilities
- Additional staff (security, ticketing etc.)
- Fencing along the water's edge in special event queuing area to prevent falls into the harbour, if required by safety regulations
- Permanent provision for removable queue management systems
- Adequate lighting for special event queuing space.

6.2.3 Public domain and access

The spatial requirements for boarding passengers has been determined using the London Underground's Station Planning Guidelines, which recommends a minimum area of 320 square metres be provided as a waiting and boarding area (Transport for London, 2012). This spatial

provision has been incorporated into the concept design for the proposal (Aurecon, 2014).

The overall wharf geometry, as detailed in the concept design (Aurecon, 2014), responds to a number of site and navigational constraints. The design promotes easy pedestrian navigation through the use of roof and promenade structures as wayfinding devices, as well as segregation of alighting pedestrian flow and passengers waiting to board. The roof form and pontoon screening responds to prevailing weather conditions (shelter from the south and more open to the north-east summer breeze) for pedestrian comfort while waiting for transport.

TfNSW has been working collaboratively with BDA and Lend Lease regarding landside ancillary facilities and impacts on public domain including those associated with special events and day to day operations. Queue management, and adequacy of pedestrian circulation space and facilities around the wharves would be the subject of ongoing consultation between TfNSW and relevant stakeholders.

6.2.4 Maintenance

Minor maintenance of ferries would be undertaken at the Barangaroo Ferry Hub, similar to the current maintenance activities that occur at Circular Quay. These would occur during layover and include activities such as minor repairs, pump-out of sewerage (generally once per day per vessel layover) and cleaning of vessels. As these activities would generally only be completed daily, they are not expected to have any significant impact on operations.

At times of wharf maintenance, specific site management plans would need to be implemented to coordinate the timing and extent of interaction with normal ferry operations and passenger access and waiting. Works would be staged and timed to minimise impacts on ferry operations.

6.2.5 Navigation and safety

In June 2012, Roads and Maritime undertook a study to identify and review navigational issues associated with the potential for a ferry hub at Barangaroo. Other objectives of the study were to consider the development of the proposal from a navigational safety perspective and to agree a safe channel width in harbour to inform early design of the proposal. The study concluded the following:

- Darling Harbour is an extremely busy waterway with a high level of commercial and recreational vessel traffic and the second highest maritime incident rate on Sydney Harbour. A comprehensive vessel traffic management plan should be developed and implemented to facilitate the safe navigation of ferries and other vessels using the waterway.
- The orientation of the wharves will have the greatest impact on the navigable channel because of associated channel width and navigation issues and therefore should be given consideration during proposal design development. The design should maximise the available

channel width and seek to maintain the current channel width of 130 metres.

- The lines of approach by ferries to and from the proposed wharves are critical to the safety of navigation in the Darling Harbour area, and these should be considered during proposal design development.
- For navigational safety, ferries should berth at the proposed Barangaroo Ferry Hub stern first to wharves angled in a north-west direction to minimise the amount of deviation from the direction of flow of traffic in the north bound lane of the channel. Additionally this will enable ferries to depart the wharves head first and join the flow of traffic at as small an angle as possible, in accordance with international navigation best practice.
- Wharves should be slanted at a northwest angle (between 30º and 45º from perpendicular to the Barangaroo seawall) and the wharf configuration should minimise the projection of the structures into the Darling Harbour channel (analysis to date indicates the optimum projection is 65 metres).

Subsequent to this study, there is no longer a requirement that all berthing would be stern first, as such; vessel berthing is being revisited in workshops with TfNSW, the Harbour Master, Roads and Maritime and other relevant agencies and therefore is yet to be determined (refer to the indicative vessel manoeuvring shown in Figure 11).

The proposed navigational procedures would be designed so that ferries accessing the wharves are able to manoeuvre and leave at least half of the navigational channel free for two-way vessel movements. This will minimise impact on other vessels accessing Darling Harbour.

Berth occupancy is dependent on the duration of the berth window. The berth window is a function of the ferry approach and departure time and the passenger boarding and alighting time for each service. The berth window varies for each service depending on the service patronage.

The duration of approach and departure at the proposed Barangaroo Ferry Hub is estimated as two minutes each. An average ferry dwell time at each berth of 15 minutes is estimated, which includes the unloading and loading of passengers. This provides an estimated average berth window of about 20 minutes, although as mentioned above this would be variable for each service.

The risk of congestion would also occur where services are not running to schedule. However, the historical on-time running of Sydney Ferries services reduces this risk to low.

A vessel traffic management plan, along the lines of that employed in Circular Quay, would be developed and implemented to minimise the impact of waiting vessels. This vessel traffic management plan would be supported by a risk assessment of the waterside operation of the proposal and its interface with Darling Harbour.

6.2.6 Berthing and manoeuvring

Each wharf would provide a single layover berth on its southern side. Layover would also occur at the passenger berths subject to timetable requirements.

During extended layover the vessels would run on shore power. It is expected that there would be up to three vessels moored at each wharf overnight.

Layover during daytime breaks would typically be between 15 and 45 minutes depending on timetable requirements.

A preliminary operational manoeuvring procedure that provides an efficient two minute duration for the approach and berthing procedure has been identified by TfNSW. The proposed operational arrangement is shown in Figure 11.

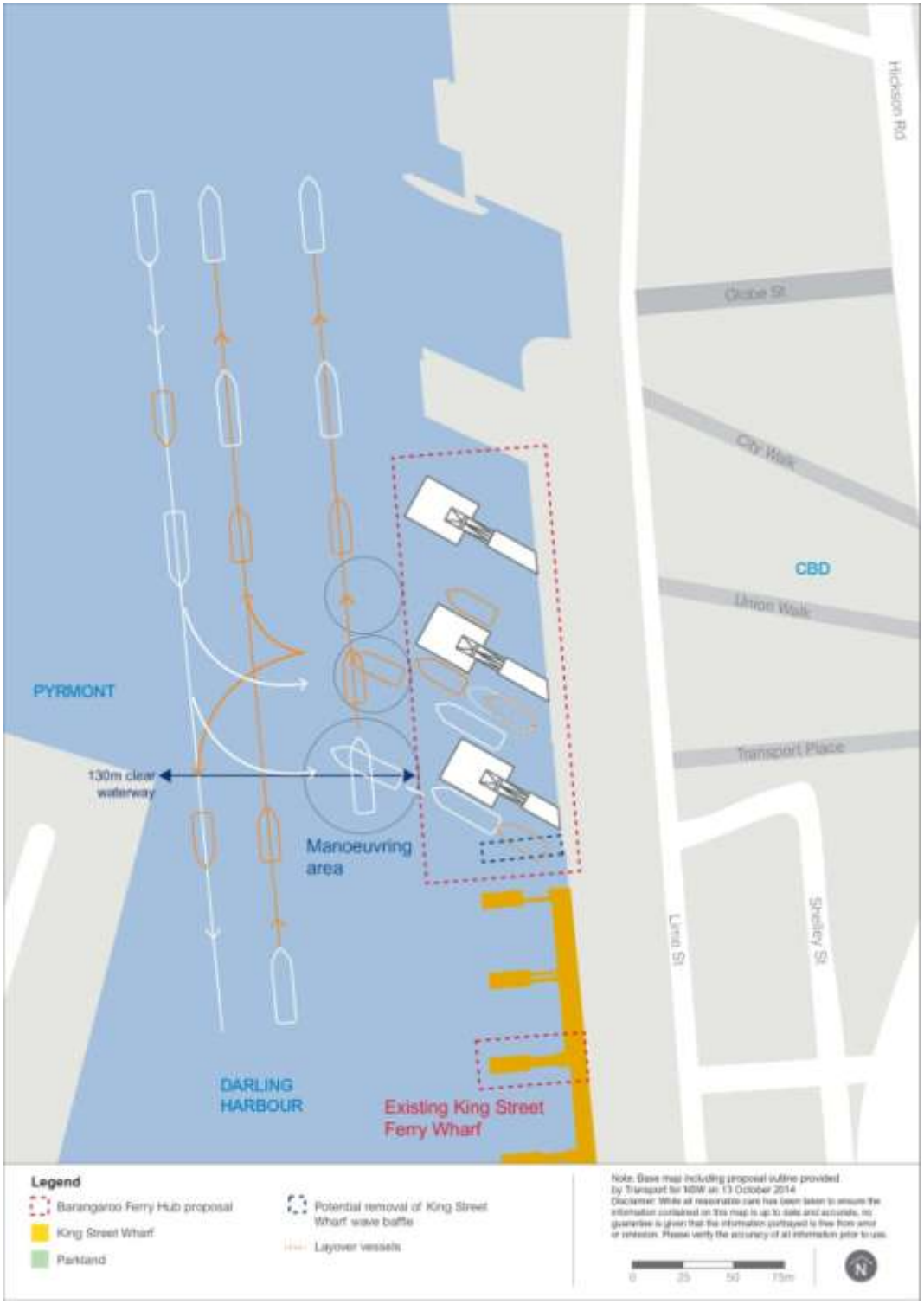

Figure 11 – Indicative Vessel Manoeuvring

The manoeuvring procedure is described as follows:

- Ferries approaching the Barangaroo Ferry Hub from the north would do so on the western side of the channel.
- The ferries would manoeuvre across the common user waterway when the channel is clear.

- Once in the manoeuvring area, the ferry would either swing to proceed astern to the berth (as shown) or continue bow first to the berth.
- Departing the berth, the ferry would proceed bow first (as shown, if berthed astern), or proceed astern and swing. The ferry would proceed to the north or cross the channel once clear to proceed to the south (route dependable).

6.2.7 Pedestrians

Public transport nodes, such as train stations, bus stops and ferry wharves usually have a potential walking catchment of between 400 metres and 800 metres, which corresponds to five minutes and ten minutes walking time respectively. However, physical barriers such as topography, lack of crossing facilities and an impermeable road network can reduce the actual walkability of the area. Walking isochrones maps (lines of equal walking time) are used as an assessment and presentation tool for public transport catchment analysis.

A walking isochrones analysis was undertaken for the proposal to determine the potential catchment of the Barangaroo Ferry Hub. The analysis considered the planned and proposed pedestrian improvement works around Barangaroo and Wynyard, including Wynyard Walk, City Walk pedestrian bridge and the Barangaroo footpath network. The resulting isochrones are illustrated in Figure 12 below.

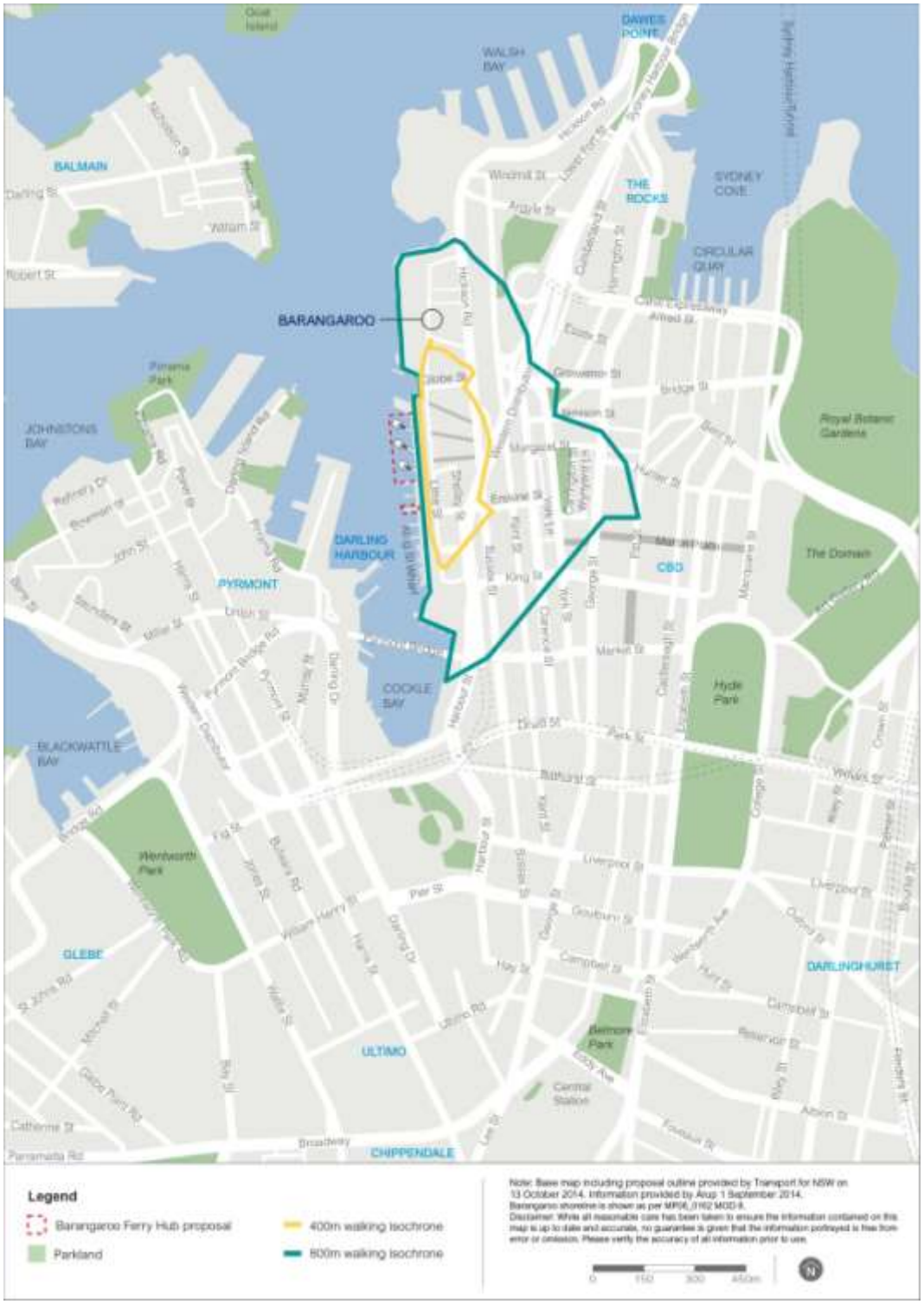

Figure 12 – Walking Isochrones from Barangaroo Ferry Hub

The analysis demonstrates the walking catchment for the Barangaroo Ferry Hub extends to George Street to the east, Darling Harbour to the south and Central Barangaroo to the north. Covering an area of approximately 20 hectares, the catchment would serve an employment population of approximately 53,000 people in 2016 (based on BTS employment forecasts).

The proposal would be well served by a number of existing and future pedestrian connections. Following the introduction of Wynyard Walk, pedestrians travelling between George Street, Wynyard Station and the Barangaroo Ferry Hub would be able to bypass on-street delays, travelling to the Barangaroo waterfront in about six to eight minutes. As Wynyard Walk has been designed to accommodate up to 20,000 pedestrians per hour (bi-directional), there would be sufficient capacity for passengers alighting from the ferry hub to be accommodated along with other pedestrian traffic accessing Wynyard Walk.

Transport Place, a new pedestrian only plaza at the western end of Wynyard Walk, would provide a safe and accessible connection to the Barangaroo Ferry Hub. The *Barangaroo Pedestrian Precinct Demand Report* (Arup, 2013) identified this linkage as the primary access route for pedestrians travelling to and from the Barangaroo Ferry Hub.

Figure 13 illustrates the key pedestrian movements that are expected to occur in the vicinity of the Barangaroo Ferry Hub.

The key destinations for customers alighting the ferry at Barangaroo are likely to be:

- Commercial office component of Barangaroo South
- Waterfront Promenade restaurants and street activities
- Wynyard Station/Sydney CBD via Transport Place
- King Street Ferry Wharf/Darling Harbour via the Foreshore.

Expected patronage numbers are presented in Section 6.2.1 above.

A formal pedestrian crossing would be located on the Transport Place alignment for pedestrians to cross Lime Street between the Barangaroo Ferry Hub and Transport Place. The expected low traffic volumes on Lime Street associated with local traffic circulation would create a pedestrian friendly environment.

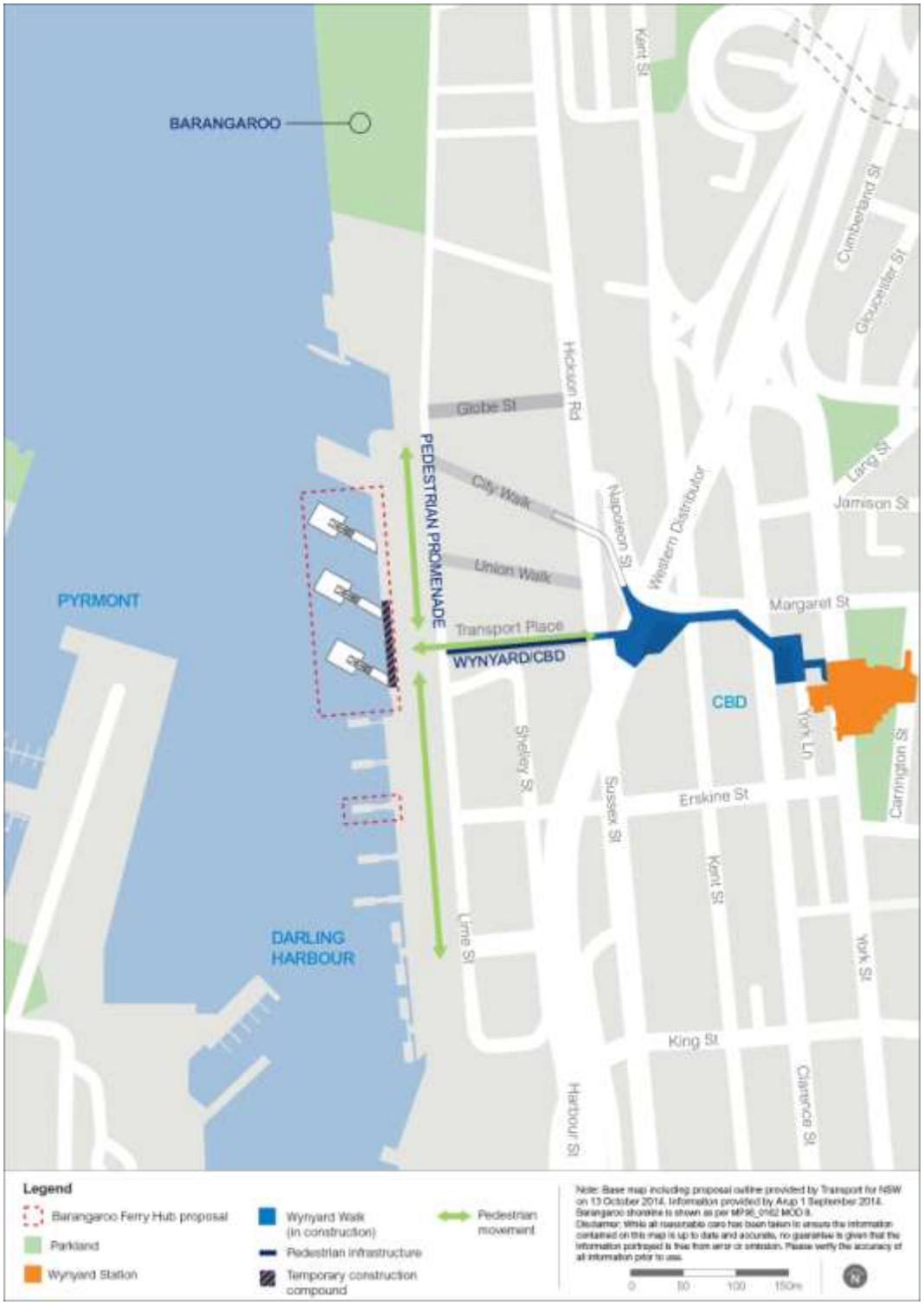

Figure 13 – Pedestrian movements around Barangaroo Ferry Hub

6.2.8 Rail

Ferry patrons using the Barangaroo Ferry Hub and changing to rail services would use Wynyard Station, located about 400 metres walking distance from the proposal. With the opening of Wynyard Walk, access between Wynyard Station and the Barangaroo Ferry Hub would be enhanced with a direct link eliminating on-street delays. As discussed above, the expected pedestrian travel time between Wynyard and Barangaroo is expected to be six minutes.

The upgrade of Wynyard Station is planned to be supported by improved operational reliability through upgraded services and removal of redundant services. The additional impact, as a result of passenger interchange between the proposed ferry hub and Wynyard Station, on passenger flows around Wynyard Station would be negligible.

6.2.9 Buses

The *Sydney City Centre Access Strategy* (TfNSW, 2013) planned city centre bus corridors, as shown in Figure 14 below, includes Hickson Road / Sussex Street, which would improve access for users travelling to and from the Barangaroo Ferry Hub via bus. New bus stops are envisaged on Sussex Street which would provide convenient access for pedestrians interchanging modes, as well as relieving capacity from Wynyard bus station.

A shuttle service running between Circular Quay, Walsh Bay, Barangaroo and Darling Harbour was proposed in the *Barangaroo Integrated Transport Plan* (NSW Government, 2012a) to address short term connectivity issues with bus and light rail services. If this temporary service is provided, it would further improve access for bus passengers travelling to and from the Barangaroo Ferry Hub.

Additional bus services along these identified routes may be required to service bus passengers travelling to and from the Barangaroo Ferry Hub. The extent of these services are currently being planned by TfNSW.

Figure 14 – Planned Bus Corridors

6.2.10 Cyclists

The Kent Street bi-directional, segregated cycleway would provide the primary access route for cyclists travelling to/from the proposed ferry hub – serving arrivals from both the north (i.e. Harbour Bridge cycleway) and the south. New cycleways on Hickson Road and Napoleon Street are planned in the future to serve the commercial and residential populations of Barangaroo.

Cyclists accessing the Barangaroo Ferry Hub from the Hickson Road and Napoleon Street cycleways would benefit from the new traffic signals being installed as part of Barangaroo South at the Hickson Road / Napoleon Street intersection.

Those arriving from the Pyrmont Bridge would either cycle down Sussex Street) or more likely walk their bike down the set of stairs at King Street and cycle along Lime Street. The *Sydney City Centre Access Strategy* identifies a future cycle connection from the Pyrmont Bridge linking directly with the Barangaroo precinct, as shown in Figure 15.

The planned closure of the northern section of Shelley Street to form a new 'Transport Place' would provide an off-road connection for cyclists between Sussex Street, Shelley Street and the waterfront. Shared access for cyclists and pedestrians along the waterfront continues from Darling Harbour around Millers Point connecting with the on-street network at Walsh Bay, providing access to the ferry hub from both the north and south.

The future cycle network in the precinct would provide ample capacity to support bicycle movements to and from the Barangaroo Ferry Hub. Access for cyclists to the Barangaroo Ferry Hub would be improved with the public domain improvements occurring throughout the Barangaroo development and there should be no impact from the proposal.

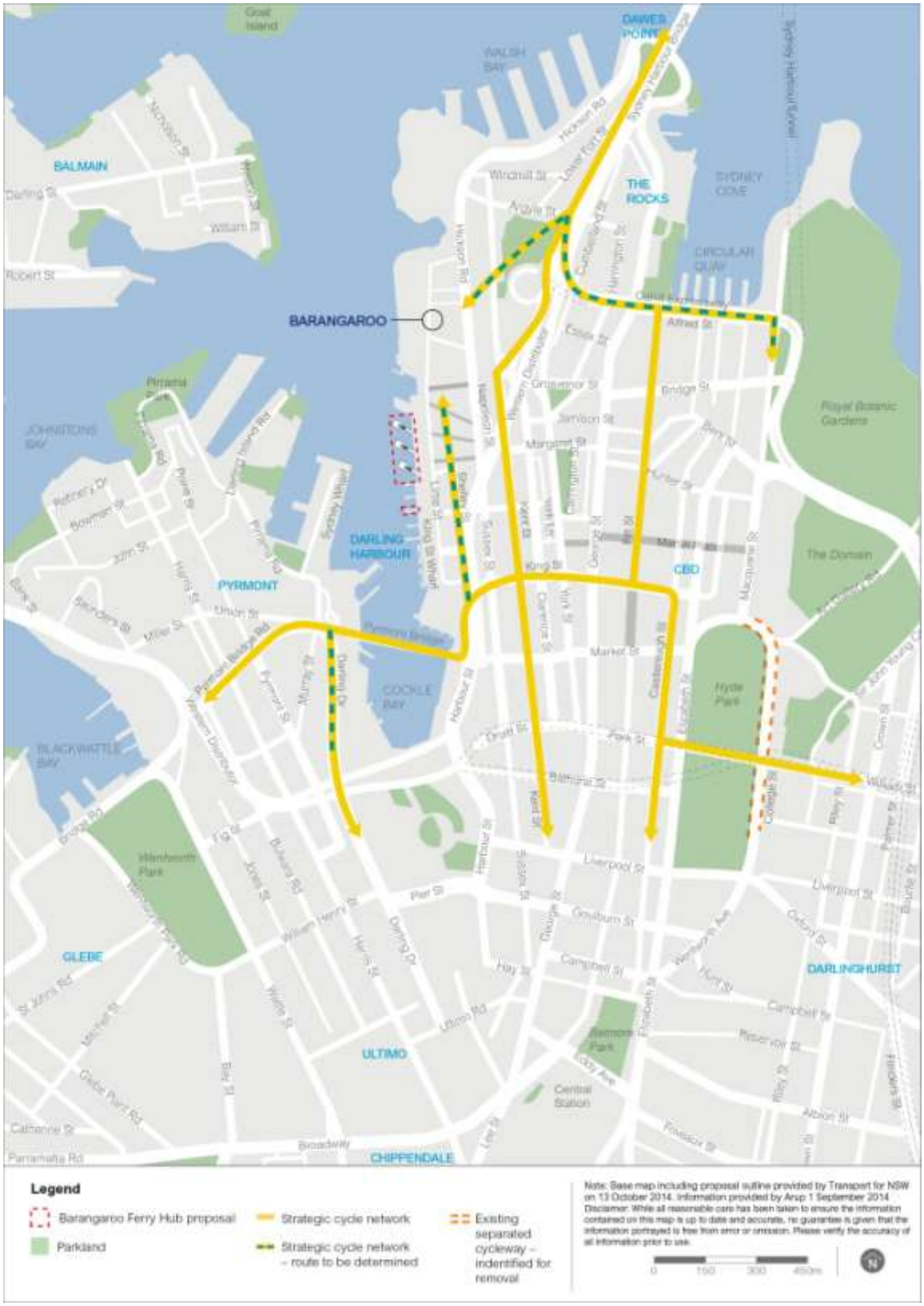

Figure 15 – Strategic Cycleway Network

6.2.11 Taxis

A formal taxi rank is currently provided at the northern end of Shelley Street, with capacity for up to seven taxis queued at any one time. Located within 100 metres of the proposal, this would provide convenient connections for passengers interchanging between ferry and taxi. New taxi ranks are planned for the precinct to service Barangaroo on Sussex Street and Globe Street North. Some informal taxi drop off and pick up activity may take place on Lime Street adjacent to the Barangaroo Ferry Hub. The road network impacts associated with these traffic movements are considered negligible.

6.2.12 Vehicular Traffic

Operation of the proposal is not expected to have an impact on vehicular traffic. A small number of passengers may be dropped off or picked up on roads in the vicinity of the Barangaroo Ferry Hub, however the vast majority of users are expected to arrive using the enhanced pedestrian network as previously discussed. No additional road network enhancements or mitigation measures would be required to manage the impacts of the proposal.

To minimise the impact on the local road network, no on-site parking is proposed to serve the Barangaroo Ferry Hub. Off-street car parking is available at a number of nearby sites.

A small number of vehicles may need to access the site from time to time for routine maintenance activities. This would be easily accommodated by the surrounding road network.

6.2.13 Emergency access

Emergency vehicles would use Lime Street to access the foreshore in the vicinity of the Barangaroo Ferry Hub.

Emergency access requirements would need to be accommodated at all times. It is likely that emergency vehicles would access the Barangaroo Ferry Hub using the pedestrian promenade via Lime Street at its intersection with Transport Place and/or Union Walk. Final arrangement of emergency access and congregation points would be subject to negotiation with BDA and Fire and Rescue NSW.

Various pieces of emergency equipment such as fire response equipment would be required to be kept at the Barangaroo Ferry Hub. Periodic testing and maintenance of emergency equipment would be required.

6.2.14 Wayfinding

The proposal would include high-quality integrated wayfinding and customer information system that will help customers to better navigate the NSW public transport network by making it easier to understand and use, as outlined in Appendix B. This would assist non-regular customers (such as tourists) using the proposed Barangaroo Ferry Hub.

A Barangaroo precinct wayfinding strategy will be developed by the BDA, and Lend Lease and TfNSW and other stakeholders will provide input into this strategy to ensure consistency across the precinct.

7 Cumulative Impacts

7.1 Construction

Construction of the proposed Barangaroo Ferry Hub is anticipated to commence in the latter half of 2015. It is anticipated that construction of the initial two wharves would take approximately 14 months to complete, including an anticipated three month piling period. The third wharf would be constructed in the future when the demand for ferry services necessitates.

The construction period of the Barangaroo Ferry Hub would overlap with other planned construction activities in the northern and western CBD area, including:

- Barangaroo South construction activities (various).
- Central Barangaroo – Waterfront Promenade
- Headland Park
- Wynyard Walk
- City Walk Bridge
- CBD and South East Light Rail
- Wynyard Station

The construction timeline for the proposal, in the context of the above adjacent construction activities that are currently known is presented in Figure 16 below. The Central Barangaroo Waterfront Promenade works have commenced and are included however the buildings associated with Central Barangaroo are still in the planning approvals process and construction commencement has not been determined.

Figure 16 – Construction Timeline

As the construction period for the proposal overlaps with other construction projects, there is potential for cumulative impacts such as increased traffic and transport disruption.

The majority of construction plant, equipment, materials and personnel for the construction of the proposal would access the construction site via Sydney Harbour, travelling by boat and/or barge from the construction contractor's main office facilities (off-site facility) to the proposal area. The other construction activities would be focused on road based truck access.

The majority of construction vehicle access for the Barangaroo Ferry Hub would be for concrete pours associated with the link structures after piling has been completed. Up to 10 concrete trucks per day would access the site during concrete pours (approximately two to three vehicles per hour) This volume of traffic is considered minimal in the context of existing traffic volumes as well as those generated by adjacent worksites. Therefore the cumulative impacts arising from the construction of the proposal are considered negligible.

7.2 Operation

The *Barangaroo Pedestrian Precinct Demand Report* (Arup, 2013) identifies the total expected weekday, weekend, and event movements around Barangaroo. It presents the anticipated movements to/from the Barangaroo Ferry Hub in the context of wider precinct demand, and includes Barangaroo workers, residents, visitors, as well as demand to local Sydney CBD destinations. Table 5 provides detail on the pedestrian volumes passing or in the vicinity of the Barangaroo Ferry Hub during different time periods.

Table 5 – Pedestrian Movements in the Vicinity of the Barangaroo Ferry Hub

Movement to/from	Weekday AM	Weekday PM	Weekday Off-Peak	Weekend	Event
Waterfront Promenade	658	1,240	2,001	2,298	14,390
King Street Wharf	60	485	792	1,834	6,957
Transport Place	2,075	1,584	1,609	946	8,990
Total	**2,793**	**3,309**	**4,402**	**5,078**	**30,337**

During weekday peak periods, movements are expected to be predominantly in an east/west direction to/from Transport Place, as people move to/from the CBD, Wynyard Station, and the main office areas of Barangaroo. Outside of peak commuter period, north/south movements along the foreshore are anticipated to be dominant, primarily towards Headland Park and Central Barangaroo, where most of the tourist facilities in Barangaroo are located.

The number of additional pedestrians generated by the Barangaroo Ferry Hub is relatively low in the context of general movements in the precinct, and would be adequately accommodated by the planned pedestrian infrastructure as described in Section 4.6. No on-shore queuing areas or

facilities are considered necessary to manage pedestrian demands outside of event periods.

During events in the precinct approximately 30,000 hourly pedestrian movements are forecast in the immediate vicinity of the Barangaroo Ferry Hub. Event management procedures would be applied to manage queuing and pedestrian movements. Queuing is most likely to occur to the north on the waterfront promenade and may occur as pedestrian activity increases during these times.

8 Mitigation Measures

8.1 Construction

The following mitigation measures are recommended to manage construction traffic and transport impacts:

- Consultation would be undertaken with the Barangaroo Integrated Transport Plan Working Group to co-ordinate management measures for cumulative transport impact during construction.
- A Construction Traffic Management Plan would be prepared before the commencement of work. The plan will include:
  - Ongoing consultation with key stakeholders including Port Authority of NSW, Roads and Maritime Services and Harbour City Ferries.
  - Specific mitigation measures to minimise impact of the works on the road and maritime networks during construction.
  - A Traffic Control Plan in accordance with the *Roads and Maritime Traffic Control at Work Sites Manual and Australian Standard 1742.3*.
  - Event management during construction including avoiding events taking place in the harbour, such as the Sydney International Boat Show.
- Should the temporary closure of any pedestrian routes be required consultation would be undertaken with key stakeholders (including BDA and Lend Lease).
- Alternative pedestrian routes would be identified and communicated through the provision of appropriate information and signage at key locations.
- The movement of construction barges in the harbour would follow the standard navigational procedures to limit impact on other vessels.

8.2 Operation

The following mitigation measures are recommended to manage operational traffic and transport impacts:

- A Vessel Traffic Management Plan would be prepared and implemented prior to commencement of operations at the Barangaroo Ferry Hub. This would be supported by a risk assessment for the Darling Harbour waterway which includes the Barangaroo Ferry Hub proposal.
- A tailored event management plan would be implemented during event periods or when a dramatic increase in pedestrians is expected, such as New Year's Eve.

9 Conclusions

Arup has prepared this report for Transport for NSW to assess the traffic and transport impacts of the proposed Barangaroo Ferry Hub. The proposal includes the staged construction of three new wharves and associated land and water-side facilities.

Construction of the wharves is expected to commence in the latter half of 2015. It is anticipated that construction of the initial two wharves would take approximately 14 months to complete. The third wharf would be constructed in the future when the demand for ferry services necessitates.

The construction of the Barangaroo Ferry Hub would predominantly be serviced via water traffic, with no more than 10 construction vehicles per day anticipated to access the land based construction compound/site. The estimated typical construction vehicle movements could be easily accommodated by the surrounding road network with ample capacity. In this regard, the proposal would result in negligible road network impacts.

Once operational, the Barangaroo Ferry Hub would operate between 5 am and 12 am on weekdays, and 7 am to 12 am on weekends and public holidays. The proposed navigational procedures are designed so that ferries accessing the wharfs are able to manoeuvre and leave at least half of the navigational channel free for two –way vessel movements. This minimises impacts on other vessels accessing Darling Harbour.

A vessel traffic management plan, along the lines of that employed in Circular Quay, would be required to minimise the impact of waiting vessels. This traffic management plan should be supported by a marine risk assessment for the Darling Harbour area which includes the Barangaroo Ferry Hub proposal.

The proposal would be well served by a number of existing and future pedestrian connections, including Wynyard Walk which has capacity to accommodate 20,000 pedestrian movements per hour.

The number of additional pedestrians generated by the Barangaroo Ferry Hub is relatively low in the context of general movements in the precinct, and would be adequately accommodated by planned pedestrian infrastructure.

During events in the precinct some queuing may occur as pedestrian activity increases during these times. Event management plans would be implemented to manage the increased pedestrian demands.

The proposal would be served by a number of existing and future cycle routes which would provide ample capacity to support bicycle movements to and from the facility. Access for cyclists to the Barangaroo Ferry Hub would be improved with the Barangaroo development and there should be little or no impact by the proposal.

The proposal would be served by other public transport modes including cycling routes, new bus stops on Hickson Road, Wynyard Station and the future Sydney CBD light rail line. A formal taxi rank on Shelley Street, approximately 100 metres from the ferry hub, would adequately

accommodate passengers interchanging between ferry and taxi. Some informal taxi drop off and pick up may occur on Lime Street, however the road impacts associated with these traffic movements are considered negligible.

A number of mitigation measures would ameliorate the impacts of the proposal as outlined in Section 8.

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