Appendix

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Appendix F

Traffic and transport

January 2020

Roads and Maritime Services

Western Harbour Tunnel and Warringah Freeway Upgrade

Technical working paper: Traffic and transport

January 2020

Prepared for

Roads and Maritime

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Glossary of terms and acronyms

Term/acronym	Definition
AADT	Annual Average Daily Traffic. The total volume of traffic (24 hours) passing a roadside observation point over a one-year period, divided by the number of days per year. It is calculated from mechanically obtained axle counts
AM peak hour	Unless otherwise stated, this refers to vehicle trips arriving at their destination during the average peak hour in the morning peak period between 7am and 9am on a normal working weekday
At-grade	An intersection where all permitted movements occur at the same level and no movements are grade separated
ATC	Automatic Traffic Count
Beaches Link	Forms part of the program of works, and includes the Warringah Freeway at Cammeray and the Gore Hill Freeway at Artarmon to the Burnt Bridge Creek Deviation at Balgowlah and Wakehurst Parkway at Seaforth, and an upgrade of Wakehurst Parkway
B-Line	A high frequency limited stops bus service between Mona Vale and Wynyard
Bus lane	A traffic lane dedicated to buses, but which can also be used by taxis, bicycles and motorcycles
Capacity	The nominal maximum number of vehicles which has a reasonable expectation of passing over a given section of a lane or roadway in one direction during a given time period under prevailing roadway conditions
Carriageway	The portion of a roadway used by vehicles including shoulders and ancillary lanes
CBD	Central Business District
CCTV	Closed-Circuit Television
CD	Chart Datum is the zero reference point from which tidal heights and chart soundings are calculated
Construction	Includes all physical works required to construct the project
Corridor	A substantial segment of the transport network, in which parallel, possibly competing, transport routes (and modes, where appropriate) operate between two locations
CTMP	Construction Traffic Management Plan
Cul-de-sac	A street or road that is open for vehicular traffic at one end only
Cumulative impacts	Impacts that, when considered together, have a different or more substantial effect than a single impact assessed on its own
Degree of saturation	The ratio of traffic volumes at an intersection or road, compared to its overall capacity
Detour	An alternative route, using existing roads, made available to traffic
Divided road	A road with a separate carriageway for each direction of travel created by placing a physical separation (eg median) between the opposing traffic directions
'Do minimum'	A model scenario that does not incorporate the proposed project infrastructure
'Do something'	A model scenario that incorporates the proposed project infrastructure
DP&E	NSW Department of Planning and Environment (now Department of Planning, Industry and Environment (DPI&E) (Planning and Assessment)
DPIE	NSW Department of Planning, Industry and Environment (formerly Department of Planning and Environment (DP&E))
EEC	Eastern Economic Corridor. Greater Sydney Commission's new name for the Global Economic

Term/acronym	Definition
	Corridor. The EEC extends from Macquarie Park to Sydney Airport.
EIS	Western Harbour Tunnel and Warringah Freeway Upgrade environmental impact statement
EPA	Environmental Protection Authority NSW
Footpath	A paved area in a footway
Footprint	The extent of the impact that a development (in plan-view) makes on an area
Gore Hill Freeway Connection	Forms part of the program of works, including the connection and integration works along the existing Gore Hill Freeway at Artarmon
Grade separation	The separation of a road, rail or other transport mode, so that crossing movements at intersections are at different levels
GVM	Gross Vehicle Mass
HCV	Heavy Commercial Vehicle
Heavy vehicles	A heavy vehicle is classified as a Class 3 vehicle (a two-axle truck) or larger, in accordance with the Austroads Vehicle Classification System
hr	Hour
IDM	Intersection Diagnostic Monitor
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment
IMT	Immersed Tube Tunnel
Interchange	An intersection of two or more roads that typically uses grade separation, and one or more ramps, to permit traffic on at least one carriageway to pass through the junction without directly crossing any other traffic stream
LCV	Light Commercial Vehicle
Local road	A road or street used primarily for access to properties in that road or street
LoS	Level of Service
LU	Land Use
M4-M5 Link	A component of the WestConnex program of works
Median	The central reservation which divides a carriageway for traffic travelling in opposite directions
Midblock	A general location on a road between two intersections
Mode	A type or method of transport movement
Motorway	Fast, high capacity, access-controlled roads that primarily link regional hubs and cities usually with grade separated interchanges and without traffic signals. May be tolled or untolled
NSW	New South Wales
Off ramp	A ramp by which one exits a limited access highway/tunnel
On ramp	A ramp by which one enters a limited access highway/tunnel
OOHW	Out-of-hours work
PCU	Passenger Car Unit (equivalent)
PM peak hour	Unless otherwise stated, this refers to vehicle trips arriving at their destination during the average peak hour in the evening peak period between 4pm and 6pm on a normal working weekday

Term/acronym	Definition
Portal	The entry or exit to a tunnel
Project	Western Harbour Tunnel and Warringah Freeway Upgrade
Public transport	Includes metro, train, bus, ferry and light rail
Roads and Maritime	NSW Roads and Maritime Services (formerly NSW Roads and Traffic Authority (RTA))
ROL	Road Occupancy Licence
Roundabout	An intersection where all traffic travels in one direction clockwise around a central island
RTA	NSW Roads and Traffic Authority (now NSW Roads and Maritime Services)
sec	Seconds
SCATS	Sydney Coordinated Adaptive Traffic System
Screenline	Theoretical boundary specifically designed to collectively analyse directional and two-way traffic volumes
Shoulder	The portion of the carriageway beyond the traffic lanes adjacent to and flush with the surface of the pavement
SIS	State Infrastructure Strategy
SMPM	Sydney Motorway Planning Model
SSI	State Significant Infrastructure
STM	The Sydney Strategic Travel Model
Strategic road network	The higher-order roads in the network that primarily serve a movement function connecting cities, ports, airports and other places of importance. The strategic road network is usually comprised of motorways and arterial roads generally used for long-distance travel
TCS	Traffic Control Signal
TPA	Transport for New South Wales' Transport Performance and Analytics division
Transport for NSW	Transport for New South Wales
Unreleased traffic	Traffic demand that goes unserved during the peak period
veh	Vehicles
VHT	Vehicle Hours Travelled
VKT	Vehicle Kilometres Travelled
V/C	Volume to Capacity ratio
VMS	Variable Message Sign
VOT	Value of Time
VTTS	Value of Travel Time Savings
Warringah Freeway Upgrade	The project beginning immediately north of the Sydney Harbour Bridge through to Willoughby Road, Crows Nest
WestConnex	A program of works that includes the M4 Widening, King Georges Road Interchange Upgrade, M4 East, New M5, M4-M5 Link Tunnels and M4-M5 Link Rozelle Interchange
Western Harbour Tunnel	The project between the Rozelle interchange, Rozelle and the Warringah Freeway, North Sydney

Executive summary

The Western Harbour Tunnel and Beaches Link is a NSW Government initiative to provide additional road network capacity across Sydney Harbour and improve connectivity with Sydney's Northern Beaches. Together, the Western Harbour Tunnel and Beaches Link program of works would form an integrated north–south motorway connection that would reduce congestion, improve journey times, support rapid movement of people and freight, and enhance the resilience of the road network across Sydney.

NSW Roads and Maritime Services (Roads and Maritime) is seeking approval under Division 5.2, Part 5 of the *Environmental Planning and Assessment Act 1979* to construct and operate the Western Harbour Tunnel and Warringah Freeway Upgrade (the project), which would comprise two main components:

- A new crossing of Sydney Harbour involving twin tolled motorway tunnels connecting the M4-M5 Link at Rozelle and the existing Warringah Freeway at North Sydney (the Western Harbour Tunnel)
- Upgrade and integration works along the existing Warringah Freeway, including infrastructure required for connections to the Beaches Link and Gore Hill Freeway Connection project (the Warringah Freeway Upgrade).

Key features of the Western Harbour Tunnel and Warringah Freeway Upgrade project are discussed in Section 1.2. A detailed description of the project is provided in Chapter 5 (Project description) of the environmental impact statement.

This technical working paper is one of a number of technical documents that form part of the environmental impact statement for the project. The purpose of this technical paper is to identify and assess the potential impacts of the project during both construction and operation in relation to traffic and transport. In doing so, this paper responds directly to the Secretary's environmental assessment requirements (SEARs), which are outlined in Section 1.6.

Overall assessment approach

The following methodology has been carried out to assess the impact of the project on the traffic and transport network:

- Identifying the strategic planning context of the project
- Detailing the existing traffic and transport environment and describing the operational performance of the existing road network in terms of network performance, intersection performance, travel times and crash history
- Carrying out traffic modelling to forecast future travel demand and traffic volumes for the project and surrounding road network, and to assess construction and operational impacts
- Assessing the traffic and transport impacts of the project's construction on road network performance, maritime traffic, public transport, pedestrians and cyclists
- Assessing the future operational performance of the road network with and without the project
- Assessing cumulative impacts on the transport network
- Identifying key management measures to mitigate the identified traffic and transport impacts of the project.

Construction

Traffic and transport impacts

Rozelle

The assessment of construction activity impacts on the road network around Rozelle indicates that performance would marginally worsen during construction due to increased traffic demands in the area. However, these impacts would still fall within acceptable limits, with no noticeable impact when compared to traffic conditions without the project. During traffic peaks, City West Link, The Crescent and Victoria Road would continue to perform at a poor Level of Service during construction. The City West Link/The Crescent intersection and The Crescent/James Craig Road intersection would continue to operate at a comparable Level of Service during the morning (7am to 9am) and evening (4pm to 6pm) peak periods. These intersections already operate at capacity during peak periods and this would not substantially change with the addition of the forecast construction traffic.

Warringah Freeway

The assessment of construction activity impacts on the road network around the Warringah Freeway indicates that performance would not materially change under construction conditions and that the impacts of construction on traffic operation would be manageable. The Miller Street/Falcon Street intersection and the Warringah Freeway/Falcon Street interchange would continue to operate at capacity, resulting in a poor Level of Service before and during construction activities. During traffic peaks, Falcon Street and Ernest Street would continue to perform at a poor Level of Service with or without the project.

Access to most construction support sites would be via State and regional roads with some exceptions where unavoidable. The majority of construction support sites would generate low construction traffic volumes along local roads. Bay Road and Balls Head Road are local roads that would provide access to the Berrys Bay construction support site (WHT7). The low volume of vehicular construction traffic generated by this site is not expected to substantially impact Bay Road and Balls Head Road.

About 73 on-street metered parking spaces in North Sydney would be permanently removed during construction on Alfred Street North between Wyagdon Street and Whaling Road.

The potential closure of the Warringah Freeway during off-peak times would increase traffic volumes on alternative routes. Traffic and demand management would be required to mitigate these impacts. The approach would be consistent with the management measures currently employed to mitigate the impacts of regular closures on the Warringah Freeway and Bradfield Highway as part of scheduled maintenance works for the Sydney Harbour Bridge and Sydney Harbour Tunnel.

Gore Hill Freeway and Artarmon

The assessment of construction activity impacts on the road network around the Gore Hill Freeway and Artarmon indicates that performance would not materially change under construction conditions and that the impacts of construction traffic on network operations would be minor and manageable.

Public transport impacts

The assessment of the impacts of Western Harbour Tunnel construction activities on the land-based public transport network indicates acceptable performance, with adjustments required to some bus stops in North Sydney and a minor increase in bus travel times for some customers.

The assessment of the impacts of Warringah Freeway Upgrade construction activities on the land-based public transport network also indicates acceptable performance, with a minor increase in bus travel times and some short-term adjustments to bus priority infrastructure, such as the temporary short-term closures of on/off ramp bus lanes and adjustments of bus stops.

Active transport impacts

The assessment of Western Harbour Tunnel construction activities on the active transport network indicates that impacts would be minor and manageable, with existing connectivity maintained.

The assessment of Warringah Freeway Upgrade construction activities on the active transport network also indicates that impacts would be relatively minor and manageable.

Detour routes would be required due to adjustments to the shared user path along Warringah Freeway near Cammeray Golf Course, the shared user path on the northern side of Ernest Street, and the shared user path in Jeaffreson Jackson Reserve. In addition, the currently underutilised Falcon Street underpass would be permanently removed. Existing alternative routes are available for pedestrians and cyclists to access the Falcon Street shared user bridge. The potential additional travel distances are considered moderate and manageable and would not require any further management measures.

Maritime impacts

The assessment of construction activities on the maritime network in the Outer Sydney Harbour indicates that impacts would be relatively minor due to infrequent marine construction vessel movements and wide navigation waterway widths.

The impacts on navigation in the Inner Sydney Harbour would also be relatively minor. Although a fairly high number of construction vessel movements are expected, the Inner Sydney Harbour would be maintained as a working harbour, with vessels larger than the marine construction vessels currently transiting through the Harbour.

Birchgrove Ferry Wharf would be temporarily closed, and there would be a temporary need to partially close the Harbour between Birchgrove and Balls Head during the immersion of the tube tunnel units. This temporary closure would affect ferry services; specifically, the F3 Parramatta River route, the F8 Cockatoo Island route and the Lane Cove to City Captain Cook Cruises service. Opportunities to relocate the Birchgrove Ferry Wharf would be investigated during construction planning. The location of the potential Birchgrove Ferry Wharf relocation would be determined in consultation with Transport for NSW and Sydney Ferries and Captain Cook Cruises. The increase in transit time is anticipated to be minor (less than five minutes compared to normal operation).

Navigational restrictions during the immersion of the tube tunnel units would temporarily prohibit larger vessels, such as oil tankers, crossing the Harbour between Birchgrove and Balls Head.

Moorings within the vicinity of the Berrys Bay construction support site (WHT7) would require temporary relocation. Relocation arrangements would be determined in consultation with the vessel owner(s). Impacts on any relocated moorings are expected to be relatively minor.

Cumulative construction impacts

The assessment of cumulative construction impacts resulting from the project, along with other construction projects including M4-M5 Link and Sydney Metro City & Southwest, indicates that the road network in Rozelle and North Sydney would perform marginally worse under the cumulative construction scenarios during peak periods due to increased construction traffic movements in these areas. The impacts of cumulative construction are considered manageable.

Management of construction impacts

The implementation of appropriate environmental management measures in addition to ongoing consultation with potentially affected stakeholders would assist in avoiding or mitigating potential impacts on the traffic and transport network during the construction of the project. Safeguards and management measures relevant to the traffic and transport impacts of the project are identified in Section 9 of this report. Key environmental management measures that would be required to mitigate construction impacts include:

- Ongoing consultation with (where relevant) the Transport for NSW Sydney Coordination Office, the Port Authority of NSW, local councils, emergency services and bus operators
- Notifying the community in advance of proposed transport network changes
- Advising the public of maritime restrictions through appropriate media and other forms of community engagement

- Requiring construction vessels to operate in a manner that minimises wash to sensitive areas of shoreline
- Scheduling construction marine traffic activities to avoid times and locations of high recreational marine traffic where feasible and reasonable
- Minimising movements of construction road traffic during peak periods
- Considering the haulage of spoil by barge as an alternative to road-based haulage
- Managing vehicle access to and from construction sites to ensure pedestrian, cyclist, and motorist safety. Depending on the location, this may require manual supervision, physical barriers, temporary traffic signals and modifications to existing signals or, on occasion, police presence
- Using directional signage and linemarking to direct and guide drivers, cyclists and pedestrians past construction sites and on the surrounding network. This would be supplemented by Variable Message Signs to advise drivers of potential delays, traffic diversions, speed restrictions or alternative routes
- Scheduling existing network modifications and closures during non-peak periods, where feasible and reasonable.

Operation

Key benefits

When operational, the project would substantially improve accessibility, travel times and travel reliability across Sydney Harbour.

Public transport customers would benefit substantially from the project. Existing services would save up to 20 minutes of travel time crossing Sydney Harbour as a result of improved bus priority and reduced congestion on Warringah Freeway and the Sydney Harbour Bridge. The project itself would facilitate the operation of express buses that would provide direct access between major centres on the Lower North Shore and Inner West.

The key traffic and transport benefits of the project include:

- Enhanced connectivity to and from Sydney's future motorway network, including provision of an alternative route between Sydney Airport and the North Shore via the WestConnex M4-M5 Link and Sydney Gateway
- A resultant reduction in traffic demand on the Sydney Harbour Bridge, Sydney Harbour Tunnel and Western Distributor compared to a future without the project ('Do minimum')
- Improved travel times across Sydney Harbour. The greatest benefits would be for travel between North Sydney and Rozelle. The project would allow the bypass of three highly congested sections of motorway (the ANZAC Bridge, Western Distributor and the Sydney Harbour Bridge) and would reduce travel times by up to 75 per cent
- Travel times would also be improved for trips via the Sydney Harbour Tunnel and the Eastern Suburbs, primarily as a result of reduced demands along this corridor
- Improved vehicle travel times along key traffic routes through Rozelle, resulting from changes in traffic demands and patterns with trips using the Western Harbour Tunnel in preference to existing surface routes including City West Link, ANZAC Bridge, and the Western Distributor
- Substantial improvements in road safety, with reduced traffic demands and conflicts along key surface road transport corridors, resulting in a forecast reduction in crashes across the network
- Substantial travel time savings for freight vehicles, improving productivity and increasing the efficiency of the freight network, particularly for freight trips that currently use the Sydney Harbour Bridge.

Key local public and active transport benefits would include:

- Improvements to southbound bus travel times on ANZAC Bridge and the Western Distributor. Travel times for buses travelling on the Warringah Freeway from both the Gore Hill Freeway and Falcon Street would also be substantially improved, particularly southbound in the morning peak
- Improved public transport priority infrastructure, with a new free-flowing continuous bus lane on Warringah Freeway between Miller Street and the Sydney Harbour Bridge, and efficient access to and from North Sydney for fast interchange with Sydney Metro and Sydney Trains
- Provision of new or upgraded pedestrian and cycle infrastructure, enhancing pedestrian and cyclist safety, accessibility and connectivity, including new shared user paths, replacement of the narrow Ridge Street bridge, a new active transport bridge near Ernest Street and dedicated cycleways.

Traffic and transport impacts

The substantial additional travel that would be facilitated by the project would increase traffic demands in some areas where the project would integrate with the existing transport network. There would be some localised residual delay surrounding these interface precincts. In such cases, localised delays would be offset by the large travel time benefits provided by the project at the broader network level.

Integration works have been developed to minimise the impact of changes to travel patterns created by the project. Proposed works are reflective of local context and constraints and would provide an appropriate balance between the competing needs of private vehicles, public transport passengers, cyclists and pedestrians.

Key local traffic and transport impacts that may arise as a result of the operation of the project include:

- Increased traffic demands and delays for traffic in the North Sydney area. This impact would be minimised through the proposed changes to road access and network arrangements in North Sydney Central Business District (CBD), as well as the ongoing development of the North Sydney Integrated Transport Program by Transport for NSW. The broader network travel time and reliability benefits delivered by the project are expected to outweigh increases to localised delays
- Potential for increased demand and consequent increases to travel times between the Lane Cove Tunnel/Longueville Road and the Gore Hill Freeway
- Changes to access in and around North Sydney, which would streamline movements around North Sydney CBD but would also impact current arrangements for some residents and businesses in the area.

Key local adverse impacts on public and active transport would include the potential for travel times on bus routes through North Sydney to generally increase in the absence of further mitigation measures.

Management of operational impacts

The implementation of appropriate environmental management measures in addition to ongoing consultation with potentially affected stakeholders would assist in avoiding or mitigating potential impacts on the traffic and transport network within the study area during the operation of the project, while maximising or enhancing project benefits. Safeguards and management measures relevant to the traffic and transport impacts of the project are identified in Section 9 of this report. Key environmental management measures that would be required to monitor and, if required, mitigate the operational impacts of the project include:

- A review of operational network performance carried out 12 months and then five years from the opening of the project to confirm the operational impacts of the project on surrounding arterial roads and major intersections. The assessment would be based on updated traffic data at the time and the methodology used would be comparable with that used in this assessment
- Conversion of transit lanes to regular traffic lanes along the Gore Hill Freeway would be considered if there is a traffic performance benefit during peak times.

1. Introduction

This section provides an overview of the Western Harbour Tunnel and Warringah Freeway Upgrade (the project), including its key features and location. It also outlines the Secretary's environmental assessment requirements addressed in this technical working paper.

1.1 Overview

The Greater Sydney Commission's *Greater Sydney Region Plan – A Metropolis of Three Cities* (Greater Sydney Commission, 2018) proposes a vision of three cities where most residents have convenient and easy access to jobs, education and health facilities and services. In addition to this plan, and to accommodate for Sydney's future growth the NSW Government is implementing the *Future Transport Strategy 2056* (Transport for NSW, 2018), a plan that sets the 40 year vision, directions and outcomes framework for customer mobility in NSW. The Western Harbour Tunnel and Beaches Link program of works is proposed to provide additional road network capacity across Sydney Harbour and to improve transport connectivity with Sydney's northern beaches. The Western Harbour Tunnel and Beaches Link program of works include:

- The Western Harbour Tunnel and Warringah Freeway Upgrade project which comprises a new tolled motorway tunnel connection across Sydney Harbour, and an upgrade of the Warringah Freeway to integrate the new motorway infrastructure with the existing road network and to connect to the Beaches Link and Gore Hill Freeway Connection project
- The Beaches Link and Gore Hill Freeway Connection project which comprises a new tolled motorway tunnel connection across Middle Harbour from the Warringah Freeway and Gore Hill Freeway to Balgowlah and Killarney Heights and including the surface upgrade of Wakehurst Parkway from Seaforth to Frenchs Forest and upgrade and integration works to connect to the Gore Hill Freeway at Artarmon.

A combined delivery of the Western Harbour Tunnel and Beaches Link program of works would unlock a range of benefits for freight, public transport and private vehicle users. It would support faster travel times for journeys between the Northern Beaches and south, west and north-west of Sydney Harbour. Delivering the program of works would also improve the resilience of the motorway network, given that each project provides an alternative to heavily congested harbour crossings.

1.2 The project

Roads and Maritime Services (Roads and Maritime) is seeking approval under Division 5.2, Part 5 of the *Environmental Planning and Assessment Act 1979* to construct and operate the Western Harbour Tunnel and Warringah Freeway Upgrade, which would comprise two main components:

- A new crossing of Sydney Harbour involving twin tolled motorway tunnels connecting the M4-M5 Link at Rozelle and the existing Warringah Freeway at North Sydney (the Western Harbour Tunnel)
- Upgrade and integration works along the existing Warringah Freeway, including infrastructure required for connections to the Beaches Link and Gore Hill Freeway Connection project (the Warringah Freeway Upgrade).

Key features of the Western Harbour Tunnel component of the project are shown in Figure 1-1 and would include:

- Twin mainline tunnels about 6.5 kilometres long and each accommodating three lanes of traffic in each direction, connecting the stub tunnels from the M4-M5 Link at Rozelle to the Warringah Freeway and to the Beaches Link mainline tunnels at Cammeray. The crossing of Sydney Harbour between Birchgrove and Waverton would involve a dual, three lane, immersed tube tunnel
- Connections to the stub tunnels at the M4-M5 Link project in Rozelle and to the mainline tunnels at Cammeray (for a future connection to the Beaches Link and Gore Hill Freeway Connection project)

- Surface connections at Rozelle, North Sydney and Cammeray, including direct connections to and from the Warringah Freeway (including integration with the Warringah Freeway Upgrade), an off ramp to Falcon Street and an on ramp from Berry Street at North Sydney
- A ventilation outlet and motorway facilities (fitout and commissioning only) at the Rozelle Interchange
- A ventilation outlet and motorway facilities at the Warringah Freeway in Cammeray
- Operational facilities including a motorway control centre at Waltham Street, within the Artarmon industrial area and tunnel support facilities at the Warringah Freeway in Cammeray
- Other operational infrastructure including groundwater and tunnel drainage management and treatment systems, signage, tolling infrastructure, fire and life safety systems, lighting, emergency evacuation and emergency smoke extraction infrastructure, CCTV and other traffic management systems.

Key features of the Warringah Freeway Upgrade component of the project are shown in Figure 1-2 and would include:

- Upgrade and reconfiguration of the Warringah Freeway from immediately north of the Sydney Harbour Bridge through to Willoughby Road at Naremburn
- Upgrades to interchanges at Falcon Street in Cammeray and High Street in North Sydney
- New and upgraded pedestrian and cyclist infrastructure
- New, modified and relocated road and shared user bridges across the Warringah Freeway
- Connection of the Warringah Freeway to the portals for the Western Harbour Tunnel mainline tunnels and the Beaches Link tunnels via on and off ramps, which would consist of a combination of trough and cut and cover structures
- Upgrades to existing roads around the Warringah Freeway to integrate the project with the surrounding road network
- Upgrades and modifications to bus infrastructure, including relocation of the existing bus layover along the Warringah Freeway
- Other operational infrastructure, including surface drainage and utility infrastructure, signage, tolling, lighting, CCTV and other traffic management systems.

A detailed description of the project is provided in Chapter 5 (Project description) and construction of the project is described in Chapter 6 (Construction work) of the environmental impact statement. The project alignment at the Rozelle Interchange shown in Figure 1-1 and Figure 1-3 reflects the arrangement presented in the environmental impact statement for the M4-M5 Link, and as amended by the proposed modifications. The project would be constructed in accordance with the finalised M4-M5 Link detailed design (refer to Section 2.1.1 of Chapter 2 (Assessment process) of the environmental impact statement for further details).

The project does not include ongoing motorway maintenance activities during operation or future use of residual land occupied or affected by project construction activities, but not required for operational infrastructure. These would be subject to separate planning and approval processes at the relevant times.

Subject to the project obtaining planning approval, construction is anticipated to commence in 2020 and is expected to take around six years to complete.

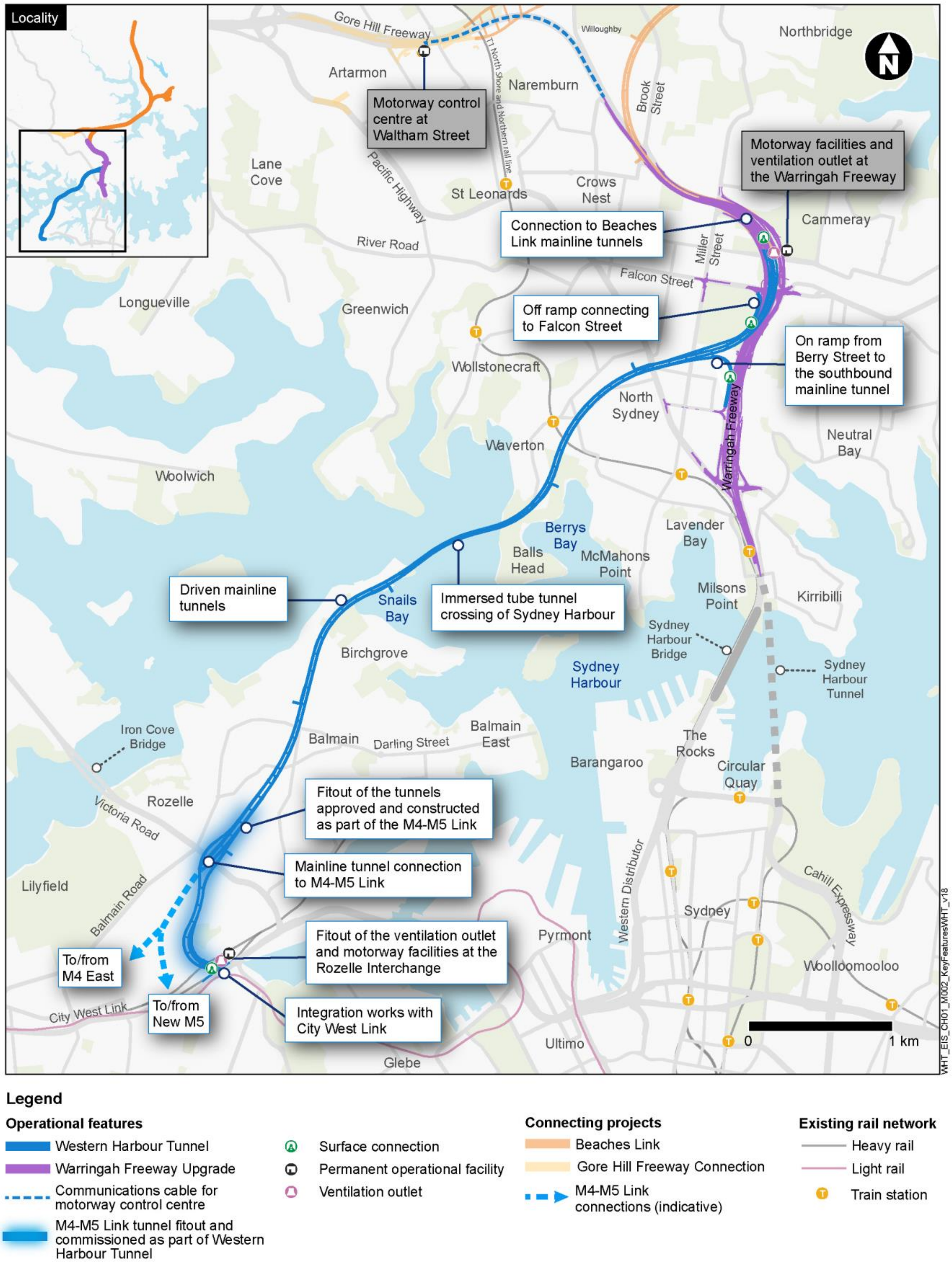

Figure 1-1 Key features of the Western Harbour Tunnel component of the project

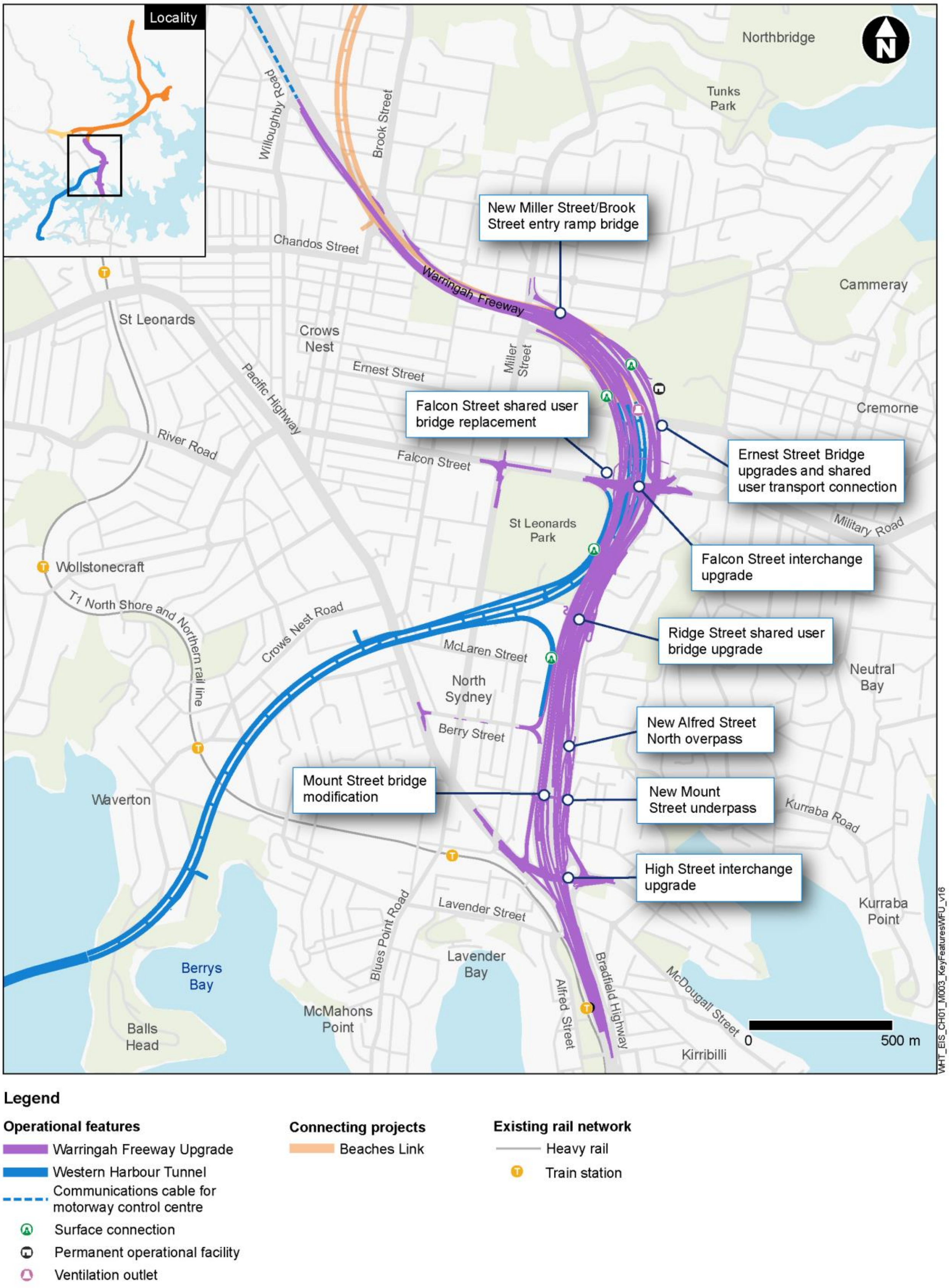

Figure 1-2 Key features of the Warringah Freeway Upgrade component of the project

1.3 Key construction activities

The area required to construct the project is referred to as the construction footprint. The majority of the construction footprint would be located underground within the mainline tunnels. However, surface areas would be required to support tunnelling activities and to construct the tunnel connections, tunnel portals and operational ancillary facilities.

Key construction activities would include:

- Early works and site establishment, with typical activities being property acquisition and condition surveys, utilities installation, protection, adjustments and relocations, installation of site fencing, environmental controls (including noise attenuation and erosion and sediment control) and traffic management controls, vegetation clearing, earthworks and demolition of structures, establishment of construction support sites including acoustic sheds and associated access decline acoustic enclosures (where required), construction of minor access roads and the provision of property access, temporary relocation of pedestrian and cycle paths and bus stops, temporary relocation of swing moorings within Berrys Bay and relocation of the historic vessels
- Construction of Western Harbour Tunnel, with typical activities being excavation of tunnel construction accesses, construction of driven tunnels, cut and cover and trough structures and construction of cofferdams, dredging activities in preparation for the installation of immersed tube tunnels, casting and installation of immersed tube tunnels and civil finishing and tunnel fitout
- Construction of operational facilities comprising of a motorway control centre at Waltham Street in Artarmon, motorway and tunnel support facilities and ventilation outlets at the Warringah Freeway in Cammeray, construction and fitout of the project operational facilities that form part of the M4-M5 Link Rozelle East Motorway Operations Complex, a wastewater treatment plant at Rozelle and the installation of motorway tolling infrastructure
- Construction of the Warringah Freeway Upgrade, with typical activities being earthworks, bridgeworks, construction of retaining walls, stormwater drainage, pavement works and linemarking and the installation of road furniture, lighting, signage and noise barriers
- Testing of plant and equipment, and commissioning of the project, backfill of access declines, removal of construction support sites, landscaping and rehabilitation of disturbed areas and removal of environmental and traffic controls.

Temporary construction support sites would be required as part of the project (refer to Figure 1-3), and would include tunnelling and tunnel support sites, civil surface sites, cofferdams, mooring sites, wharf and berthing facilities, laydown areas, parking and workforce amenities. Construction support sites for Western Harbour Tunnel would include:

- Rozelle Rail Yards (WHT1)
- Victoria Road (WHT2)
- White Bay (WHT3)
- Yurulbin Point (WHT4)
- Sydney Harbour south cofferdam (WHT5)
- Sydney Harbour north cofferdam (WHT6)
- Berrys Bay (WHT7)
- Berry Street north (WHT8)
- Ridge Street north (WHT9)
- Cammeray Golf Course (WHT10)
- Waltham Street (WHT11).

During the construction of the Warringah Freeway Upgrade, smaller construction support sites would be required to support the construction works (as shown on Figure 1-3). These include:

- Blue Street (WFU1)
- High Street south (WFU2)
- High Street north (WFU3)
- Arthur Street east (WFU4)
- Berry Street east (WFU5)
- Ridge Street east (WFU6)
- Merlin Street (WFU7)
- Cammeray Golf Course (WFU8)
- Rosalind Street east (WFU9).

A detailed description of construction works for the project is provided in Chapter 6 (Construction work) of the environmental impact statement.

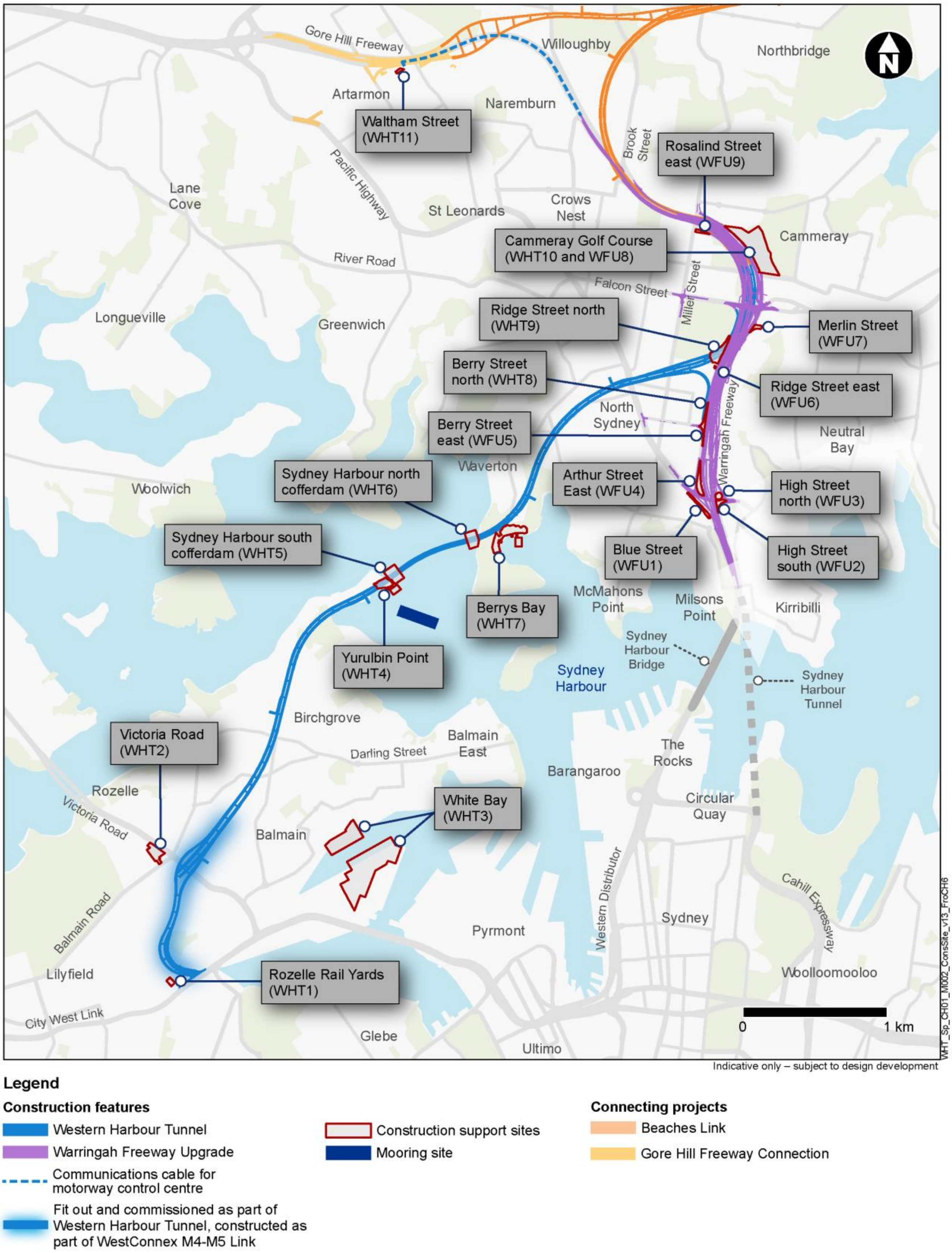

Figure 1-3 Overview of construction support sites

1.4 Project location

The project would be located within the Inner West, North Sydney and Willoughby local government areas, connecting Rozelle in the south with Naremburn in the north.

Commencing at the Rozelle Interchange, the mainline tunnels would pass under Balmain and Birchgrove, then cross Sydney Harbour between Birchgrove and Balls Head. The tunnels would then continue under Waverton and North Sydney, linking directly to the Warringah Freeway to the north of the existing Ernest Street bridge.

The motorway control centre would be located at Waltham Street, Artarmon, with a trenched communications cable connecting the motorway control centre to the Western Harbour tunnel along the Gore Hill Freeway and Warringah Freeway road reserves.

The Warringah Freeway Upgrade would be carried out on the Warringah Freeway from around Fitzroy Street at Milsons Point to around Willoughby Road at Naremburn. Upgrade works would include improvements to bridges across the Warringah Freeway, and upgrades to surrounding roads.

1.5 Purpose of this report

This report has been prepared to support the environmental impact statement for the project and to address the environmental assessment requirements of the Secretary of the Department of Planning, Industry and Environment (formerly Department of Planning and Environment) ('the Secretary's environmental assessment requirements').

This report includes:

- A review of the existing transport network, including a description of transport infrastructure in the study area, traffic volumes and patterns, public transport service provision, mode share, and a review of the pedestrian and cycle networks
- Assessment of the operational performance of the existing road network in terms of network performance, intersection performance, travel times and crash history
- Assessment of construction traffic impacts, including the impact of construction-related vehicles travelling on roads providing access to construction facilities and sites
- Assessment of the future operational performance of the road network without the project
- Assessment of the future operational performance of the transport network with the project in operation
- Assessment of cumulative impacts on the transport network
- A suite of measures proposed to mitigate and manage the identified traffic and transport impacts of the project during construction and operation.

1.6 Secretary's environmental assessment requirements

The Secretary's environmental assessment requirements relating to traffic and transport, and where these requirements are addressed in this report are outlined in Table 1-1.

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

Secretary's environmental assessment requirements	Where addressed
1. The Proponent must assess construction transport and traffic (vehicle, marine, pedestrian and cyclists) impacts, including, but not necessarily limited to: a) a considered approach to route identification and scheduling of marine and land transport movements, particularly outside standard construction hours;	Sections 5.1, 5.2, 5.3, 5.4 and 5.5
b) the number, frequency and size of construction related vehicles (passenger, marine, commercial and heavy vehicles, including spoil management movements);	Sections 5.1, 5.2, 5.3, 5.4 and 5.5 Appendix A
c) construction worker parking;	Sections 5.2.4, 5.3.4 and 5.4.4
d) the nature of existing traffic (types and number of movements) on construction access routes (including consideration of peak traffic times and sensitive road users and parking arrangements including internal Port roads such as James Craig Road where Glebe Island and/or White Bay land is utilised during construction);	Section 4
e) access constraints and impacts on public transport, pedestrians and cyclists;	Sections 5.2.4, 5.3.4, 5.4.4, 5.5.1 and 5.5.2
f) how construction of the project affects the capacity of, and the need to close, divert or otherwise reconfigure elements of, the road, cycle and pedestrian network;	Sections 5.2.4, 5.3.4, 5.4.4 and 5.5.2
g) details of how construction and scheduling of works are to be coordinated in regard to public events and cumulative traffic impacts resulting from concurrent work on the project and other major projects, under or preparing for or commencing construction in the vicinity of the proposal;	Sections 5.5.4 and 5.6
h) alternatives to road transport of construction spoil including marine and rail options as well as potential re-use in existing land reclamation areas or in association with Resource Recovery Exceptions (if obtained from the EPA) to minimise traffic impacts on the road network;	Section 9 Chapter 4 of the EIS
i) the likely risks of the project to public safety, paying particular attention to pedestrian safety and users of Sydney Harbour; and	Section 5.5.2 and 5.5.3
j) impacts to water based traffic and shipping channels on Sydney Harbour.	Section 5.5.3
2. The Proponent must assess and model the operational transport impacts of the project including, but not necessarily limited to: a) forecast travel demand and traffic volumes (expressed in terms of total numbers and heavy and light vehicle numbers) for the project and the surrounding road, cycle and public transport network, including potential shifts of traffic movements on alternate routes outside the proposal area (such as toll avoidance) and impact of permanent street closures directly attributable to the SSI;	Sections 7 and 8
b) accessibility impacts in commercial centres within the vicinity of the project;	Sections 7.4.4, 7.5.4, 7.6.4, 8.4.4, 8.5.4 and 8.6.4
c) travel time analysis;	Sections 7.2.1, 7.4.2, 7.4.5, 7.5.2, 7.5.5, 7.6.2, 7.6.5, 8.2.1, 8.4.2, 8.4.5, 8.5.2, 8.5.5, 8.6.2 and 8.6.5,

Secretary's environmental assessment requirements	Where addressed
d) performance of key interchanges and intersections by carrying out a Level of Service analysis at key locations;	Sections 7.4.3, 7.5.3, 7.6.3, 8.4.3, 8.5.3 and 8.6.3
e) wider transport interactions (local and regional roads, cycling, public and freight transport), taking into account the Sydney City Centre Access Strategy and planned future urban release areas such as the Bays Precinct;	Sections 7.2 and 8.2
f) induced traffic and operational implications for existing and proposed public transport (particularly with respect to strategic bus corridors and bus routes and permanent closure/relocation of bus stops) and consideration of opportunities to improve public transport;	Sections 7.4.5, 7.5.5, 7.6.5, 8.4.5, 8.5.5 and 8.6.5
g) impacts on cyclists and pedestrian access and safety;	Sections 7.4.6, 7.5.6, 7.6.6, 8.4.6, 8.5.6 and 8.6.6
h) opportunities to integrate cycling and pedestrian elements with surrounding networks and within the project;	Sections 7.4.6, 7.5.6, 7.6.6, 8.4.6, 8.5.6 and 8.6.6
i) property and business access and on street parking; and	Sections 7.4.4, 7.5.4, 7.6.4, 8.4.4, 8.5.4 and 8.6.4
j) an explanation for the scope of the modelled area, including justification of the nominated boundaries.	Section 3

1.7 Structure of this report

The remainder of this report is structured as follows:

- Section 2 summarises the strategic planning context of the project
- Section 3 documents the traffic modelling approach adopted to forecast future travel demand and traffic volumes for the project and surrounding road network, and to assess construction and operational impacts
- Section 4 details the existing traffic and transport environment and describes the operational performance of the existing road network in terms of network performance, intersection performance, travel times and crash history
- Section 5 addresses the traffic and transport impacts of construction of the project
- Section 6 describes the future operational performance of the road network without the project
- Section 7 describes the future operational performance of the transport network with only the project in operation (excluding Beaches Link and Gore Hill Freeway Connection)
- Section 8 describes the future operational performance of the transport network with both the project and Beaches Link and Gore Hill Freeway Connection in operation
- Section 9 documents environmental management measures that are proposed to mitigate the identified traffic and transport impacts of the project.

2. Strategic transport and planning context

This section summarises the strategic transport and planning context of the project.

2.1 Alignment with transport policies and plans

The project addresses broader NSW Government objectives set in the *Premier's Priorities* (NSW Department of Premier and Cabinet 2017) and supports, or is recognised in, strategic plans including:

- *State Infrastructure Strategy 2018–2038* (SIS) (Infrastructure NSW, 2018)
- *A Metropolis of Three Cities – the Greater Sydney Region Plan* (Greater Sydney Commission, 2018)
- *Future Transport Strategy 2056* (NSW Government, 2018)
- *NSW Freight and Ports Plan 2018–2023* (Transport for NSW, 2018a)
- *Sydney City Centre Access Strategy* (Transport for NSW, 2013a).

These strategies, together with other mode specific strategies, are detailed below.

2.1.1 State Infrastructure Strategy 2018–2038

The SIS is a 20-year strategy that identifies and prioritises the delivery of critical public infrastructure to drive productivity and economic growth. Infrastructure NSW's assessment of the state's existing infrastructure highlights critical deficiencies in Sydney's road capacity. The SIS identifies strategic infrastructure options to meet the challenges of growth in travel demand and substantial increases in freight volumes.

Specifically, the SIS identifies the Western Harbour Tunnel project as the next major motorway for investment to relieve congestion on the Harbour Bridge and Tunnel and complete a western bypass of the Sydney Central Business District (CBD), and inner urban motorway network. This would both reduce travel times and increase travel time reliability for trips travelling across Sydney Harbour during peak periods. The SIS also recognises the importance of smart motorway technology and digital infrastructure, which, subject to the completion of business cases, is recommended to be deployed across the network in time for the expected opening of Western Harbour Tunnel.

2.1.2 A Metropolis of Three Cities – the Greater Sydney Region Plan

A Metropolis of Three Cities – the Greater Sydney Region Plan (*Greater Sydney Region Plan*) establishes a 40-year strategic land use plan for Sydney, based on a metropolis of three cities (Eastern Harbour City, Central River City and Western Parkland City).

The project supports the following objectives identified in the plan:

- Infrastructure supports the three cities – the project would improve mobility across the Eastern Harbour City and, in conjunction with WestConnex, improve accessibility to the Central River City and the Western Parkland City
- Infrastructure aligns with forecast growth – the project would serve natural growth in demand from Sydney's growing population and economy
- Integrated land use and transport creates walkable and '30-minute cities' (see Section 2.1.3) – the project, in conjunction with Beaches Link and Gore Hill Freeway Connection and WestConnex, and as part of a multimodal transport solution, would increase the number of people and places that are able to be reached within 30 minutes

- The Eastern Economic Corridor (EEC)[1] is better connected and more competitive – the project would provide critical land transport network capacity through the core of the EEC, connecting with international gateways and their surrounds
- Freight and logistics network is competitive and efficient – the project would improve network efficiency and deliver travel time savings, improving the efficiency of freight movement and reducing freight operational costs.

2.1.3 Future Transport Strategy 2056

The *Future Transport Strategy 2056* (*Future Transport*) is a 40-year strategy for mobility for Sydney and regional NSW. It sets out a vision, strategic directions and customer outcomes with a focus on technology and innovation across the transport system to transform the customer experience, improve communities and boost economic performance.

A key element of *Future Transport* is the vision of a '30-minute city'. The 30-minute city is a guiding principle that provides people with access to education, jobs and services within 30 minutes of travel by public and active transport, regardless of where they live. This means people can reach their nearest metropolitan and strategic centres within 30 minutes, seven days a week. The project, as part of a multimodal transport solution, would increase the number of people and places that are able to be reached within 30 minutes.

The strategy identifies the project as a committed initiative in the zero to 10-year horizon. The project fulfils the strategic vision presented for the future strategic road network for Greater Sydney by supporting key movements by road for public transport, private vehicles and freight.

2.1.4 NSW Freight and Ports Plan 2018–2023

The *NSW Freight and Ports Plan 2018-2023* supports *Future Transport* and provides direction to business and industry for managing and investing in freight into the future. It reinforces the importance of freight and ports in NSW to the national economy and ensures the state's freight and port system needs are well positioned to respond to emerging national and international markets and opportunities. It is estimated that freight contributes about $66 billion to the NSW economy, with freight volume expected to increase by almost 50 per cent over the next 20 years in Greater Sydney.

The project supports the following objectives identified in the plan:

- Efficiency, access and connectivity – the project would improve network efficiency and reduce travel times for long distance trips. This would improve the efficiency of freight movement, resulting in reduced freight operational costs
- Capacity – in conjunction with WestConnex, the project would increase north–south road capacity
- Sustainability – the provision of an alternative Harbour crossing would reduce travel time and vehicle hours travelled and would lead to reductions in greenhouse gas emissions.

2.1.5 Sydney City Centre Access Strategy

The *Sydney City Centre Access Strategy* (NSW Government, 2013) is the NSW Government's strategy to deliver a fully integrated transport network in Sydney's city centre that meets the growing demand for all transport modes. The strategy aims to prioritise and allocate road space for public transport, general traffic, pedestrians, cyclists, taxis and service vehicles.

The project addresses one of the key actions of the strategy, which is to establish traffic bypass routes to move traffic around the Sydney CBD. The bypass of the Sydney CBD by through traffic would result in:

- Reduced congestion in Sydney CBD

[1] The Eastern Economic Corridor is the Greater Sydney Commission's new name for the Global Economic Corridor. The EEC extends from Macquarie Park to Sydney Airport.

- Reduced impact of traffic on other modes
- Increased reliability on designated bus corridors in the Sydney CBD
- Reduced likelihood of conflict and competition between different customers.

2.1.6 Transport mode specific strategies

North Sydney Integrated Transport Program

The city-shaping multi-modal transport projects throughout the Western Harbour Tunnel and Beaches Link program of works (program of works) area present a major opportunity to develop an integrated, transport strategy that addresses a range of customer needs. The transport infrastructure investment in North Sydney is an unprecedented opportunity for the North Sydney CBD to realise place based improvements.

The *North Sydney Integrated Transport Program* (the North Sydney Program) is currently being developed by Transport for NSW in collaboration with North Sydney Council to guide transport planning and investment in the North Sydney CBD – and interconnected areas – over the next 20 years and beyond. The North Sydney Program is being developed to support and facilitate the outcomes envisaged by the *Greater Sydney Region Plan* and *Future Transport*. The timing for deliverables in the North Sydney Program would be cognisant of the Western Harbour Tunnel and Beaches Link program of works delivery timeframes.

Realising opportunities presented by land use development and transport infrastructure requires balanced and integrated solutions to service customer needs and manage the potential impacts of increasing travel demand to, from and within North Sydney. The *North Sydney Program* will address the strategic multi-modal changes required to enable the precinct to grow and support its role as part of the Eastern Harbour City. It is framed by the desired growth and physical constraints of the North Sydney CBD, which underlines that future success of the precinct is dependent on improved transport infrastructure and efficient operations for all transport modes.

The *North Sydney Program* could deliver improved pedestrian amenity and safety, improved access for cyclists to and through the CBD, convenient interchanges between bus and rail services, and management of kerbside access to support business activity across the day, including night time activation.

The introduction of the program of works provides an opportunity to enhance and integrate the regional bus network which supports the broad and diverse transport needs of North Sydney, the Lower North Shore, Northern Beaches and areas south of Sydney Harbour. An integrated future bus network could also leverage the opportunities presented by Sydney Metro.

The Western Harbour Tunnel creates the opportunity to introduce new express bus services to key employment and education centres, directly linking North Sydney to the Inner West region of Sydney. This opportunity would better integrate employment, residential and education hubs and provide improved road transport access to a wider range of services and facilities. It would also provide an opportunity to reduce pressure on transport services and infrastructure within the Sydney CBD.

The Beaches Link presents an opportunity to improve travel times and consequent patronage on peak express bus services by re-directing bus services from the Northern Beaches through the new motorway to North Sydney and the Sydney CBD. It also provides an opportunity to consider new express services that could use the Beaches Link to provide more direct public transport access between strategic centres across the region, reducing reliance on private vehicle travel.

The development of the *North Sydney Program* is ongoing. Consequently, the program of works has been designed to preserve opportunities for a future integrated and multi-modal transport network. In addition, to minimise the impact on the North Sydney precinct, Western Harbour Tunnel and Beaches Link program planning and design to date has been developed to:

- Continue to provide motorway access only via existing major road corridors
- Focus on the utilisation of existing road space to maintain network efficiency and balance the needs of all road users while minimising road widenings

- Ensure operational impacts are minimised (and critical performance issues avoided), by spreading the demand generated by new infrastructure across multiple locations
- Provide network efficiencies and safer outcomes by simplifying network operations, prioritising strategic movements and minimising conflicts
- Adopt ‘movement and place’ principles to help reprioritise access and support efficient connections for traffic, pedestrians and other transport customers.

The proposed Western Harbour Tunnel and Beaches Link program of works would result in a resilient network which can accommodate key road transport customers, while at the same time promoting walking, cycling and public transport access to and within the North Sydney CBD. In the event that road transport demand is lower, or demands otherwise differ as land use and transport developments mature, this approach also provides flexibility to adjust the future transport network in response to customer needs.

Transport for NSW will continue to work with North Sydney Council and other stakeholders to investigate options to improve movement and place outcomes through the North Sydney Program, further leveraging the strategic benefits of the program of works.

Sydney’s Bus Future

Sydney’s Bus Future (Transport for NSW, 2013b) presents a three-stage approach to improve service outcomes, focusing on improving customer experience, integrating bus services across Sydney and serving future growth. Proposed bus initiatives include a bus rapid transit for the Northern Beaches and Victoria Road to improve capacity and efficiency for bus users.

By reducing network congestion, improving network resilience and increasing reliability in peak periods, a new Sydney Harbour crossing would make bus routes on the Sydney Harbour Bridge a more attractive transport option, supporting and encouraging a mode shift to public transport. A new harbour crossing would also create the opportunity for new public transport routes to be developed in response to diverse travel demands and future social and economic development.

The Northern Beaches B-Line began operation in November 2017, providing more frequent and reliable services between the Northern Beaches and Sydney CBD. The project, including the Warringah Freeway Upgrade, would support the operation of the B-Line program, as it would facilitate connections to the future Beaches Link Tunnel and enable improved bus travel time along the Warringah Freeway and across the Sydney Harbour Bridge.

Sydney’s Cycling Future

Sydney’s Cycling Future (Transport for NSW, 2013c) identifies priority cycleways to improve connections to major centres and assist in reducing congestion for trips of up to five kilometres. The strategy also includes walking and cycling projects linking to public transport interchanges and stops.

The project would improve cycle connectivity along the fragmented Warringah Freeway corridor, where the current cycle facilities are a combination of off-road and on-road paths. There is a strong community desire to fill a perceived missing link in the cycleway networks in these locations. The project would also result in a reduction in congestion on surface roads, which would contribute to improved conditions for cyclists.

Sydney’s Walking Future

Sydney’s Walking Future (Transport for NSW, 2013d) is the NSW Government’s long-term plan to promote walking as an active transport mode throughout Sydney and an integral component in the planning of urban growth precincts and new transport infrastructure. The project would support the objectives of *Sydney’s Walking Future* by providing pedestrian facilities to encourage this mode for local trips.

2.2 WestConnex and other major road infrastructure projects

WestConnex is a program of works designed to provide 33 kilometres of motorways, linking Sydney's west, south-west, CBD, Sydney Airport and the Port Botany precinct. The overall scheme comprises a number of components staged over a period of 10 years. The scheme brings together previous proposals for the M4 Motorway and M5 Motorway corridors that have been in development over many years. WestConnex is a major investment in Sydney's road infrastructure that will transform urban travel and reshape the localities through which it passes.

The Western Harbour Tunnel and Beaches Link program of works would complement the multiple components of the WestConnex program of works and related projects including the proposed Sydney Gateway and F6 Extension (Stage 1). These are described in Table 2-1 and shown in Figure 2-1.

Table 2-1 WestConnex and related projects

Project	Description	Current status (as at mid 2019)
WestConnex program of works		
M4 Widening	Widening of the existing M4 Motorway between Pitt Street, Parramatta and Homebush Bay Drive, Homebush.	Opened to traffic in July 2017
M4 East	Extension of the M4 Motorway in tunnels between Homebush and Haberfield via Concord – includes provision for future connection to the M4-M5 Link.	Opened to traffic in July 2019
King Georges Road Interchange upgrade	Upgrade of the King Georges Road Interchange between the M5 South West Motorway and the M5 East Motorway at Beverly Hills, in preparation for the New M5 project.	Opened to traffic in December 2016
New M5	Duplication of the M5 East from the King Georges Road Interchange at Beverly Hills to a new interchange at St Peters. The St Peters Interchange allows for connections to the proposed future Sydney Gateway project and an underground connection to the M4-M5 Link. The New M5 tunnels also include provision for a future connection to the proposed F6 Extension.	Under construction, planned completion early 2020
M4-M5 Link	Tunnels connecting to the M4 East at Haberfield and New M5 at St Peters (Stage 1), a new interchange at Rozelle and a link to Victoria Road near Iron Cove Bridge (Stage 2). The Rozelle Interchange includes provision for future connection to Western Harbour Tunnel and Beaches Link.	Under construction, planned completion early 2023
Related projects		
Sydney Gateway	Provision of a high capacity road link between the St Peters Interchange, Sydney Airport and Port Botany.	Planning is in progress by Roads and Maritime and is subject to environmental assessment and approval
F6 Extension (Stage 1)	Tunnels connecting the New M5 at Arncliffe to President Avenue at Kogarah with provision for future extension south to Loftus and Waterfall.	Planning is in progress by Roads and Maritime and is subject to environmental assessment and approval

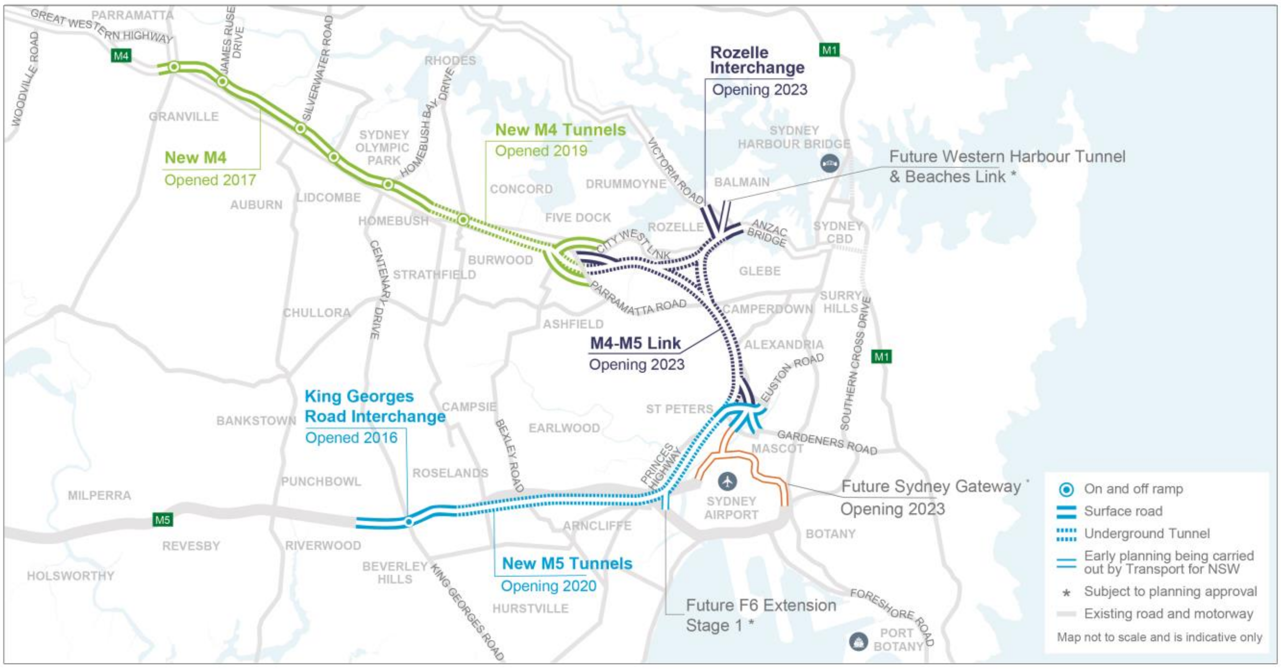

Figure 2-1 WestConnex and related projects

Source: Transurban, 2019

2.3 Northern Beaches B-Line

The Northern Beaches B-Line bus service is a new fleet of modern double deck buses which provide frequent and reliable services between Mona Vale and Wynyard, stopping at Narrabeen, Warriewood, Collaroy, Dee Why, Brookvale, Manly Vale, Spit Junction and Neutral Bay.

The following road network changes are also included as part of the B-Line project:

- Conversion of existing T3 transit lanes to bus lanes along Burnt Bridge Creek Deviation (from Condamine Street to Sydney Road) and along Spit and Military Roads (from Spit Junction, Mosman to Watson Street, Neutral Bay)
- Six new commuter car parks at Mona Vale, Warriewood, Narrabeen, Dee Why, Brookvale and Manly Vale
- Supporting road works designed to reduce congestion and improve bus reliability along the corridor.

The project would create opportunities to reduce congestion and improve travel times and reliability across the Sydney Harbour Bridge, including for B-Line services travelling to and from the Sydney CBD. The project would also provide the opportunity to increase the coverage of potential future B-Line services by extending the potential coverage of any services using the Western Harbour Tunnel. A key opportunity created by the project would be to expand the coverage of public transport services by taking advantage of new connections across Sydney Harbour created by the project. In addition, expansion of B-Line services to take advantage of the opportunities presented by Beaches Link would greatly increase public transport connections to and from the Northern Beaches.

2.4 Sydney Metro City & Southwest

Sydney Metro is a new standalone rail network identified in *Sydney's Rail Future* (Transport for NSW, 2012). The network, comprising Sydney Metro Northwest and Sydney Metro City & Southwest, will deliver seamless metro rail services for more than 65 kilometres between Rouse Hill and Bankstown. Sydney Metro will improve reliability across the rail network by addressing current and emerging constraints such as train crowding, platform and station crowding, and network complexity. The metro rail network will be capable of carrying more people, more quickly, delivering a new tier for Sydney's rail network and supporting high demand with a high capacity turn-up-and-go service. The Sydney Metro network is shown in Figure 2-2.

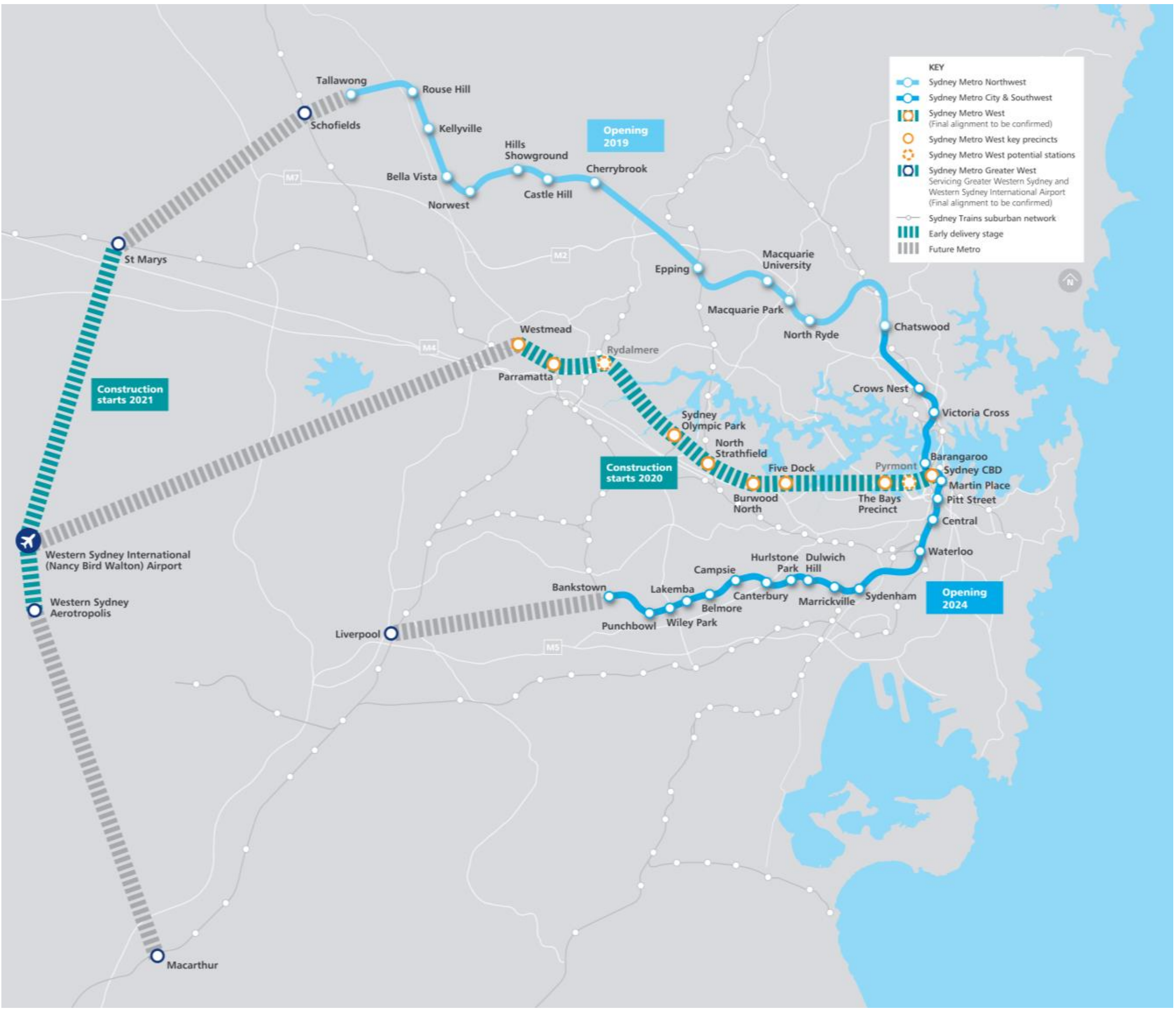

Figure 2-2 The Sydney Metro network

Source: Sydney Metro Corporate Plan 2019-21 (Sydney Metro, 2019)

The Chatswood to Sydenham component of Sydney Metro City & Southwest involves construction and operation of a 15.5 kilometre metro line from Chatswood, under Sydney Harbour and through the Sydney CBD to Sydenham. This component of Sydney Metro would influence travel patterns within the footprint of the full program of works particularly around the Lower North Shore, with metro stations provided at Victoria Cross in North Sydney, Crows Nest and Chatswood, as well as multiple locations within the Sydney CBD.

The Sydney Metro network would provide substantial public transport capacity to key corridors from Sydney's northwest, through to the Sydney CBD and Bankstown. By relieving rail capacity constraints crossing Sydney Harbour and opening up Sydney's northwest to rail, its opening in 2024 would substantially increase the capacity of the public transport network to serve trips crossing Sydney Harbour, facilitating a mode shift from private cars to public transport. The design of the project, in conjunction with the Beaches Link tunnel, has been carried out with this mode shift in mind to provide opportunities for interchange with metro and rail services, and facilitate the movement of trips that do not have the option to travel by rail.

2.5 Role and function of key road corridors

There are six key road corridors in the project's area of influence, shown in Figure 2-3. They perform a critical function for travel across Sydney Harbour, to the Sydney CBD and around the Sydney CBD.

- Northern M1 corridor – Gore Hill Freeway, Warringah Freeway, Sydney Harbour Bridge and Sydney Harbour Tunnel. This is the core north–south cross Harbour route for access to the Sydney CBD and through traffic bypassing the Sydney CBD as part of the Sydney Orbital Network. It is also a major bus corridor for services from the Hills District, North Shore and Northern Beaches
- Pacific Highway and M2 Motorway corridor – these are the main routes for access to the Sydney CBD and North Sydney from the Hills District and Upper North Shore. It is also a major bus corridor with a mix of bus lanes, transit lanes and bus priority infrastructure at key locations
- Military Road/Spit Road corridor and Warringah Road/Eastern Valley Way corridor – these are the main routes for traffic from the Northern Beaches to the wider Sydney metropolitan area. Both routes, in particular Military Road and Spit Road, are major bus corridors for services from the Northern Beaches
- Victoria Road corridor – this is the main route for traffic from the Ryde area and one of two main routes from Parramatta to the Sydney CBD. It also provides an alternative route for parts of the Lower North Shore via Burns Bay Road, and during periods of congestion, for the M2 and M4 corridors. Victoria Road is also a major bus corridor for services from Parramatta, Ryde and Gladesville, with clearways and bus lanes operating in peak periods
- City West Link and Western Distributor – this is the main route for access to the Sydney CBD, North Sydney and beyond from parts of the Inner West and Western Sydney, via the M4 Motorway and Parramatta Road. The Western Distributor, Harris Street and Wattle Street form the existing western bypass route of the Sydney CBD
- Southern M1 corridor – Eastern Distributor, Cahill Expressway, Southern Cross Drive and General Holmes Drive. This is the main north–south route for access to the Sydney CBD and through traffic to North Sydney and beyond from the Eastern Suburbs and southern Sydney.

These six key corridors that serve cross Harbour traffic are forced to converge at the approaches to the Sydney Harbour Bridge and Sydney Harbour Tunnel, presenting operational challenges for managing traffic flow on the approaches and on the crossings themselves. This presents medium and long-term challenges for managing ongoing growth in travel demand, both for general traffic and bus services.

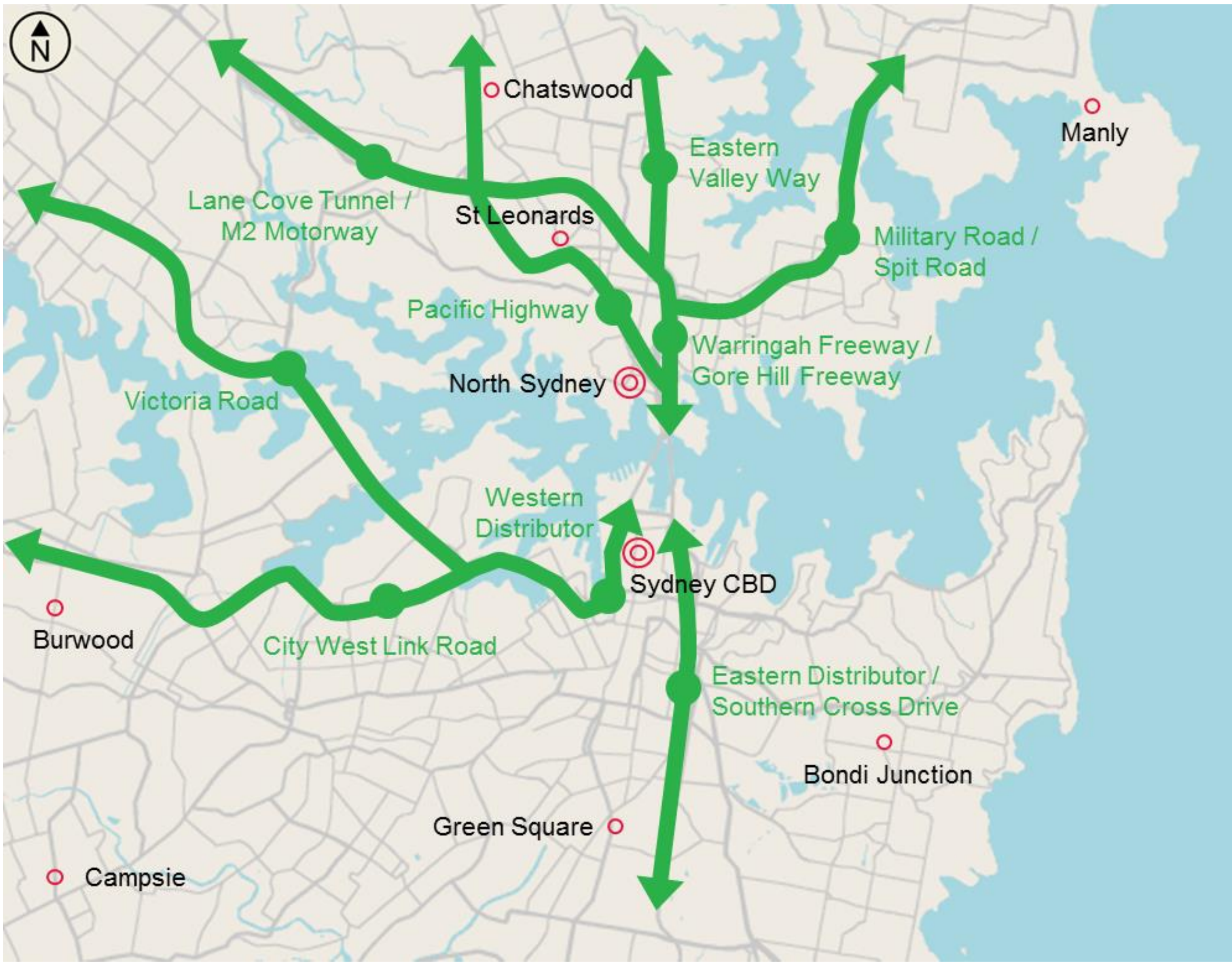

Figure 2-3 Existing key road corridors in the project's area of influence

2.6 Strategic planning consideration – serving the right customers

By supporting the appropriate customer markets, the project can improve the productivity of the freight and business travel task, improve travel times and increase amenity for centres.

2.6.1 Target customers of the project

The emphasis on identifying the project's customers and meeting their needs is consistent with *Future Transport*. The outcome of this is that the project would also support customers that are best served by other transport modes rather than compete with them. The identification of customers of the project is supported by best practice nationally and internationally on motorway function and design, which treats motorways as best serving long distance and inter-regional trips connecting to or bypassing major urban centres.

Likewise, *Future Transport* states that city shaping corridors, including motorways:

- Are important for city-to-city and centre-to-centre movement corridors
- Move people and goods over long distances and, along with trunk public transport corridors, provide higher speed and volume connections between cities and centres that shape location decisions of residents and businesses in Greater Sydney
- Will continue to support journeys on trunk routes in Greater Sydney

- Have a particularly important function in supporting road freight travelling in and around Sydney, thereby minimising impacts on amenity and safety on local roads
- Will evolve, moving towards a mass movement function for people and freight, with increased automation to support 'turn up and go' services in high demand areas.

The project, in conjunction with WestConnex and the Beaches Link and Gore Hill Freeway Connection project, would serve customer needs that are well suited to road based travel.

There are seven target customer markets for the project that are defined by trip purpose:

i. Movement of people and goods to and from the EEC, involving dispersed levels of demand across Sydney. This includes longer metropolitan freight trips between freight hubs located on the M2, M4 and M5 corridors and employment lands in the EEC

ii. Heavy freight movements, involving moderately dispersed trips across Sydney to areas of production, consumption, construction, transport and logistics

iii. Light freight movements to highly dispersed locations, including employment lands, major centres, localised centres and specialised precincts, such as the Camperdown education and health precinct or Macquarie Park

iv. Commercial service vehicles to highly dispersed locations, including major centres, localised centres, specialised centres and households

v. Commercial business vehicles, which tend to be moderately dispersed across major centres, specialised precincts and employment lands

vi. Long distance personal trips to non-centre locations, involving diffuse origins and destinations, where locations are set away from trunk public transport corridors and interchanges

vii. Inter-regional and interstate personal trips, including trips between Sydney and the South Coast (via WestConnex and the F6 Extension); the North Coast (via the Warringah and Gore Hill Freeways, Lane Cove Tunnel, M2 Motorway and NorthConnex); the Blue Mountains (via WestConnex and the M4 Motorway); and the Southern Highlands, Goulburn and Canberra (via WestConnex and the M5 Motorway).

2.6.2 Non-target customers of the project

The project would complement the function of the wider transport network. There are two non-target customer markets for the project:

- Short distance personal travel to centres that are already highly accessible from the existing motorway network. The alignment has been selected to maximise improvement of travel times between a limited selection of strategic centres with minimal intermediate connections between the start and end of the project
- Long distance freight movements to regional and interstate areas, which can be efficiently served by freight rail. These trips have a relatively higher value than personal travel and occur at all times of the day.

While shorter trips and long distance freight are not the direct customers of the project, there would be a substantial reduction in traffic on the current arterial alternatives as a result of the project, which would reduce delays on these roads and provide a secondary benefit to these customers.

2.7 Strategic need

Sydney's transport network faces complex challenges now and over the next 40 years. Sydney's population is anticipated to grow from five million today to eight million by 2056, which equates to an average of 75,000 additional residents per year. This growth will mean the transport network will handle 28 million trips a day and double the current metropolitan freight volume[2]. As part of a multimodal network-wide effort to tackle Sydney's

[2] Source: *Future Transport Strategy 2056* (NSW Government, 2018)

transport challenges, major investments in road capacity across Sydney are required to address network underperformance and support Sydney's long-term economic growth.

The solution to Sydney's complex challenges requires the identification of the right strategic investments to provide long-term network capacity consistent with *Future Transport*, including modern road infrastructure, freight and passenger rail, public and active transport. This means that while the project is a critical component in improving road network efficiency across Sydney in the long-term, it is also part of a wider integrated transportation plan that includes public transport and demand management initiatives.

The project would help address Sydney's future transport challenges as follows:

- The project would address major capacity constraints of the road network. It would relieve congestion on the Sydney Harbour Bridge and Sydney Harbour Tunnel. This would provide opportunities to improve public transport accessibility across the Harbour, which is currently constrained by the existing allocation of road space. In addition, along critical demand corridors leading to the existing Harbour crossings, ageing, narrow or lower-order roads perform a traffic function that is better suited to motorway infrastructure. This reduces amenity and results in congestion, increased travel times, decreased travel time reliability and more traffic incidents
- The project (in conjunction with the Beaches Link and Gore Hill Freeway Connection project) would facilitate the Greater Sydney Region Plan's goal of delivering a 30-minute city by facilitating greater access to jobs, schools and health care within 30 minutes of people's homes by public transport on the Northern Beaches. While the project would primarily deliver these benefits for private car customers, the project also offers the opportunity for express buses, which would also substantially reduce travel times and increase the 30-minute public transport catchments for key interchange locations such as North Sydney, Rozelle and Lane Cove
- The project would provide critical transport network capacity through the core of the EEC, connecting with international gateways and their surrounds. The EEC is home to many high-value service industries such as finance, insurance, technology, health, education and tourism and contributed two thirds of the NSW economic growth for the 2015/16 Financial year (Greater Sydney Commission, 2018b)[3]. The EEC is a major trip generator and economically critical to Sydney and the NSW economy. Even with the NSW Government's investment in major public transport initiatives in the EEC (for example Sydney Metro and the CBD and South East Light Rail), major new road capacity is needed to connect the EEC to markets and customers across Sydney
- The project would serve Sydney's wider, highly diverse freight and business travel task, which involves the distribution of goods and services across Sydney, and which relies on more diverse and dispersed point-to-point transport connections. The project supports this task by improving the reliability of the motorway network to connect employment areas and population centres
- The project would serve natural growth in demand from Sydney's growing population and economy. Population and employment growth are major drivers of transport demand; much of this growth will occur on the motorway network
- The project would better serve the fragmented land use patterns across Sydney by supporting efficient transport connections for trips that are not well-served by other transport modes due to uneven or fragmented economic or residential development (for example between the northern and southern extremities of the EEC, away from CBD locations).

2.8 Strategic transport benefits

The project is a key component of the NSW Government's road network strategy, providing critical new strategic links within Sydney's existing motorway network. The key strategic transport benefits of the project include:

- Fulfilling the strategic vision for the future strategic road network for Greater Sydney by supporting key movements by road for public transport, private vehicles and freight

[3] Source: *State Infrastructure Strategy 2018-2038* (Infrastructure NSW, 2018)

- Improving mobility across Greater Sydney Commission’s Eastern Harbour City and, in conjunction with WestConnex, improving accessibility to the Central River City and the Western Parkland City
- Serving natural growth in demand from Sydney’s growing population and economy
- In conjunction with Beaches Link and Gore Hill Freeway Connection project and WestConnex, and as part of a multimodal transport solution, increasing the number of people and places that are able to be reached within 30 minutes
- Providing critical land transport network capacity through the core of the EEC, connecting with international gateways and their surrounds, improving the efficiency of freight movement, resulting in reduced freight operational costs
- Improving network efficiency and reduce travel times for long-distance trips. This would improve the efficiency of freight movement, resulting in reduced freight operational costs
- In conjunction with WestConnex, providing increased north–south road capacity across Sydney Harbour
- Creating the potential to introduce direct express bus access between the Inner West and Lower North Shore. New express services to key employment and education centres would directly link North Sydney with key centres including the Bays Precinct, University of Sydney and Royal Prince Alfred Hospital
- Reducing greenhouse emissions through the provision of an alternative Sydney Harbour crossing with the resultant travel time savings and reduced vehicle hours travelled
- Reducing congestion in the Sydney CBD and the impact of traffic on other modes
- Increasing reliability on designated bus corridors in the Sydney CBD
- Reducing the likelihood of conflict and competition between different customers through the Sydney CBD
- Relieving congestion on existing Sydney Harbour crossings, particularly the Sydney Harbour Bridge and Sydney Harbour Tunnel
- Improving connectivity of existing cycle facilities along the Warringah Freeway by connecting currently fragmented on-road and off-road corridors.

3. Assessment methodology

This section documents the assessment methodology carried out to determine the traffic and transport impacts of the project, including impacts of construction, impacts on operation and the cumulative impacts of the project with other projects being planned and delivered in the vicinity of the project.

3.1 Relevant guidelines and policies

The following guidelines were followed in carrying out this assessment:

- *Guide to Traffic Management – Part 3 Traffic Studies and Analysis* (Austroads, 2013)
- *Traffic Modelling Guidelines* (Roads and Maritime, 2013)
- *Guide to Traffic Generating Developments Version 2.2* (NSW Roads and Traffic Authority (RTA), 2002)
- *Cycling Aspects of Austroads Guides* (Austroads, 2014)
- *NSW Bicycle Guidelines Version 1.2* (RTA, 2005)
- *Planning Guidelines for Walking and Cycling* (Department of Infrastructure, Planning and Natural Resources, 2004)
- *NSW Sustainable Design Guidelines Version 3.0* (Transport for NSW, 2013e).

3.2 Overall assessment approach

To assess the impact of the project on the traffic and transport network, the following methodology has been carried out to identify and, where appropriate, quantify:

- **Impacts on road network performance** – assessed through the use of traffic modelling at both the strategic and operational levels to determine the standard of performance of the road network with and without the project as described in Section 3.3 and Section 3.4
- **Impacts on public transport** – assessed through the use of traffic modelling to determine the quantitative impacts on public transport performance (increase or decrease in travel times) and through analysis of proposed changes to route and stop coverage to determine the qualitative impacts on service accessibility (increase or decrease in number of stops or change in stop coverage) as described in Section 3.4
- **Impacts on parking** – assessed through an analysis of lost parking spaces and availability of comparable alternative parking in nearby locations to determine the qualitative impacts of parking overflow to parking in nearby locations
- **Impacts on pedestrians and cyclists** – assessed through quantitative analysis of pedestrian and cycle demands (number of users at affected locations) and through analysis of proposed changes to shared user paths, cycleways, footpaths and pedestrian crossings to determine the qualitative impacts on pedestrian and bicycle accessibility (access to and availability of pedestrian and cycle infrastructure)
- **Impacts of construction** – assessed through the analysis of construction traffic generation and management plans. This includes quantitative assessment of the performance of the road network through the use of traffic modelling (intersection Level of Service and arterial road capacity) as described in Section 3.5. It also includes analysis of proposed changes to parking, public transport routes, public transport stops, shared user paths, cycleways, footpaths, pedestrian crossings, navigational waters and maritime facilities to determine the qualitative impacts on the road, public transport, pedestrian and bicycle networks, and maritime network (access to and availability of parking, public transport, pedestrian and cycle infrastructure, and maritime infrastructure).

3.3 Transport modelling approach

Transport modelling is a fundamental component of the methodology used to assess the quantitative impacts of the project on the road network. A multi-tiered transport modelling approach was adopted to carry out a comprehensive assessment of the current and future performance of the road network, as described in the following sections.

An overview of the transport modelling methodology used in the assessment of the project is provided in Figure 3-1.

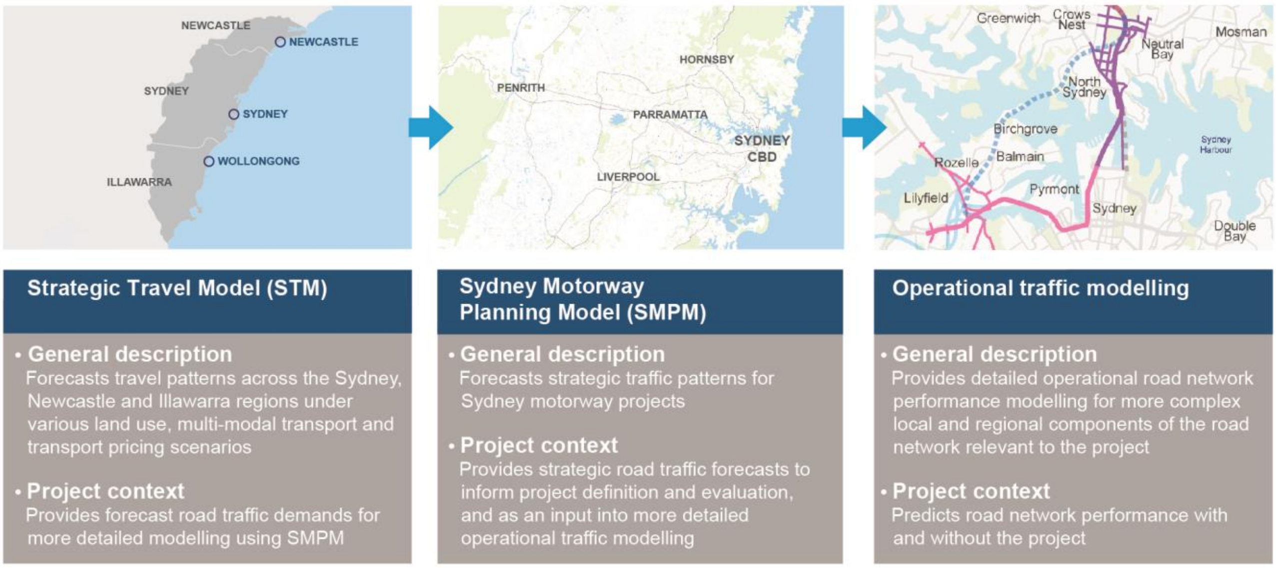

Figure 3-1 Overview of transport modelling approach

3.3.1 Sydney Strategic Travel Model

The Sydney Strategic Travel Model (STM), developed and operated by Transport for NSW, is the primary source for the extraction of region-wide trip patterns and travel demand on the transport network across Sydney, Newcastle and the Illawarra. The STM was used to extract trip matrices for road traffic demand modelling within the Sydney area (using the Sydney Motorway Planning Model, described in Section 3.3.2). Future year trip matrices that take into account NSW Government plans and policies, population and employment projections, and transport infrastructure and service operation assumptions were also extracted from the STM.

3.3.2 Sydney Motorway Planning Model

The Sydney Motorway Planning Model (SMPM), developed and operated by Roads and Maritime, provides a platform to understand changes in future traffic patterns under different land use, transport infrastructure and pricing scenarios. Although the SMPM is a network-wide model that encompasses all existing and future road networks in the Sydney metropolitan area, it was principally developed to assess infrastructure improvements associated with the new motorway projects under planning and assessment individually and in combination. The SMPM was used for this environmental impact statement. As traffic models undergo constant development and refinement, it is anticipated that future projects would use further iterations of SMPM as they become available.

Modelling approach

The SMPM was developed as an evolution of previous planning models and calibrated to current observed travel behaviour, validated against 2014 Sydney-wide conditions from a series of traffic counts and travel time surveys. The model also reflects driver behaviour on Sydney's toll roads as indicated by Value of Travel Time Savings (VTTS) surveys. The model calibration and validation processes maintained a specific focus and refinement on the roads within the project footprints of the Western Harbour Tunnel and Beaches Link program of works, and retained enhancements developed during the course of assessing components of the WestConnex program of works.

Key inputs and assumptions of SMPM used for this assessment include:

- Existing road infrastructure was reviewed for the 2014 base year. A set of future road infrastructure project assumptions for the modelled Sydney metropolitan area was developed and is consistent with current funding and planning policies. These projects formed the basis for the future 'Do minimum' networks modelled in SMPM. The WestConnex project and the Western Harbour Tunnel and Beaches Link program of works were coded into the SMPM future year scenarios (see Section 3.4.2 for definitions of modelled scenarios)
- The SMPM comprises separate weekday (school day) time period sub-models, with average one-hour peak multi-class traffic assignments run for:
  - AM period: 7am – 9am
  - Daytime inter-peak: 9am – 3pm
  - PM period: 3pm – 6pm
  - Evening off-peak: 6pm – 7am
- Base and future population and employment data for metropolitan Sydney was sourced from Transport for NSW Transport Performance and Analytics (TPA), which are available at five-year intervals from the most recent Census year; corresponding traffic demands were sourced from the Sydney Strategic Travel Model (STM)
- Future demands were estimated by applying future year traffic growth forecast by the STM to the SMPM to produce the most likely or future base case scenario. Traffic estimates were produced by the SMPM for the years 2021, 2026, 2031 and 2036. The demands for 2027 (assumed year of opening) were then determined by interpolating between the demands from the standard census forecast years of 2026 and 2031. The demands for 2037 (assumed year of opening plus 10 years) were determined by extrapolating the demands from the standard census forecast years of 2031 and 2036 demand matrices. This produced vehicle demands by time period for an average school day at each year and vehicle class for toll assessment
- Traffic demand data contained within this traffic and transport assessment was taken from the SMPM following assessment of the model calibration and validation by independent peer reviewers and agreement that the model is suitable for this purpose.

Data inputs into the SMPM

Available data was initially used as primary inputs for the development of the SMPM including:

- Traffic volume counts for screenlines and project specific counts
- Road travel time data sourced from Google over 2016
- Base 2011 and future year vehicle demand matrices by travel purpose from the STM, sourced from TPA in January 2017
- Population and employment by small zone area provided by TPA consistent with demographics released by NSW Department of Planning and Environment (DP&E) in 2017 (version Land Use (LU)16v1.3)
- Household travel survey data collected by TPA

- Private car driver stated and revealed preference value of travel time survey data collected in early 2013
- Commercial vehicle stated preference value of travel time survey data collected in late 2012
- Aerial photography collected for detailed auditing of road networks
- Recently completed and future infrastructure project lists, including information from Transport for NSW, which is delivering and planning the following Sydney Metro projects:
  - Sydney Metro Northwest (Rouse Hill to Chatswood) – opened in May 2019, the first stage of Sydney Metro has eight new railway stations and 4000 commuter car parking spaces to Sydney's Northwest. It has been included in the future strategic modelling
  - Sydney Metro City & Southwest (Chatswood to Bankstown) – the second stage of Sydney Metro would extend the metro rail across Sydney Harbour, through the Sydney CBD and to Bankstown. It would deliver seven new railway stations and is currently under construction. It has been included in the future strategic modelling
  - Sydney Metro West was recently announced by NSW Government and is planned to link Parramatta and Sydney CBDs and serve Sydney Olympic Park and The Bays Precinct along the route. This project is at the early stage of development and has not been included in the future strategic modelling
- Existing strategic models and data within the Sydney region.

Structure of the SMPM

The regional SMPM traffic forecasting model process comprises two separate elements: base demand model (based on STM, with updates to incorporate more recent data) and SMPM toll choice assignment model. The role of each element of SMPM and interaction between each element is outlined in the following subsections.

Base demand model

The base demand model was developed using the STM, with updated information used to produce improved travel demand matrices for detailed toll choice route assignment and project appraisal testing. The base demand model provides the forecast capability to address changes in land use, trip distribution and mode choice and produces vehicle traffic demands for peak and off-peak periods for subsequent allocation to routes in the detailed SMPM toll choice assignment model.

Toll choice assignment model

The SMPM toll choice assignment model was developed to test impacts of toll and infrastructure strategies and provide infrastructure project traffic forecasts. The model is designed to forecast the traffic choosing to use tolled and non-tolled routes for the representative peak and inter-peak periods of the day. The development of the toll choice assignment model included:

- VTTS survey analysis to investigate people's willingness to pay tolls to use toll roads based on project specific market research surveys
- Development of improved road traffic demand matrices for the following vehicle classifications:
  - Private vehicles: cars not registered for business use
  - Light commercial vehicles (LCV): vehicles up to 4.5 tonnes gross vehicle mass (GVM) (or under 2.8 metre height/12.5 metre length), including cars registered for business use
  - Heavy commercial vehicles (HCV): all vehicles with a GVM of more than 4.5 tonnes that have been registered for business use.

To support the development of the SMPM, an investigation was carried out into the various toll choice assignment methods in the Sydney and Australian context. Based on the assessment, it was determined that the SMPM toll choice assignment model should adopt a distributed Value of Time (VOT) multi-class equilibrium assignment methodology.

The VOT multi-class equilibrium assignment methodology approach addresses the functional requirements of the project model with capabilities to consider a range of tolling strategies and scenario tests. This methodology appears to be emerging as an industry standard and has recently been used as the preferred modelling approach for a number of Australian toll roads. The SMPM toll choice assignment model was constructed to model the range of driver behaviour and was adjusted to match the observed patronage on the existing toll facilities. A series of validation checks were carried out to verify the performance of the SMPM.

Land use projections

The SMPM is linked to the STM, which undertakes the trip generation, trip distribution and mode choice modules of the traffic forecasting process and incorporates demographic data related to land uses including population, employment and education enrolment projections. For SMPM, this data has been supplied by TPA as data extracts from the STM and is based on the latest population and employment projections based on the latest land use data (version LU16v1.3) provided by TPA. This data has been projected from 2011 Census data and incorporates known major urban renewal projects and developments, including those around Frenchs Forest, North Sydney and the Bays Precinct. The base vehicle demands from STM are consistent with these demographic assumptions and therefore provide a consistent base for the future demand assumptions used in the SMPM.

Projects and developments included in the SMPM modelling also include the strategic directives contained in the Greater Sydney Region Plan. The SMPM also included planned future port activities and uses, for instance at Port Botany, Sydney Airport Freight terminal and intermodal terminals.

Induced demand

Traffic growth on new or upgraded roads is generally a result of the following influences:

- Regional increase in number of trips due to population growth and increased economic activity
- Trips attracted from competing routes or modes as a result of improved travel times on the new or upgraded road
- Induced demand (new trips) as a result of improved travel times between homes and destinations, such as workplaces, shopping centres and education facilities, which cause changes to region-wide trip patterns.

Even with no growth in regional population and economic activity, a new or substantially upgraded road can induce changes in trip patterns, which then appear as induced traffic demand. The SMPM includes the changes in traffic associated with all three of the above sources of traffic, with induced demand equating to about 0.3 per cent additional daily trips in the Sydney metropolitan area in 2037.

SMPM also assumes instantaneous ramp-up of traffic. This assumption means that traffic patterns and volumes following network modifications – for example on project opening – would immediately change to a balanced and settled end state, rather than gradually shifting over a period of time.

3.4 Operational modelling approach

3.4.1 Overview

While strategic modelling tools such as the STM and the SMPM can estimate the performance of the road network using assumptions about the relationship between forecast demand and estimated link-based capacity, it is preferable to carry out more detailed operational modelling to provide a more accurate understanding of the forecast performance of the road network. Microsimulation traffic models have the ability to reflect key network features such as traffic signal operations, freeway merging and weaving, and other detailed vehicle interactions based on individual vehicles and movements at specific times on the road network.

Due to the scale and geographical scope of the project and the complexity and significance of the road network being assessed, operational modelling was carried out in geographical sub-areas using the software package Vissim, as shown in Figure 3-2.

The operational model areas are as follows:

- One tunnel model
  - Western Harbour Tunnel
- Three surface interface models
  - Rozelle and surrounds
  - Warringah Freeway Upgrade
  - Gore Hill Freeway Connection.

The tunnel model was used to assess the future year performance of the proposed road layout within the tunnelled carriageways, including merge and diverge locations and the impact of grades.

The three surface interface models were used to assess the current and future year road network performance, both with and without the project. Also shown in Figure 3-2 are the operational road traffic model areas associated with the Beaches Link and Gore Hill Freeway Connection project (Balgowlah and surrounds, Frenchs Forest and surrounds, and the Beaches Link).

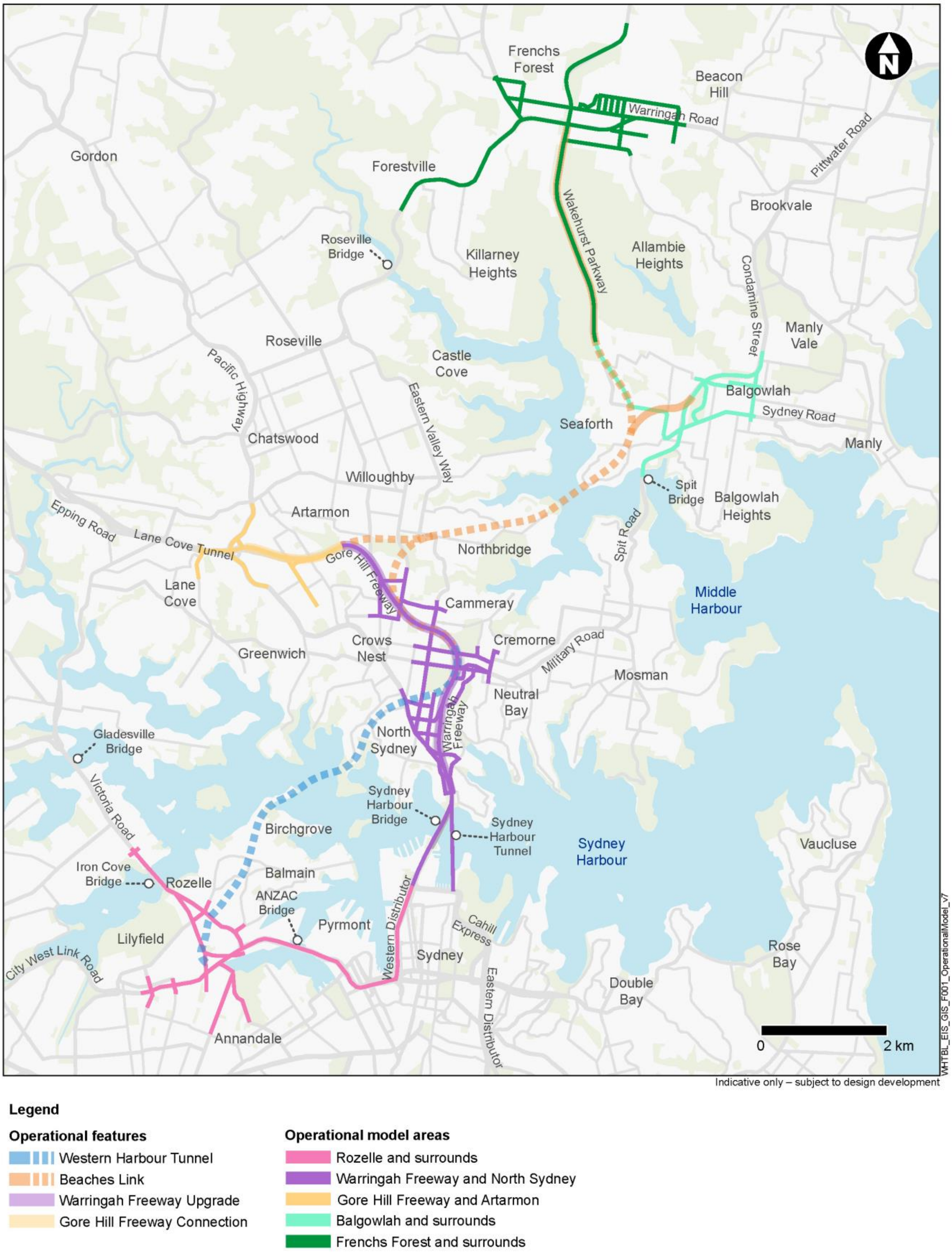

Figure 3-2 Operational road traffic model areas

3.4.2 Modelled scenarios

A summary of the scenarios modelled and assessed is provided in Table 3-1.

The calibrated base scenario reflects existing observed traffic conditions. The 'Do minimum' scenario reflects the business-as-usual road network conditions that would occur if the project was not built. The two project scenarios ('Do something' and 'Do something cumulative') reflect the road network conditions once the project is built, both on its own and in conjunction with other projects that directly and indirectly connect to it.
The purpose of modelling each of these scenarios is to determine the changes in traffic flows and performance in each of the precincts surrounding the project network over time, as population and employment increases for each of the proposed network arrangements associated with the project.

Table 3-1 Summary of modelled scenarios

Scenario	Description	2016	2027	2037
Base year	Traffic model scenario used for calibration purposes and quantification of existing network performance.	X		
'Do minimum'	Traffic model scenario with approved and under construction motorway projects (NorthConnex and WestConnex) but <u>without</u> Western Harbour Tunnel and Warringah Freeway Upgrade, Beaches Link and Gore Hill Freeway Connection, Sydney Gateway and F6 Extension (Stage 1) projects. Also reflects operational effects of approved and under construction major public transport projects (eg Sydney Metro City & Southwest).		X	X
'Do something'	Traffic model scenario with NorthConnex, WestConnex, Western Harbour Tunnel and Warringah Freeway Upgrade projects but <u>without</u> Beaches Link and Gore Hill Freeway Connection, Sydney Gateway and F6 Extension (Stage 1) projects. Also includes Sydney Metro City & Southwest.		X	X
'Do something cumulative'	Traffic model scenario with NorthConnex, WestConnex, Western Harbour Tunnel and Warringah Freeway Upgrade, Beaches Link and Gore Hill Freeway Connection, Sydney Gateway and F6 Extension (Stage 1) projects. Also includes Sydney Metro City & Southwest.		X	X

3.4.3 Base model development

The development of each of the surface interface models involved building calibrated and validated base year models, before producing future year models with and without the project. The approach to the development of the base models is described in Table 3-2.

Table 3-2 Base model development details

Element	Comments
Model specification	• Model periods – extended peak periods modelled, two-hour morning and evening peak periods for assessment • Traffic compositions – multimodal including cars, heavy vehicles, buses (routes and stops) and impacts of pedestrians (at select key crossing locations) • Route choice – dynamic assignment.
Supply assumptions	• Road network definition – lane configurations, lane use management, intersection control, speeds and grades • Traffic signal operations – based on SCATS IDM and LX data.

Element	Comments
Demand assumptions	• Traffic demand – developed using collected traffic count data at intersections and mainlines, with strategic model cordon matrices used to establish trip patterns as required.
Road network performance	• Estimated from recorded travel time data for key routes, in conjunction with site observations of traffic conditions.

Each base model was calibrated to ensure a match between modelled and observed traffic demands. This was followed by validation of each model by comparing a secondary set of modelled and observed results – in this case, travel times for key traffic routes. Calibration and validation of the base models was carried out to demonstrate accurate representation of the existing road network and to enable a satisfactory level of confidence in the modelling of the future year scenarios with and without the project. Calibration and validation of the base models was carried out in accordance with the *Traffic Modelling Guidelines* (Roads and Maritime, 2013).

3.4.4 Future year modelling and demand adjustment approach

The growth in SMPM forecasts has been used to grow the demands from the base year to the relevant future year models. While the simulation models are over multiple hour peak periods, the SMPM forecasts typical one-hour peak (morning and evening) volumes. The forecast one-hour volumes were extrapolated across the full simulation periods to reflect typical demand profiles on either side of the peak hours. This profile was based on observed count data across the relevant networks.

SMPM is a demand-based model with limited detail to fully consider the effect of capacity constraints on traffic demand during the peak period. This means that demand forecasts from SMPM can exceed the road network capacity at specific locations.

Operational traffic models include more detail around critical capacity constraints than SMPM, so that when forecast demand growth from SMPM is applied in operational traffic models, they can show that the forecast growth in demand could not all be accommodated on the road network during the peak period. In reality, when the demand for travel exceeds the capacity of the road network, drivers would change their behaviour, often travelling at a different time, by a different route or mode, or not making their trip at all.

The Western Harbour Tunnel and Warringah Freeway Upgrade project assessment has taken into consideration the observed and theoretical capacities of key network constraints in locations where the SMPM forecasts exceed capacity to provide a more realistic assessment of the performance of the road network under high forecast demands. At relevant locations, input demand has been adjusted so that it does not substantially exceed nominal capacity.

Traffic demand that is not able to be assigned in the operational models during the peak period is assumed to still exist; however, these trips would be delayed and not completed until after the peak period, effectively increasing the duration of the peak period. This effect is partly quantified by the ‘latent’ or ‘unreleased’ demand statistics generated by the operational models.

Similarly, in the Rozelle area, many intersections along City West Link and Victoria Road are currently constrained in terms of throughput and operation by traffic conditions occurring further downstream on the ANZAC Bridge and Western Distributor, where capacity constraints may result in queues through these intersections that are unrelated to the capacity of the intersection itself.

For the purposes of analysing intersection performance in the Rozelle and surrounds study area, where traffic demand on ANZAC Bridge and Western Distributor is forecast to grow but no additional capacity would be provided, intersection performance has been assessed with these constraints removed in the operational model. This allows for an assessment of intersection performance based on the capacity of the intersection itself and independent of any downstream queues that may influence delays through these intersections.

Modelling using SIDRA software (specialised software package used for intersection analysis), carried out for the construction assessment (see Section 3.5), is not subject to the same limitations in assessing each intersection in isolation. Traffic demands used in the SIDRA assessment of individual intersections have not been adjusted and would not account for downstream constraints on ANZAC Bridge and Western Distributor or for the direct interactions of adjacent intersections. As a result, the SIDRA intersection analysis generally reports larger delays than the operational models, when in reality these delays would be distributed across all adjacent intersections along the corridor. In both cases, assessment of the impact of construction and operation of the project is based on the relative differences in intersection and network performance, irrespective of differences in the baseline operation reported by the different models.

3.5 Construction modelling approach

The construction modelling methodology involved deriving base year traffic patterns and developing base and future year traffic models, similar to the operational modelling approach. To ensure an accurate representation of existing conditions, further network traffic counts were gathered across the study area in the locations of the proposed construction support sites.

Base year construction models were developed using a combination of Vissim microsimulation and SIDRA intersection modelling. The construction models developed were calibrated in a similar manner to that described above for the operational models.

Future year construction models were developed for three scenarios using SIDRA intersection modelling and Vissim microsimulation modelling:

- 2022 construction – peak tunnelling for the project (SIDRA only)
- 2022 construction – cumulative peak tunnelling for the project, in combination with Sydney Metro City & Southwest and M4-M5 Link (Vissim for Rozelle and surrounds only)
- 2024 construction – peak construction year for the Western Harbour Tunnel and Beaches Link program of works (Vissim for Warringah Freeway and surrounds only).

In a similar way to the future operational demand volumes, the growth forecast by the SMPM was used to derive background traffic demand for the two construction assessment years. This differs from the operational modelling approach, where the use of microsimulation network models (rather than SIDRA isolated intersection models) accounts for capacity constraints between intersections, as discussed in Section 3.4.4.

Construction traffic was then added to the background traffic. This was based on the proposed construction methodology covering vehicle types, volumes and construction traffic routes to and from the various construction support sites. The performance of intersections in the vicinity of the construction support sites was then assessed.

3.5.1 SIDRA modelling

To forecast the performance of key intersections where construction traffic accesses the arterial road network, intersections along the construction haulage routes between the construction support site and the arterial road network that would experience an increase in construction traffic of more than 50 vehicles per hour were selected to be modelled using SIDRA, as well as intersections that would be modified to accommodate construction activities. Intersections modelled for the construction assessment are outlined in Table 3-3. A qualitative assessment was carried out for all other road segments.

Traffic growth of less than 50 vehicles per hour (less than one vehicle per minute) would generally not result in a meaningful change in the Level of Service, and hence assessment has not been carried out for any intersection where construction traffic volumes would increase by less than this threshold.

Table 3-3 Modelled SIDRA intersections during construction

Assessment area	Intersections
Warringah Freeway and surrounds	• Miller Street/Falcon Street • Warringah Freeway/Falcon Street interchange • Warringah Freeway/Ernest Street interchange • Ernest Street/Merlin Street • Ernest Street/Miller Street • Warringah Freeway/Miller Street interchange
Rozelle and surrounds	• City West Link/The Crescent • The Crescent/James Craig Road • Victoria Road/Wellington Street

3.5.2 Vissim modelling

Vissim modelling of the Rozelle and Warringah Freeway and surrounds areas was carried out using the models identified and detailed in Section 3.4. Vissim modelling was carried out to understand the combined impact of construction traffic on overall network and corridor performance in Rozelle and North Sydney. These areas are highly constrained and subject to increased construction traffic volumes from the construction of a number of concurrent transport projects already approved or in planning in addition to the project and hence have warranted further, more holistic construction traffic modelling.

3.5.3 Warringah Freeway closure assessment

In addition to construction activities associated with the Western Harbour Tunnel, upgrade works for the Warringah Freeway are likely to involve closures of sections of the Warringah Freeway from Miller Street to High Street (North Sydney). These closures would be carried out during off-peak periods at times agreed with Sydney Coordination Office. Assessment of the impacts of potential Warringah Freeway closures has been limited to the likely increases in traffic on surrounding roads that would result from each scenario. Each closure scenario was modelled using SMPM, and daily modelled flow differences were factored based on observed traffic flows surveyed on the Warringah Freeway during the likely busiest hour of the proposed closure period (10pm to 11pm) to estimate the potential increased traffic volumes on key roads impacted.

3.6 Desired standards of service

Generally, traffic operational performance can be assessed in several ways, including:

- At a network level, in terms of average speed, total distance travelled, and total time travelled
- At a corridor level, in terms of average travel times on a particular route for general traffic and buses
- At an intersection level, showing individual performance of these typically constraining elements of urban road networks
- For single point assessment at a midblock level, showing changed travel routes and impacts.

Typically, shorter distance and less time travelled through a network implies increased network efficiency. However, because demands and networks may be different, higher values may well be indicative of a better performing network because more vehicles are able to travel through the network to reach their destinations, while shorter distances may be caused by congestion and slower vehicle speeds.

Given the existing congestion in the study area, single-point assessment criteria do not present a complete picture of road network traffic operations. Traditional midblock and intersection levels of service do not recognise that traffic is often constrained upstream, meaning that vehicles cannot get to the evaluation point,

and therefore give an unrealistically low level of demand and delay. Similarly, they do not recognise that traffic is constrained downstream, meaning vehicles are queued through the evaluation point. The measurements therefore only show throughput at that point rather than overall network performance. The operation of the modelled road network as a whole is regarded as being of prime importance, recognising that there may be single locations where there may be improvement, while at others there may be some deterioration.
These changes should not be considered in isolation. Overall, the critical evaluation measure is that the project does not overburden the network and provides more efficient network operations as a whole.

3.6.1 Network-wide statistics

Key network-wide statistics during the morning and evening peak periods for each modelled network are as follows:

- Primary
  - Total throughput (vehicles)
  - Average network travel speed (kilometres per hour)
  - Latent demand (vehicles)
- Secondary
  - Total vehicle hours travelled (VHT)
  - Total vehicle kilometres travelled (VKT).

Results for each of the above statistics have been used to compare the performance of each network with and without the project. VHT and VKT have been treated as secondary measures as they are demand-dependant, and demands through the modelled areas are very different when comparing the 'Do minimum' and 'Do something' scenarios. Presenting VHT and VKT in isolation can be misleading when considering them in the context of network performance. Therefore, average network speed (which is the ratio of VKT to VHT) has been used as a primary performance metric.

3.6.2 Travel times

Travel times along key routes in each modelled area have been used to determine the relative impacts or benefits of the project. Travel times are expressed in minutes and refer to both general traffic and buses.
Bus travel times are for key routes through each modelled area and have been used as a key indicator of the benefits and impacts of the project on bus performance.

3.6.3 Intersection Level of Service

The assessment of intersection performance is based on criteria outlined in Table 3-4 and defined in the *Guide to Traffic Generating Developments Version 2.2* (RTA, 2002). The average delay assessed for signalised intersections is for all movements. The average delay assessed for priority (sign-controlled) intersections is for the worst movement and is expressed in seconds per vehicle.

When assessing intersection performance for parts of the road network that already experience substantial congestion over the course of the day, achieving Level of Service (LoS) D or better may not represent good value for money, or may not be physically possible within the constraints of the project. In these locations, consideration has been given to whether achieving LoS D is practical within the constraints of the project; if not, a minimum of LoS E has been deemed acceptable.

Many intersections surrounding the project currently operate at capacity during the peak period. It is expected that as traffic volumes across Sydney increase, delays would also increase with or without the project. Intersections that are outside of the scope of works but still affected by the project are expected to operate no worse than they would under the 'Do minimum' scenario. Any works required to improve the operation of these intersections would be considered under Roads and Maritime's wider programs to ease congestion in metropolitan Sydney.

Table 3-4 Level of Service (LoS) criteria for intersections

LoS	Average delay per vehicle (seconds/vehicle)	Traffic signals and roundabouts
A	Less than 15	Good operation
B	15 to 28	Good with acceptable delays and spare capacity
C	29 to 42	Satisfactory
D	43 to 56	Operating near capacity
E	57 to 70	At capacity; at signals, incidents will cause delays Roundabouts require other control mode
F	Over 70	Extra capacity required

Source: Guide to Traffic Generating Developments Version 2.2 (RTA, 2002)

Interchanges modelled in SIDRA consisted of two or more isolated intersections which were then connected as a network. Network Level of Service in SIDRA is defined by speed efficiency, which is the ratio of average travel speed for the network to the desired speed. The network Level of Service criteria adopted for this assessment is shown in Table 3-5.

Table 3-5 SIDRA Level of Service (LoS) criteria for networks

LoS	Speed efficiency
A	0.91 to 1.00
B	0.81 to 0.90
C	0.71 to 0.80
D	0.51 to 0.70
E	0.31 to 0.50
F	0.00 to 0.30

Source: Sidra INTERSECTION 7 User Guide (Ackelik and Associates, 2016)

3.6.4 Midblock Level of Service

The assessment of network performance is based on criteria defined in the *Guide to Traffic Management – Part 3 Traffic Studies and Analysis* (Austroads, 2013) and the *Highway Capacity Manual 2010* (Transportation Research Board, 2010). The performance of surface roads is defined by the midblock Level of Service which is based on the volume to capacity (V/C) ratio. The Level of Service for freeways and motorways is calculated from vehicle density, which is the traffic volume divided by the average passenger car speed. Density is measured in passenger car units (PCU)[4] per kilometre per lane. The Level of Service criteria for midblock sections is shown in Table 3-6.

[4] Passenger car units account for the amount of road space various vehicle types use. Heavy vehicles and buses use more road space than cars or light commercial vehicles.

Table 3-6 Level of Service (LoS) criteria for midblock sections

LoS	Definition	Multi-lane roads[1] V/C ratio	Freeways/ motorways[2] Density (PCU/km/lane)
A	A condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and manoeuvre within the traffic stream in extremely high, and the general level of comfort and convenience provided is excellent.	≤ 0.26	≤ 7.0
B	In the zone of stable flow where drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is a little less than with Level of Service A.	0.27 to 0.41	7.1 to 11.0
C	Also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.	0.42 to 0.59	11.1 to 16.0
D	Close to the limit of stable flow and approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow would generally cause operational problems.	0.60 to 0.81	16.1 to 22.0
E	Traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream would cause breakdown.	0.82 to 1.00	22.1 to 28.0
F	In the zone of forced flow, where the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs, and queuing and delays result.	> 1.00	> 28.0

Note 1: Where free flow speed is taken as 70 km/h.

Note 2: Where free flow speed is taken as 90 km/h.

Source: Guide to Traffic Management – Part 3 Traffic Studies and Analysis (Austroads, 2013).

4. Existing traffic and transport environment

The project would provide broad road network benefits by increasing travel speeds and improving travel time reliability for travel within and surrounding the project footprint. At some locations changes to the existing road network would be required to facilitate and manage the impacts of increased connectivity provided by the project. The project includes mitigations to address potential localised impacts created by changes to the existing network, with residual local impacts offset by the broader network benefits provided by the project. For example, increased delays at an intersection would be outweighed by the travel time benefits to and from that location.

This section details the existing traffic and transport environment around the project area that would be potentially affected, which would be largely confined to the area around the Gore Hill Freeway and Artarmon, the Warringah Freeway and surrounds, and Rozelle and surrounds.

A summary of existing road network performance within the area of influence of the project is also provided. These reflect the operational conditions of the road network prior to the construction of the project.

Assessment of the existing road network conditions within the study area is based on the following performance measures:

- Network performance based on overall traffic flows and congestion
- Travel times based on average speeds along key routes
- Intersection performance based on intersection levels of service
- Road safety and crash history based on crash data collected over the last five years.

4.1 Metropolitan road network

4.1.1 Strategic corridors

Crossing Sydney Harbour in the vicinity of the project is currently limited to the following locations:

- Sydney Harbour Bridge (Bradfield Highway)
- Sydney Harbour Bridge (Cahill Expressway)
- Sydney Harbour Tunnel
- Gladesville Bridge.

Taken as a group, these locations define a 'screenline' that can be used to compare the changes in directional and two-way traffic demands across Sydney Harbour at a strategic level. A plot showing the Sydney Harbour screenline and each of the crossing points along this screenline is provided in Figure 4-1.

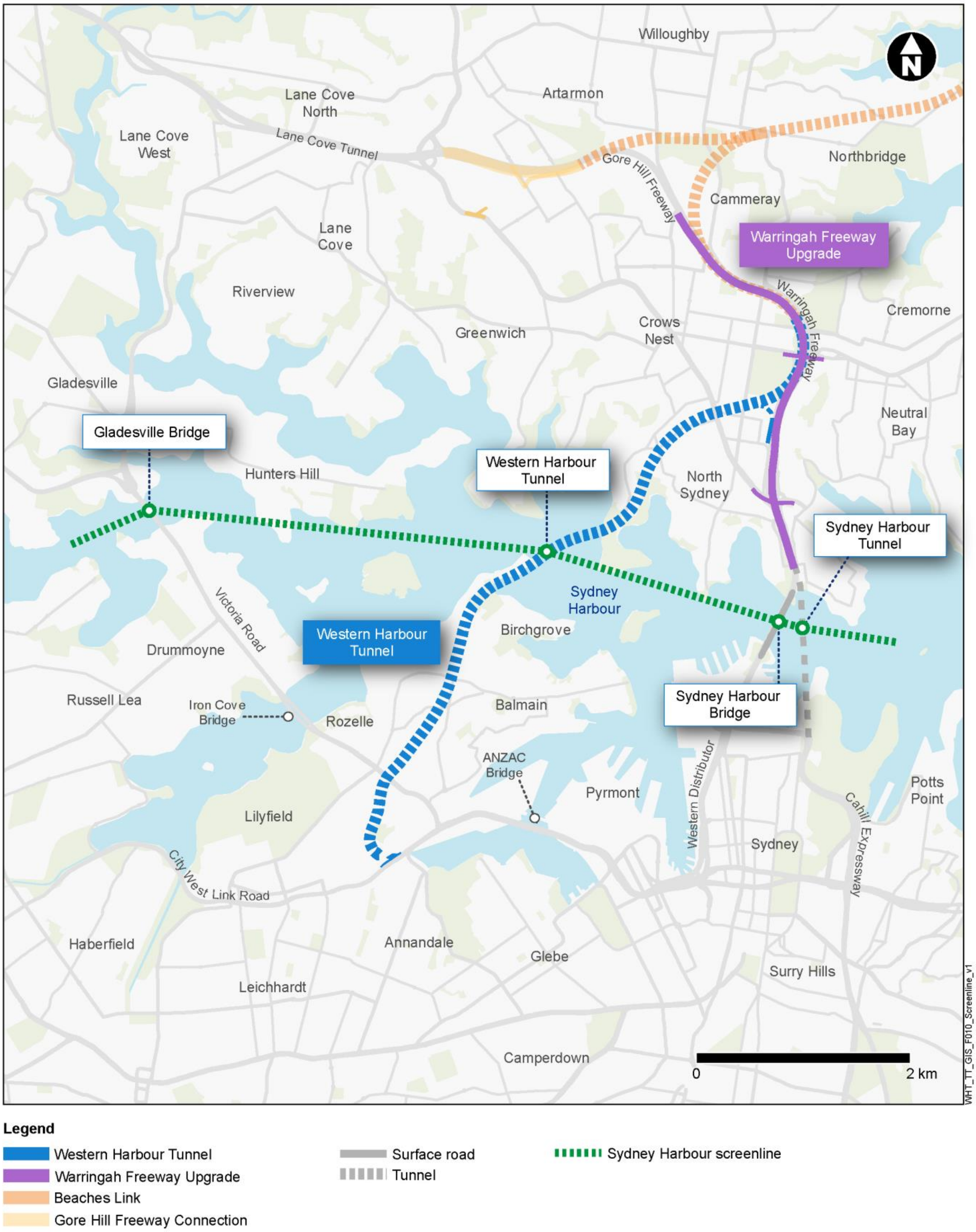

Figure 4-1 Sydney Harbour crossing screenline location

Table 4-1 presents a summary of traffic demands at key crossing points on each of these roads, as well as Western Distributor and ANZAC Bridge, which – while not on the screenline – are nevertheless critical road sections relevant to the performance of the Sydney Harbour crossings.

Table 4-1 Modelled 2016 traffic demands at key locations (SMPM)

Road	Location	Direction	Morning peak hour (veh)	Evening peak hour (veh)	Daily (veh)
Sydney Harbour Bridge	Bradfield Highway	Northbound	4850	6150	90,500
		Southbound	5500	3150	52,500
		Combined	*10,350*	*9300*	*143,000*
Sydney Harbour Bridge	Cahill Expressway	Southbound	2600	2500	39,000
Sydney Harbour Tunnel	Sydney Harbour	Northbound	3950	3850	55,000
		Southbound	3700	2850	48,500
		Combined	*7650*	*6700*	*103,500*
Gladesville Bridge	Parramatta River	Northbound	3050	3750	51,000
		Southbound	3650	2900	43,000
		Combined	*6700*	*6650*	*94,000*
Sydney Harbour screenline		**Northbound**	**11,850**	**13,750**	**196,500**
		Southbound	**15,450**	**11,400**	**183,000**
		Combined	***27,300***	***25,150***	***379,500***
ANZAC Bridge	Pyrmont	Eastbound	5100	4200	75,500
		Westbound	3000	4250	63,000
		Combined	*8100*	*8450*	*138,500*
Western Distributor	Sydney CBD	Northbound	2550	3200	52,500
		Southbound	2800	1850	42,000
		Combined	*5350*	*5050*	*94,500*

At a network level, the Western Harbour Tunnel would provide an alternative route to the following corridors:

- **Sydney Harbour Bridge, Bradfield Highway and Cahill Expressway:** The Bradfield Highway is the primary gateway into the Sydney CBD from the North Shore, Northern Beaches and North West. This corridor operates at capacity during peak periods and close to capacity for much of the day. There is tidal flow in operation during the morning peak on the Sydney Harbour Bridge allowing for five lanes southbound and three lanes northbound. Generally, there are four lanes operating in each direction at all other times. As well as being a critical road corridor, the Sydney Harbour Bridge carries some of the highest bus volumes in Sydney and is a critical bus corridor into the Sydney CBD from the north
- **Sydney Harbour Tunnel and Eastern Distributor:** The Sydney Harbour Tunnel and Eastern Distributor form a critical link along the M1 Motorway, providing a Harbour crossing for trips heading to southern Sydney and eastern Sydney. The Sydney Harbour Tunnel also provides limited access to the Sydney CBD from Cowper Wharf Road and William Street. The Sydney Harbour Tunnel operates at capacity during peak periods and is generally constrained by traffic merging and weaving behaviour at its interface with the Domain Tunnel and Eastern Distributor
- **Victoria Road:** Victoria Road is the primary arterial corridor for trips from Ryde, Epping and North Parramatta to the Sydney CBD. It is a highly constrained urban arterial corridor that operates at capacity during peak periods. Congestion along Victoria Road is frequently observed at most intersections south of the Gladesville Bridge, with tidal flow in operation between Gladesville Bridge and Iron Cove Bridge during

the morning peak allowing for four lanes eastbound and two lanes westbound, and in the evening peak operating with three lanes in each direction. Victoria Road is also a critical bus corridor for trips from Ryde, Drummoyne and Rozelle into the Sydney CBD with high passenger demands from Darling Street through to City West Link

- **Western Distributor and ANZAC Bridge:** The Western Distributor and ANZAC Bridge form the primary western route around the Sydney CBD, providing motorway standard access to the Sydney CBD via Bathurst Street and King Street, as well as bus access via Druitt Street. The corridor also provides a route for trips from the Inner West to the North Shore and Northern Beaches. ANZAC Bridge operates at capacity during peak periods, with the Western Distributor frequently congested during the morning peak when weaving and diverging traffic movements limit capacity for northbound trips into the CBD and north across Sydney Harbour.

The following corridors have been selected to provide an overview of travel times and speeds across the network for key trips that provide current alternatives to the Western Harbour Tunnel.

- Rozelle to North Sydney – via The Crescent, ANZAC Bridge, the Western Distributor, the Sydney Harbour Bridge, Warringah Freeway, Pacific Highway and Miller Street
- North Sydney to Rozelle – via Berry Street, Arthur Street, Mount Street, Warringah Freeway, the Sydney Harbour Bridge, the Western Distributor, ANZAC Bridge and The Crescent.

Trips using the Sydney Harbour Tunnel are likely to benefit from reduced demand following the introduction of the Western Harbour Tunnel; therefore the following trips via the Sydney Harbour Tunnel have also been analysed:

- Moore Park to North Sydney – via ANZAC Parade, the Eastern Distributor, the Sydney Harbour Tunnel, Warringah Freeway, Falcon Street and Miller Street
- North Sydney to Moore Park – via Miller Street, Falcon Street, Warringah Freeway, the Sydney Harbour Tunnel, the Eastern Distributor and ANZAC Parade.

The existing travel times and average travel speeds on key trips that would potentially improve from the project are provided in Figure 4-2 and Figure 4-3.

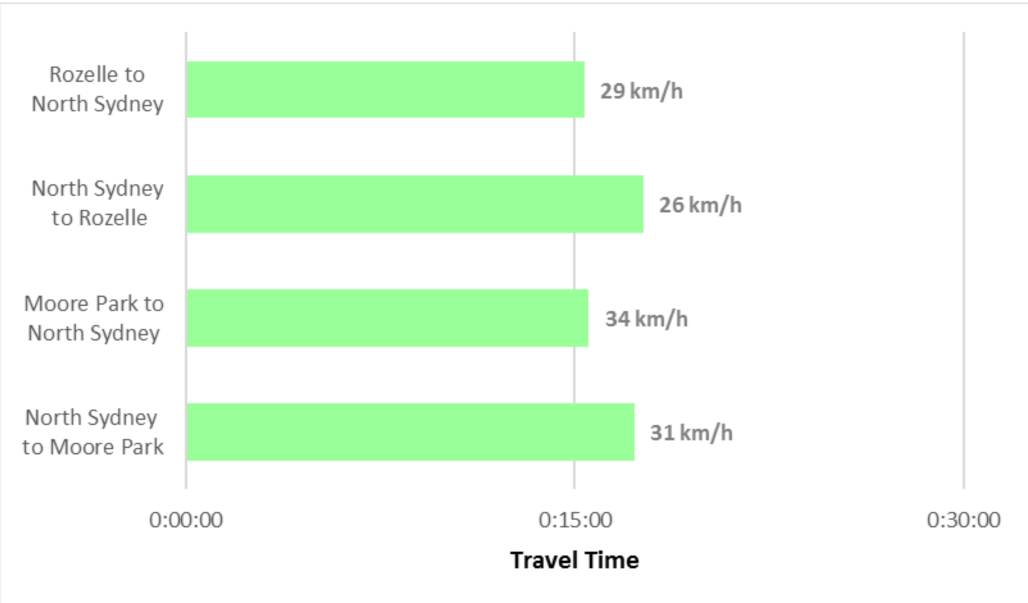

Figure 4-2 Modelled 2016 morning peak hour travel times and average speeds along key corridors (SMPM)

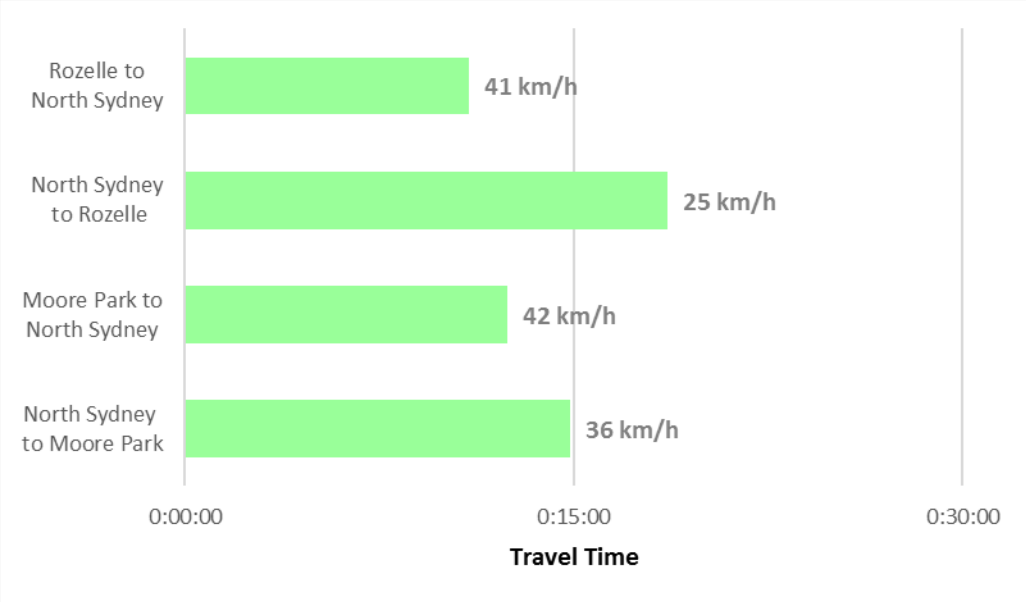

Figure 4-3 Modelled 2016 evening peak hour travel times and average speeds along key corridors (SMPM)

4.1.2 30-minute city catchments

NSW Government's *Future Transport* identifies a vision for Greater Sydney where people can conveniently access jobs and services. The goal for this accessibility is to provide transport infrastructure that allows people to reach their nearest Metropolitan and Strategic Centres by public transport within 30 minutes, seven days a week. While the inclusion of new public transport services is not proposed as part of the project, the project would create opportunities for new, or extension of existing, public transport services. These new service opportunities would benefit from the same increases in catchment size as private vehicles.

The current Metropolitan and Strategic Centres that would benefit from the Western Harbour Tunnel and Warringah Freeway Upgrade include:

- Sydney CBD
- North Sydney
- Chatswood.

Plots of the existing 30 minute catchments by road during peak periods for each of these centres are provided in Figure 4-4 to Figure 4-6.

Analysis of the 30-minute catchments from 2016 shows:

- Chatswood currently has very good accessibility to nearby strategic centres, with Brookvale-Dee Why, Manly, North Sydney and northern Sydney CBD accessible within 30 minutes
- North Sydney currently has good accessibility to the adjacent strategic centres of Chatswood and the Sydney CBD, but Manly or Brookvale-Dee Why cannot be reached within 30 minutes by road
- The majority of nearby strategic centres north of Sydney Harbour cannot access the Sydney CBD by road within 30 minutes, with only North Sydney accessible within this timeframe.

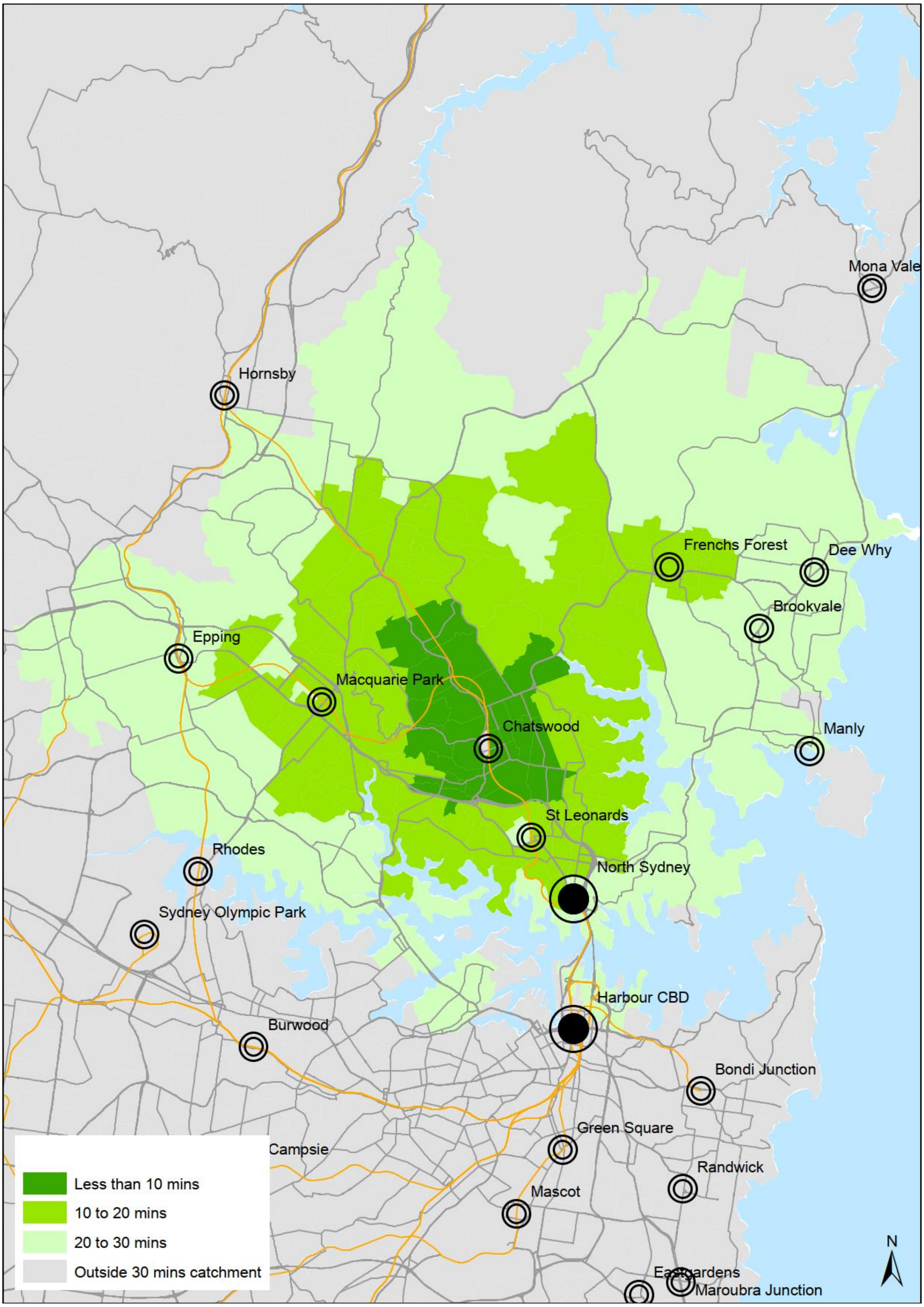

Figure 4-4 Modelled 2016 morning peak 30-minute catchment by road from Chatswood (SMPM)

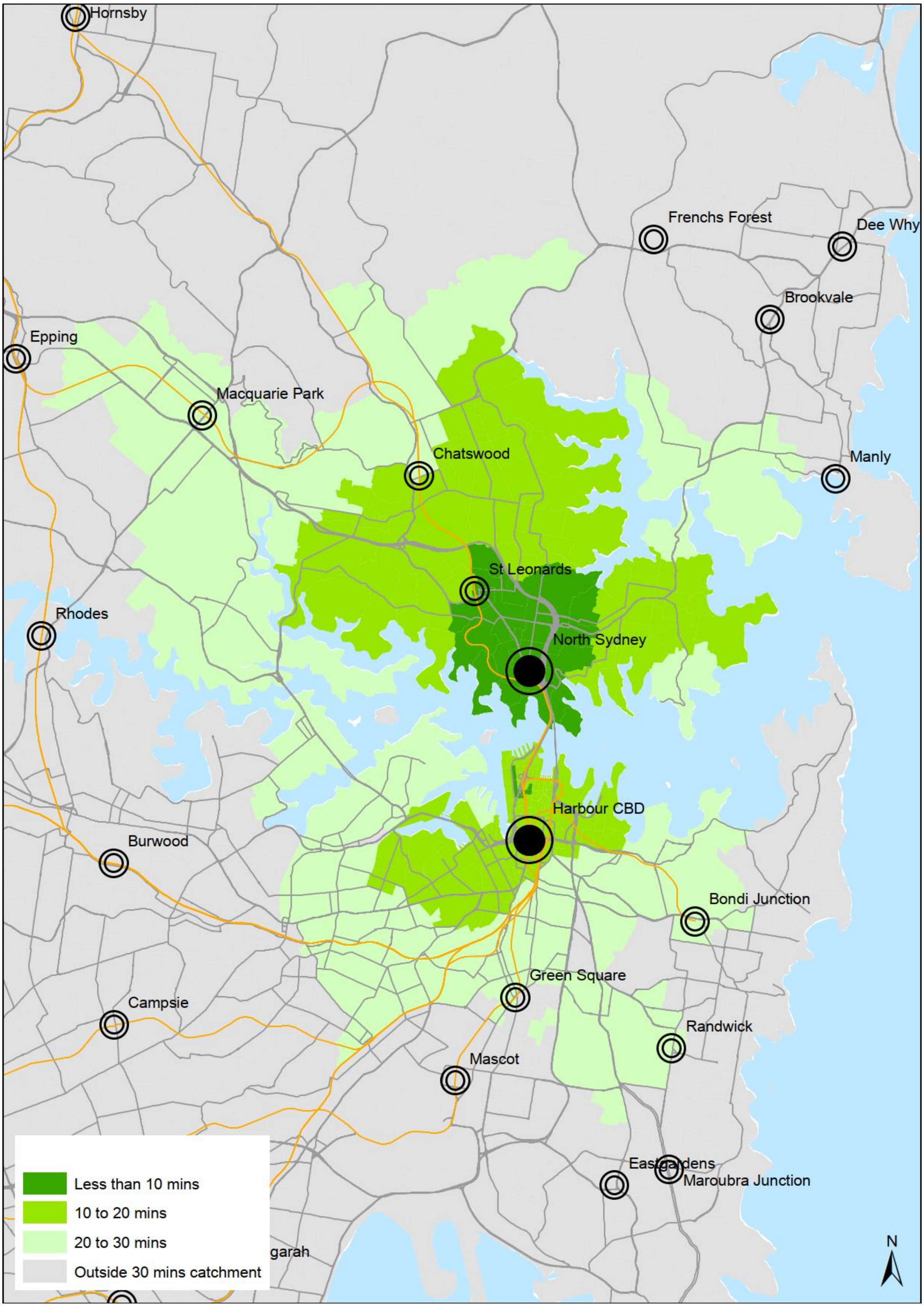

Figure 4-5 Modelled 2016 morning peak 30-minute catchment by road from North Sydney (SMPM)

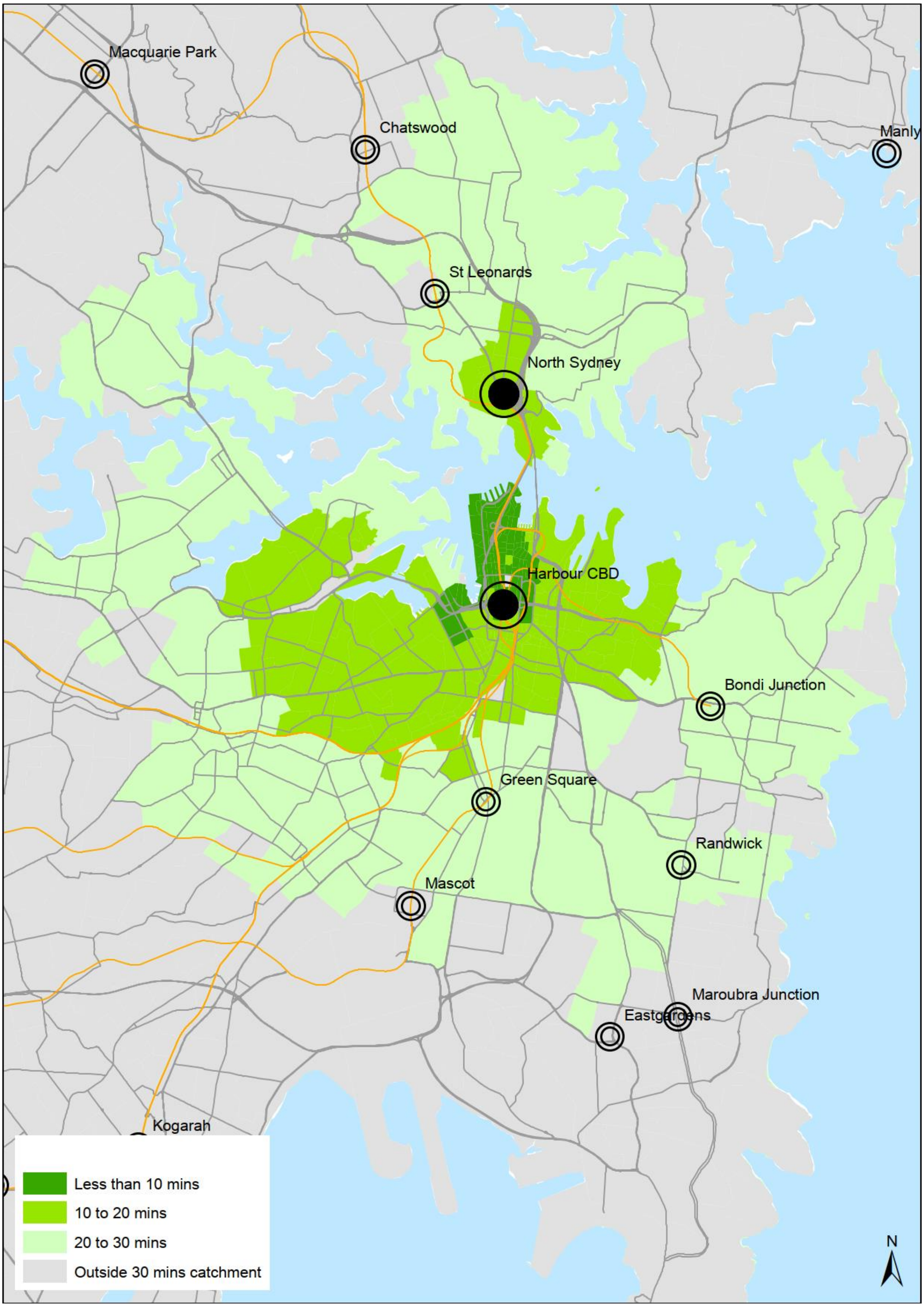

Figure 4-6 Modelled 2016 morning peak 30-minute catchment by road from Sydney CBD (SMPM)

4.1.3 Heavy vehicles and freight

The *NSW Freight and Ports Plan 2018-2023* states that freight in greater Sydney is expected to increase by almost 50 per cent over the next 20 years. Manufacturing, construction materials and wholesale/retail haulage are the top three freight activities that occur in greater Sydney, together accounting for more than half of freight activity, with the largest growth expected to occur in manufacturing and wholesale/retail. Road is by far the dominant mode for all of these freight activities. Figure 4-7 shows the mode share split of freight activities in 2016.

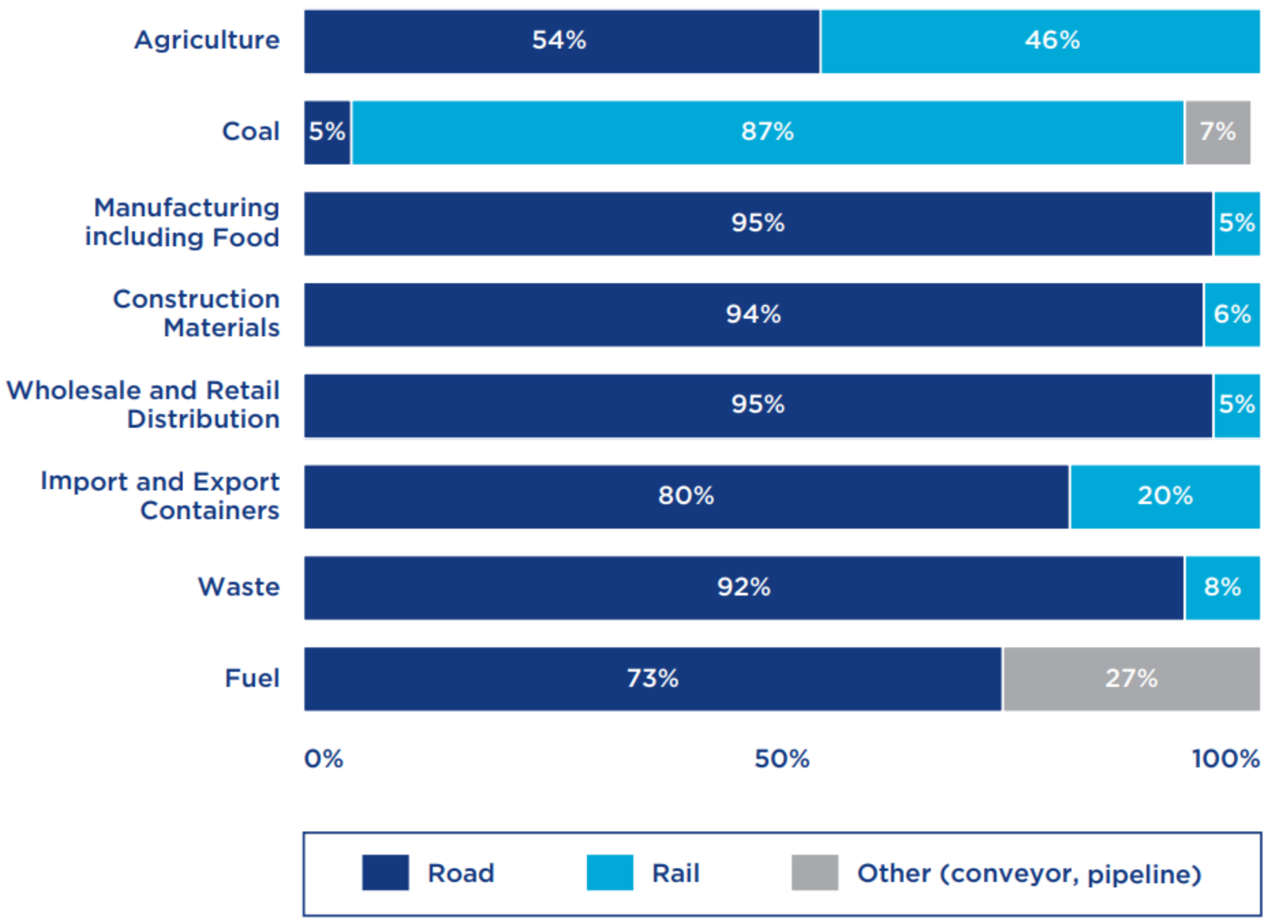

Figure 4-7 Freight mode share

Source: NSW Freight and Ports Plan 2018-2023 (Transport for NSW, 2018a)

The forecast growth in freight traffic has immediate implications for the capacity of the road network with the greatest impact generally on arterial roads where no motorway standard alternative exists. Heavy vehicle movements are expected to increase on ANZAC Bridge, the Western Distributor and in the Sydney Harbour Tunnel by 2036. More detailed forecasts of freight growth on these corridors are provided in Section 7.2.3.

The safe and efficient transport of freight throughout greater Sydney is highly dependent on the motorway network, with more than 37 per cent of all heavy vehicle kilometres of travel taking place on motorways and highways, despite these roads accounting for less than 17 per cent of the arterial road network. While rail freight will play an increasing role in serving the freight task, particularly in and around ports and intermodal terminals, access to freight rail is limited, particularly in the urban centre of Sydney, which means that roads will continue to play the dominant role in serving freight needs for the foreseeable future.

Current freight access across Sydney Harbour is limited to the following motorway and arterial roads:

- Sydney Harbour Bridge
- Sydney Harbour Tunnel
- ANZAC Bridge
- Victoria Road corridor (including Iron Cove Bridge, Gladesville Bridge and Fig Tree Bridge).

All of these are heavy commuter corridors and the movement of freight along these roads is limited by capacity constraints and congestion, particularly during peak periods.

A summary of existing heavy vehicle demands across Sydney Harbour is provided in Table 4-2. Analysis of these heavy vehicles indicates that truck movements across Sydney Harbour are relatively evenly distributed across the existing crossings. However, B-Doubles are not permitted to travel on the Sydney Harbour Bridge and dangerous goods vehicles are not permitted through the Sydney Harbour Tunnel. Gladesville Bridge is an unrestricted B-double alternative route to these crossings. Partially due to the high traffic delays on the Sydney Harbour Bridge and Sydney Harbour Tunnel, the majority of heavy vehicle travel across both these routes occurs outside peak periods.

Table 4-2 Modelled 2016 heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	Morning peak hour (veh)	Evening peak hour (veh)	Daily (veh)
Sydney Harbour Bridge	Bradfield Highway	Northbound	200	280	4600
		Southbound	160	130	2100
		Combined	*360*	*410*	*6700*
Sydney Harbour Bridge	Cahill Expressway	Southbound	20	10	600
Sydney Harbour Tunnel	Sydney Harbour	Northbound	150	130	2400
		Southbound	170	130	2300
		Combined	*320*	*260*	*4700*
Gladesville Bridge	Parramatta River	Northbound	140	110	2000
		Southbound	230	120	2200
		Combined	*370*	*230*	*4200*
Sydney Harbour screenline		**Northbound**	**490**	**520**	**9000**
		Southbound	**580**	**390**	**7200**
		Combined	***1070***	***910***	***16,200***
ANZAC Bridge	Pyrmont	Eastbound	190	140	3200
		Westbound	170	130	3000
		Combined	*360*	*270*	*6200*
Western Distributor	Sydney CBD	Northbound	150	190	3400
		Southbound	130	110	2300
		Combined	*280*	*300*	*5700*

4.1.4 Strategic model road network performance

A summary of the existing daily VKT and VHT of the Sydney region and the Western Harbour Tunnel and Beaches Link operational road traffic model area is provided in Table 4-3. Compared to the Sydney region, the Western Harbour Tunnel and Beaches Link operational road traffic model area accounts for a slightly higher proportion of motorway trips.

Table 4-3 Modelled 2016 daily VKT and VHT (SMPM)

Network measure	Road	Daily
Sydney region		
VKT	Motorway	22,594,000
	Other	71,656,000
	Total	*94,250,000*
VHT	Motorway	388,000
	Other	2,363,000
	Total	*2,751,000*
Western Harbour Tunnel and Beaches Link study area		
VKT	Motorway	4,821,000
	Other	14,300,000
	Total	19,121,000
VHT	Motorway	106,000
	Other	579,000
	Total	*685,000*

4.2 Rozelle and surrounds

The broad study area adopted for the traffic and transport assessment of Rozelle and surrounds is shown in Figure 4-8 and includes the suburbs of Balmain, Birchgrove and Rozelle.

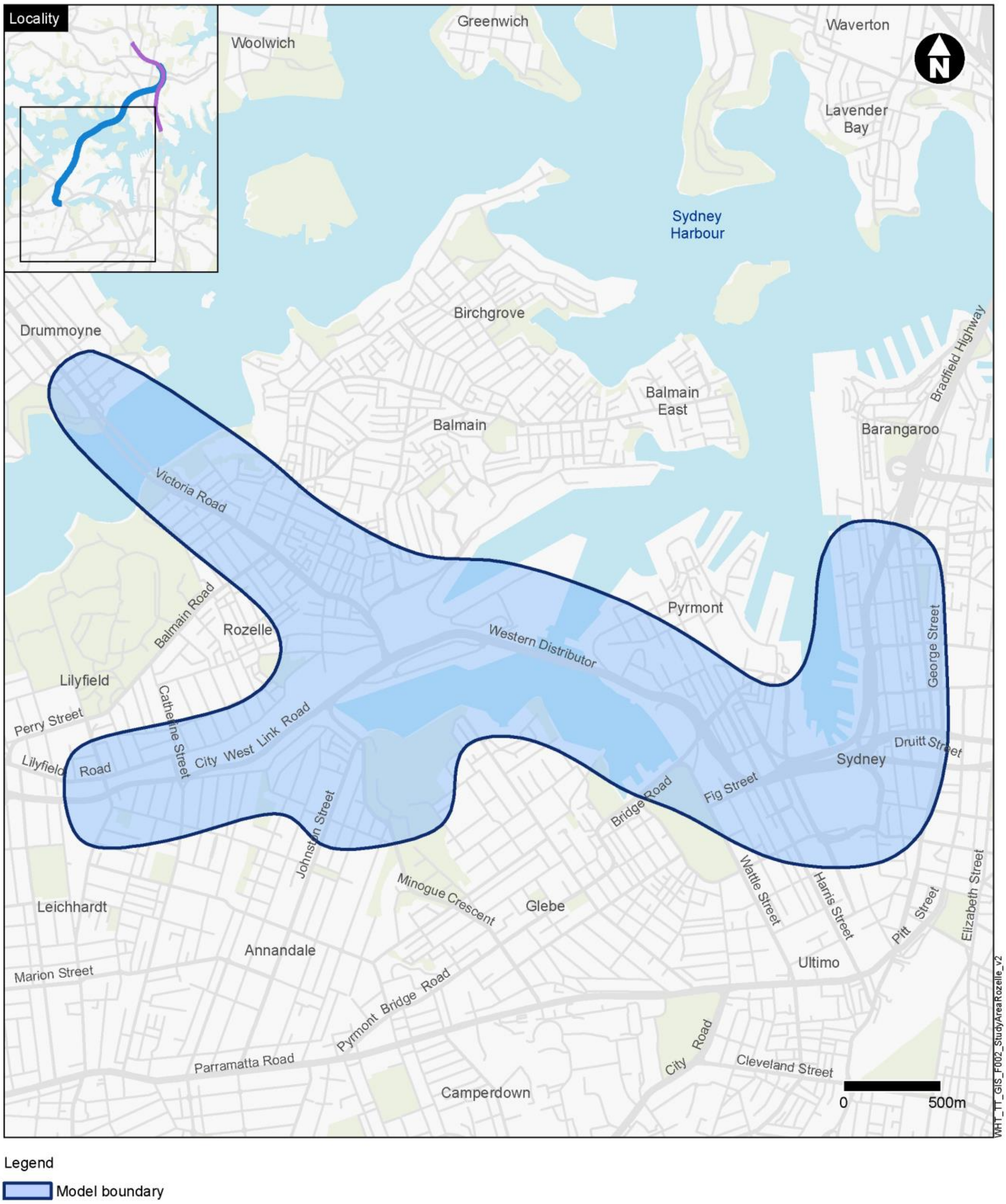

Figure 4-8 Rozelle and surrounds study area and operational model boundary

4.2.1 Modes of travel

Journey to work data for the Rozelle and surrounds study area (based on travel zones within the geographical suburb boundary) was analysed to determine travel patterns for residents and workers.

In 2011[5] the population in the Rozelle and surrounds study area was about 12,200. The mode share for residents travelling to their employment destinations is shown in Figure 4-9. Private vehicles accounted for 52 per cent of trips, with 48 per cent as vehicle drivers and four per cent as passengers. Public transport accounted for 35 per cent of trips, with 26 per cent by bus, five per cent by ferry or tram and four per cent by train. Walking accounted for seven per cent of trips. When compared to the Sydney average, the public transport mode share is relatively high and the private vehicle mode share is relatively low. This can be attributed to the locations where the majority of residents work, which are Sydney Inner City and Leichhardt. These locations are highly accessible by public transport from the Rozelle and surrounds study area, and parking is discouraged in the Sydney CBD through pricing mechanisms.

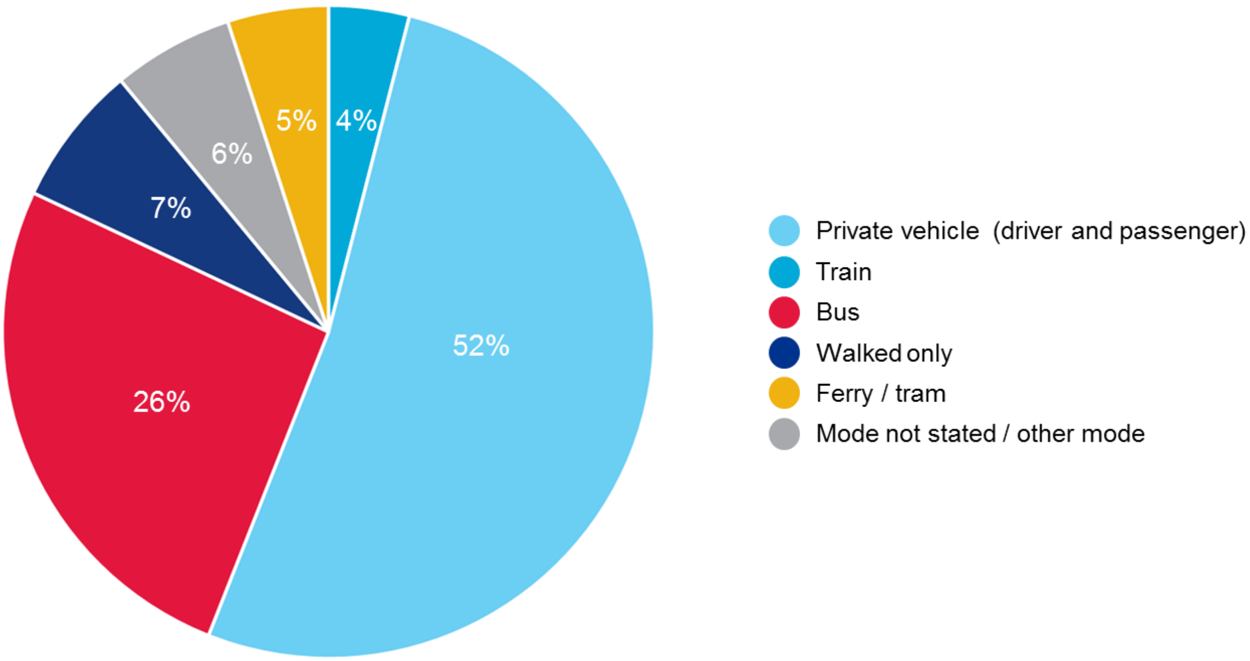

Figure 4-9 Mode share for residents in Rozelle and surrounds travelling to their relative employment destinations

Source: Journey to Work 2011 (Transport for NSW, 2017)

In 2011 there were about 7900 workers in the Rozelle and surrounds study area. The mode share for workers travelling to employment is shown in Figure 4-10. Private vehicles accounted for 70 per cent of trips, with 66 per cent as vehicle drivers and four per cent as passengers. Public transport accounted for 18 per cent of trips with nine per cent by bus, eight per cent by train and one per cent by ferry or tram. Walking accounted for nine per cent of trips. The mode share split between public transport and private vehicles is comparable to the Sydney average and can be attributed to the disparate locations across Sydney where workers live.

[5] Journey to work data is based on information collected in the 2011 Census. Analysis of information collected in the 2016 Census was not available at the time of writing.

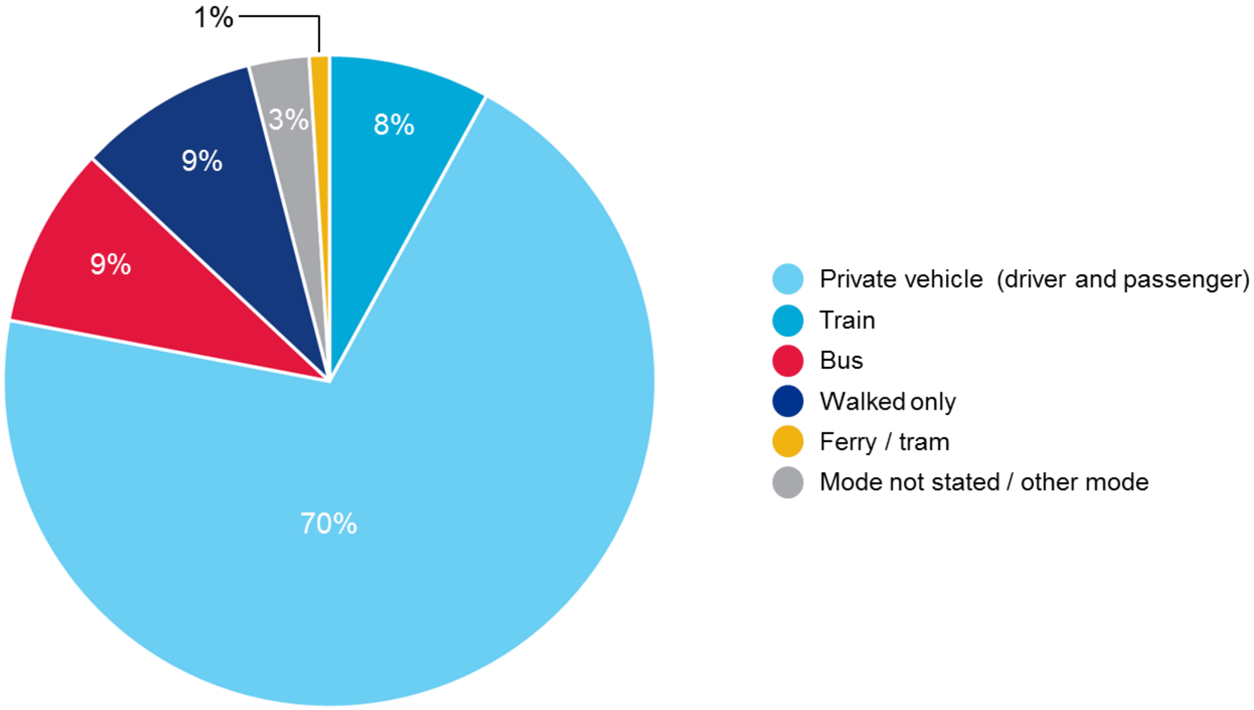

Figure 4-10 Mode share for workers travelling to employment in Rozelle and surrounds

Source: Journey to Work 2011 (Transport for NSW, 2017)

4.2.2 Road network key features

Key roads in the Rozelle and surrounds study area and their characteristics are summarised in Table 4-4.

Table 4-4 Summary of key roads – Rozelle and surrounds

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
A40 Victoria Road	Rozelle	Major arterial road 60 km/h	Six	Drummoyne, Gladesville, Ryde, Parramatta	Major bus corridor. Services to Sydney CBD, the Inner West, Ryde, Macquarie Park and Parramatta. Eastbound bus lane during weekday morning peak.	Clearways in operation during weekday peak periods and during daytime on weekends.
A4 City West Link/The Crescent	Rozelle	Major arterial road 70 km/h	Six	Inner West. Sydney Olympic Park, Parramatta, Blacktown, Penrith and the Blue Mountains (via M4 Western Motorway).	Local services to Sydney CBD, Glebe and Balmain.	24-hour clearway in operation.

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
A4 ANZAC Bridge/Western Distributor	Rozelle, Pyrmont	Major arterial road 60 km/h	Eight	Sydney CBD, North Sydney	Major bus corridor. Services to Sydney CBD, the Inner West, Ryde, Macquarie Park and Parramatta.	24-hour clearway in operation.
Johnston Street	Annandale	Collector road 50 km/h	Four	Annandale, Rozelle and Balmain (via Victoria Road)	N/A	N/A
Darling Street	Rozelle, Balmain	Collector road 40 km/h north of Victoria Road, 50 km/h south of Victoria Road	Two	Rozelle and Balmain local town centres	Local services to Sydney CBD, Leichhardt and Campsie.	N/A
Robert Street	Rozelle	Collector road 40 km/h	Up to four (variable, depending on location)	White Bay berths 3 to 6	Local services to Sydney CBD, Balmain East and Birchgrove.	N/A
James Craig Road/ Sommerville Road	Rozelle	Local road 50 km/h	Two	White Bay Cruise Terminal and other maritime-related land uses in Rozelle Bay, Glebe Island and White Bay	N/A	N/A

4.2.3 Traffic volumes and patterns

City West Link, The Crescent and Victoria Road are major arterial roads that carry high volumes of traffic in both directions, generally between 1660 and 4060 vehicles per hour. Eastbound volumes on City West Link and The Crescent are similar or higher than the westbound direction during the morning and evening peak hour. Victoria Road exhibits a southbound morning peak direction and a northbound evening peak direction.

Lower traffic volumes are experienced on James Craig Road, with up to 260 vehicles per hour in each direction.

Heavy vehicles generally comprise between three and seven per cent of all traffic in the Rozelle and surrounds study area. Heavy vehicle proportions are typically higher in the morning peak hour compared to the evening peak hour.

The midblock volumes on key access roads in the Rozelle and surrounds study area are summarised in Table 4-5.

Table 4-5 Year 2016 peak hour traffic volumes – Rozelle and surrounds

Road	Direction	Morning peak hour		Evening peak hour	
		Volume (vehicles)	Heavy vehicle percentage	Volume (vehicles)	Heavy vehicle percentage
City West Link west of The Crescent	Eastbound	2630	4%	2350	3%
	Westbound	1660	7%	2140	6%
James Craig Road south of The Crescent	Eastbound	260	5%	120	3%
	Westbound	140	5%	140	3%
The Crescent west of Victoria Road	Eastbound	3590	5%	2950	3%
	Westbound	2390	6%	3090	5%
Victoria Road north of The Crescent	Northbound	2090	6%	3710	5%
	Southbound	4060	6%	2930	5%

4.2.4 Road network performance

City West Link and Victoria Road through Rozelle are two of the busiest road corridors in Sydney, providing access to and from the Sydney CBD for people living and working in Sydney's West, Inner West and Lower North Shore. The majority of traffic travelling through this corridor is heading to and from the Sydney CBD or to the Lower North Shore and Northern Beaches via ANZAC Bridge, the Western Distributor and the Sydney Harbour Bridge.

Although City West Link and Victoria Road carry high traffic volumes at all times of the day, due to the highly directional nature of traffic flow during peak periods, the Victoria Road corridor has active traffic management infrastructure to dynamically change traffic capacities inbound and outbound during peak periods. Key features of the tidal flow traffic facilities along the Victoria Road corridor include:

- A moveable central median between Seymour Street in Drummoyne and Iron Cove Bridge
- A kerbside bus lane during the morning peak period between Seymour Street in Drummoyne and Iron Cove Bridge as well as Iron Cove Bridge and Darling Street in Rozelle
- Dynamic lane management of right turn lanes at Darling Street and The Crescent
- Right turn ban from Robert Street to Victoria Road in the morning peak.

Congestion and delays on Victoria Road and City West Link are highest during the morning peak period, with the key constraints to traffic flows headed to the Sydney CBD on Victoria Road at Terry Street, Darling Street and Robert Street in Rozelle where right turns are permitted, and on City West Link at Balmain Road, Catherine Street and The Crescent. The two-lane grade-separated eastbound movement on The Crescent at Victoria Road is also a major constraint, due to the merge arrangement for these two lanes into the accompanying two lane eastbound movement from Victoria Road, which limits the volume of eastbound traffic on the ANZAC Bridge. East of ANZAC Bridge, merging and weaving activity over a short distance to Pyrmont Bridge Road, Bathurst Street and Western Distributor results in congestion and reduced speeds.

In the evening peak, the primary constraint for westbound traffic is the right turn movement from ANZAC Bridge to Victoria Road, which frequently queues across the ANZAC Bridge and onto the Western Distributor. Westbound congestion and queuing are also observed on the approaches to Evans Street in Rozelle, where steep grades slow down buses travelling in the kerbside lane, and at Darling Street. Northbound traffic on The Crescent also experiences high delays due to the limited capacity of the intersection of Johnston Street and The Crescent.

Further east of Rozelle, ANZAC Bridge and the Western Distributor form the main motorway network on the western side of the Sydney CBD, facilitating high traffic demands for travel both into and through the Sydney CBD and further north across Sydney Harbour to North Sydney and the Northern Beaches. The ANZAC Bridge operates close to capacity in both directions during peak periods. A high degree of weaving, merging and diverging activity occurs on the Western Distributor around the Bathurst Street and King Street exits. In addition, the weave movement from the Western Distributor to the Bradfield Highway occurs over a short 200 metre distance, all of which generates delay and reduces capacity through this section of the motorway.

A summary of the modelled network performance statistics for the Rozelle and surrounds study area is provided in Table 4-6.

Table 4-6 Modelled 2016 morning and evening peak network performance through Rozelle and surrounds

Network measure	Morning peak period	Evening peak period
Network statistics for all vehicles		
Total traffic demand (veh)	41,900	43,200
Total VKT through network	115,800	123,000
Total vehicle travel time through the network (hours)	5660	4880
Total number of stops	406,500	214,600
Average vehicle statistics		
Average vehicle trip length through the network (km)	2.7	2.7
Average vehicle trip time through the network (hours)	0:07:49	0:06:26
Average number of stops per trip	9.4	4.7
Average trip speed	20.5	25.2
Unreleased traffic		
Total unreleased trips	2020	1190
% of demand unreleased	4%	2%

4.2.5 Intersection performance

Modelled performance for key intersections in the Rozelle and surrounds study area under 2016 travel demands are presented in Table 4-7. Modelled intersection performance indicates that the following intersections are currently performing at a relatively poor Level of Service (LoS E or F):

- Victoria Road and Darling Street
- Victoria Road and Gordon Street
- Victoria Road and Robert Street
- Victoria Road and The Crescent
- The Crescent and Johnson Street
- City West Link and Balmain Road.

These locations generally reflect the key constraints along Victoria Road and City West Link, where high through-traffic volumes conflict with right turning or cross-street traffic. The majority of major intersections along Victoria Road are at or close to their capacity during peak periods.

Table 4-7 Modelled 2016 morning and evening peak hour intersection performance in Rozelle and surrounds

Intersection	Morning peak hour		Evening peak hour	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
Victoria Road/Darling Street	85	F	75	F
Victoria Road/Evans Street	43	D	48	D
Victoria Road/Gordon Street	21	B	63	E
Victoria Road/Robert Street	49	D	>100	F
Victoria Road/The Crescent	27	B	88	F
The Crescent/James Craig Road	10	A	25	B
The Crescent/City West Link	21	B	55	D
The Crescent/Johnston Street	42	C	89	F
City West Link/Catherine Street	38	C	15	B
City West Link/Balmain Road	72	F	51	D

4.2.6 Road safety and crash history

A summary of crash data for the five-year period between October 2012 and September 2017 on roads that would be substantially affected by the project (based on forecast traffic demand with and without the project) is presented in Table 4-8.

Key statistics include:

- Sixty-one per cent of crashes (270 crashes) resulted in at least one injury
- Two crashes resulted in a fatality; one on City West Link and one on Victoria Road
- Twenty-eight per cent of crashes (125 crashes) involved a heavy vehicle, with the majority occurring on Victoria Road
- Six per cent of crashes (27 crashes) involved a cyclist or pedestrian
- The three most common crash types involved vehicles travelling in the same direction (70 per cent), vehicles veering off path and onto a straight section of road (seven per cent), and crashes at an intersection involving vehicles from adjacent approaches (six per cent)
- Fifty-six per cent of crashes occurred at a midblock, while 44 per cent of crashes occurred at an intersection.

Table 4-8 Crash history summary – Rozelle and surrounds

Road segment	Number of crashes by severity				Top 3 crash types	Number of pedestrian and cyclist crashes	Number of heavy vehicle crashes	% of midblock and intersection crashes
	Fatality	Injury	Non-injury	Total				
City West Link	1	56	40	97	• Vehicles from same direction (74%) • Opposing vehicles (8%) • Intersection, adjacent approaches (6%).	1 cyclist crash	30	72% intersection, 28% midblock
The Crescent	0	8	7	15	• Vehicles from same direction (73%) • Manoeuvring (13%) • Veering off path on a straight (13%).	1 cyclist crash	5	71% midblock, 29% intersection
Victoria Road	1	147	84	232	• Vehicles from same direction (68%) • Intersection, adjacent approaches (9%) • Veering off path on a straight (7%).	10 pedestrian crashes and 14 cyclist crashes	64	52% midblock, 48% intersection
Western Distributor	0	59	43	102	• Vehicles from same direction (72%) • Veering off path on a straight (8%) • Veering off path on a curve (7%).	1 pedestrian crash	26	92% midblock, 8% intersection
Total	2	270	174	446	• Vehicles from same direction (70%) • Veering off path on a straight (7%) • Intersection, adjacent approaches (6%).	11 pedestrian crashes and 16 cyclist crashes	125	56% midblock, 44% intersection

A summary of casualty crashes for the five-year period between October 2012 and September 2017 on roads that would be substantially impacted by the project (based on forecast traffic demand with and without the project) is presented in Table 4-9.

Key road safety issues in the Rozelle and surrounds study area include:

- Relatively high crash rates are observed on Victoria Road (45.3 crashes per 100 million VKT), and City West Link (40.6 crashes per 100 million VKT)
- Casualty crash rates on City West Link, Victoria Road and the Western Distributor exceed the Sydney region average for their respective similar type of road. These roads are operating at or above capacity for extended periods and experience substantial congestion during peak periods, contributing to the higher than average crash rates observed.

Table 4-9 Casualty crashes analysis – Rozelle and surrounds

Road segment	Length	AADT	Crash rate per 100 million VKT	Casualty crashes per km per year	Casualty crashes (Sydney average)[6]
City West Link	2.2 km	58,800	40.6	5.1	3.0
The Crescent	1.5 km	19,400	24.1	1.1	2.6
Victoria Road	3.8 km	80,800	45.3	7.8	3.0
Western Distributor	3.4 km	89,700	11.8	3.5	3.0

4.2.7 Public transport network

The Rozelle and surrounds study area is highly accessible by public transport. Light rail services are provided at the Rozelle Bay stop, which is located near the intersection of City West Link and The Crescent. The L1 Dulwich Hill Line provides direct connections to Pyrmont, Leichhardt, and Central and Dulwich Hill railway stations. There are about 300 timetabled services on weekdays and 200 services on weekends and public holidays.

The Rozelle and surrounds study area is a major thoroughfare for buses with 26 routes and about 1700 timetabled services on weekdays, 1000 services on Saturdays and 800 services on Sundays and public holidays. Bus services are operated by Sydney Buses and Transit Systems NSW. Victoria Road and ANZAC Bridge are major bus corridors for services to Sydney CBD, the Inner West, Ryde, Macquarie Park and Parramatta. Bus route maps are shown in Figure 4-11 (Sydney Buses) and Figure 4-12 (Transit Systems NSW).

Ferry services are also accessible from the Rozelle and surrounds study area. The existing ferry network is discussed in Section 4.5.

[6] Roads and Maritime Services, 2017

Figure 4-11 Bus routes – Rozelle and surrounds – Sydney Buses

Source: North Shore & West region guide (Transport for NSW, 2019a)

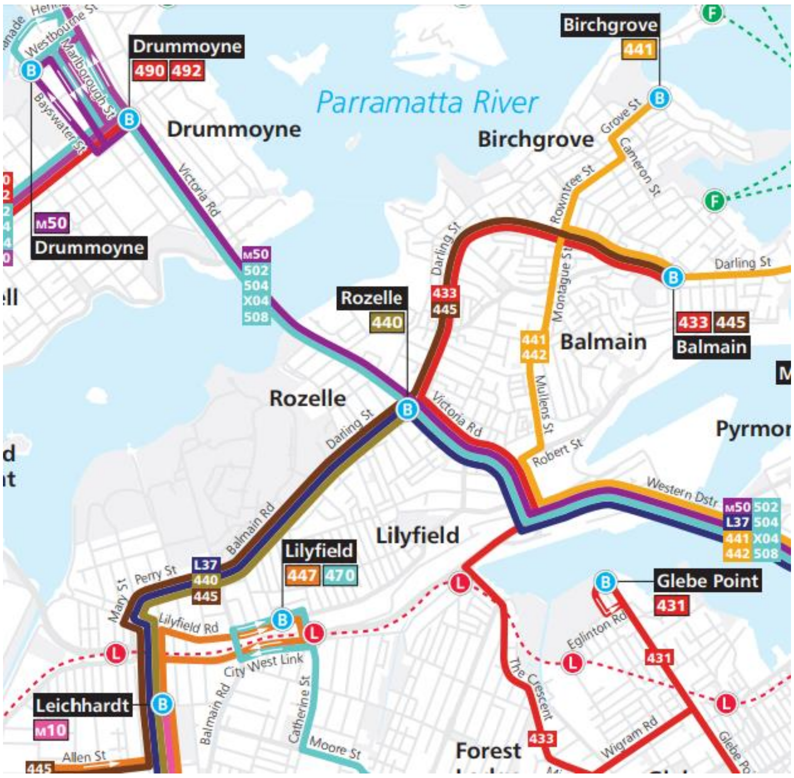

Figure 4-12 Bus routes – Rozelle and surrounds – Transit Systems NSW

Source: Inner West and Southern region network (Transit Systems NSW, 2019)

4.2.8 Active transport network

The pedestrian network in the Rozelle and surrounds study area is well developed, with footpaths provided alongside the majority of roads and controlled crossings provided at most signalised intersections. A high level of pedestrian activity associated with the Rozelle and Balmain local town centre occurs along Victoria Road and Darling Street. Two shared user bridges span Victoria Road – one about 90 metres north of The Crescent and the other about 70 metres east of The Crescent.

The cycle network in the Rozelle and surrounds study area is shown in Figure 4-13 and consists of a mixture of off-road shared user paths and on-road cycle routes on local and collector roads. The regional strategic cycle network provides connections between the study area and the Sydney CBD, North Sydney, Redfern, Green Square, Sydney Airport, Pyrmont, Surry Hills, Haberfield and Summer Hill. Off-road shared user paths are provided at the following locations:

- Victoria Road between The Crescent and Drummoyne
- ANZAC Bridge
- Along the foreshores of Iron Cove, Rozelle Bay and Blackwattle Bay.

A shared user land bridge connecting Rozelle Rail Yards to The Crescent would also be provided as part of the approved M4-M5 Link.

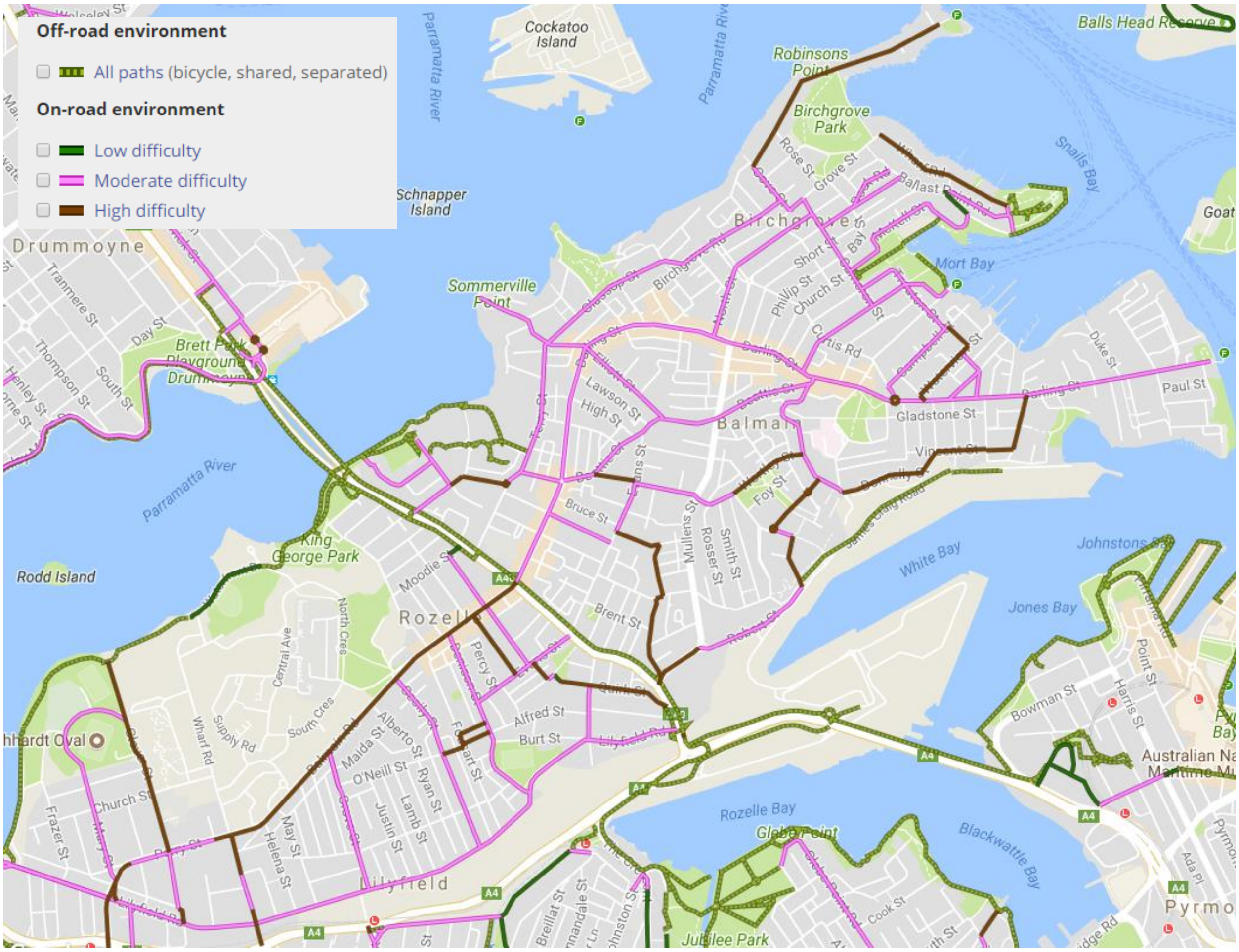

Figure 4-13 Cycle network in Rozelle and surrounds

Source: Cycleway Finder (Roads and Maritime, 2018)

4.3 Warringah Freeway and surrounds

The broad study area adopted for the traffic and transport assessment of the Warringah Freeway and surrounds is shown in Figure 4-14 and includes the suburbs of Cammeray, Crows Nest, Naremburn, Neutral Bay, North Sydney and Waverton.

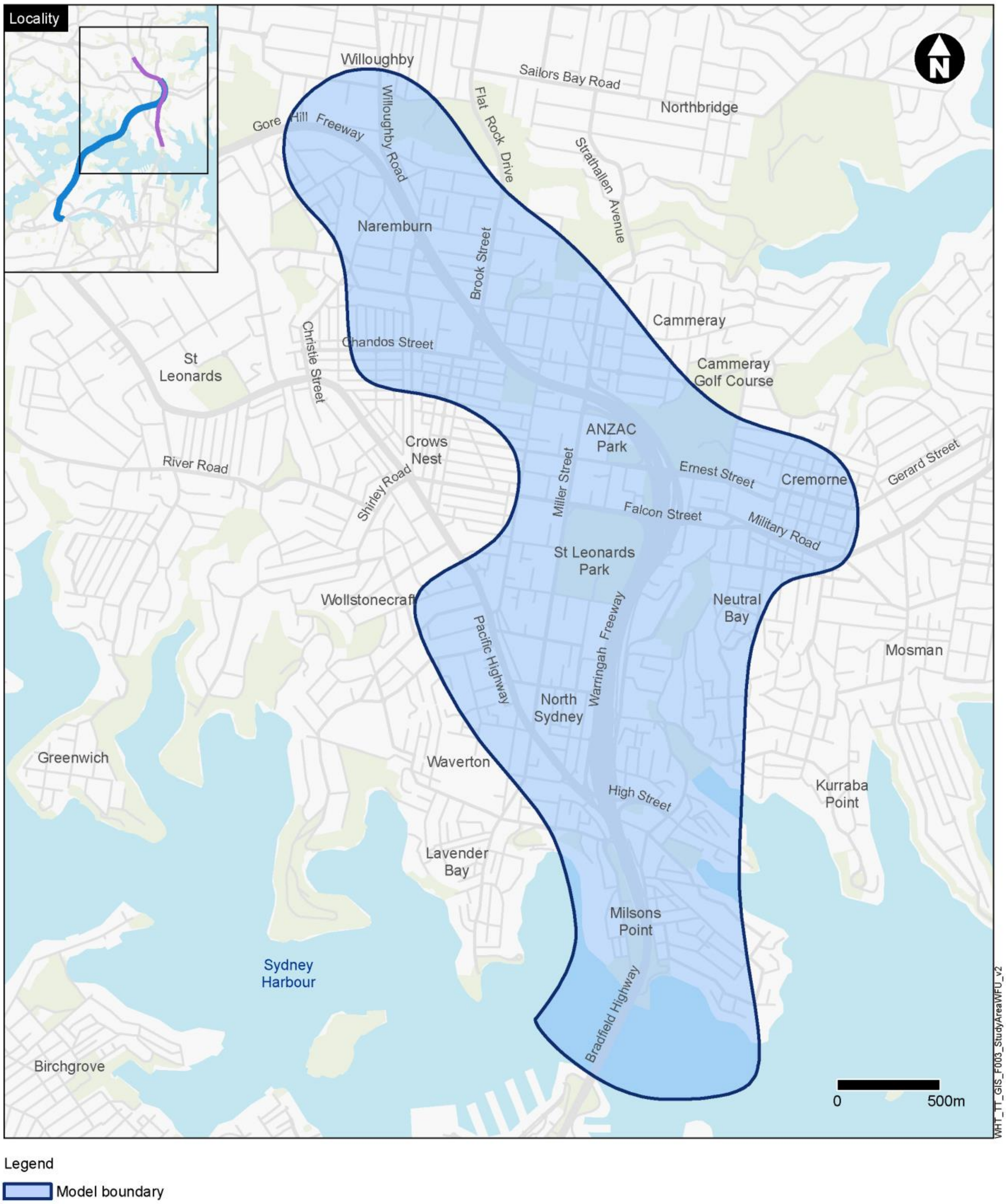

Figure 4-14 Warringah Freeway and surrounds study area and operational model boundary

4.3.1 Modes of travel

Journey to work data for the Warringah Freeway and surrounds study area (based on travel zones within the geographical suburb boundary) was analysed to determine travel patterns for residents and workers.

In 2011[7] the population in the Warringah Freeway and surrounds study area was 15,500. The mode share for residents travelling to their employment destinations is shown in Figure 4-15. Public transport accounted for 41 per cent of trips, with 21 per cent by train, 19 per cent by bus and one per cent by ferry or tram. Private vehicles accounted for 40 per cent of trips, with 37 per cent as vehicle drivers and three per cent as passengers. Walking accounted for 15 per cent of trips. When compared to the Sydney average, the public transport mode share is relatively high and the private vehicle mode share is relatively low. This can be attributed to the locations where the majority of residents work which are highly accessible by public transport, and include Sydney Inner City, North Sydney–Mosman and Chatswood–Lane Cove.

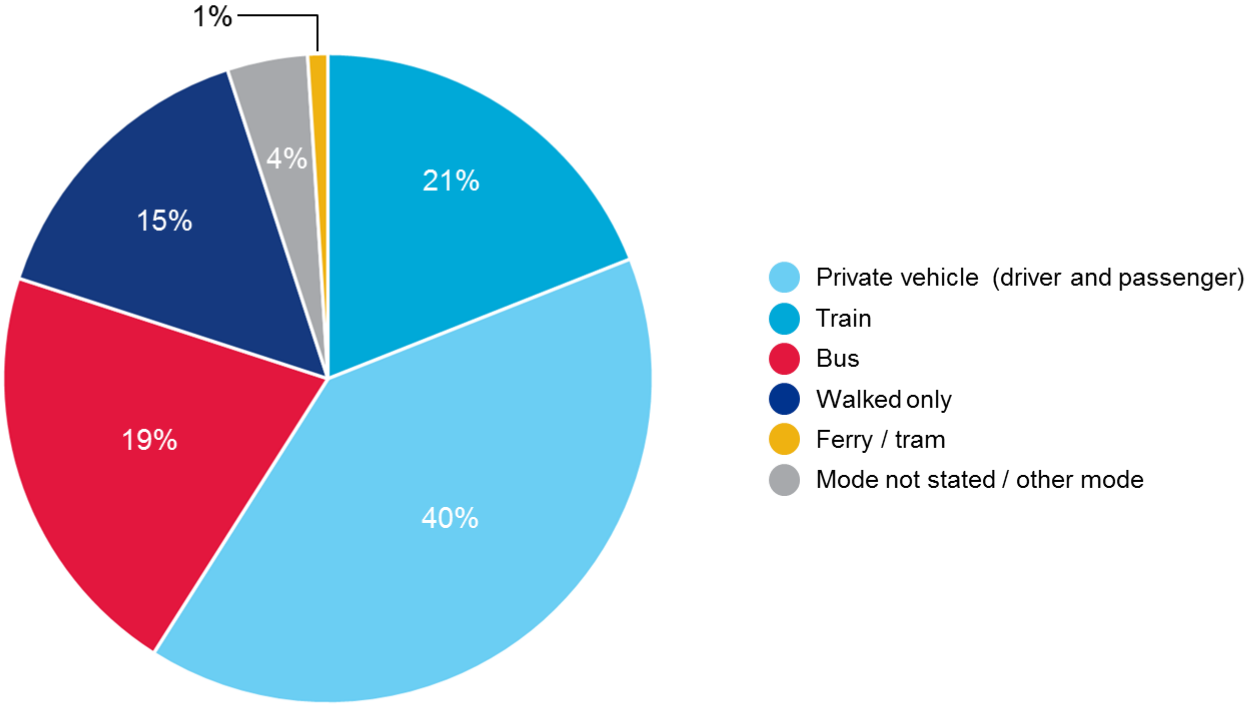

Figure 4-15 Mode share for residents in Warringah Freeway and surrounds travelling to their relative employment destinations

Source: Journey to Work 2011 (Transport for NSW, 2017)

In 2011 there were 47,000 workers in the Warringah Freeway and surrounds study area. The mode share for workers travelling to employment is shown in Figure 4-16. Public transport accounted for 53 per cent of trips, with 42 per cent by train and 11 per cent by bus. Private vehicles accounted for 37 per cent of trips, with 34 per cent as vehicle drivers and three per cent as passengers. Walking accounted for seven per cent of trips. When compared to the Sydney average, the public transport mode share is relatively high and the private vehicle mode share is relatively low. This can be attributed to the locations where the majority of workers live, which are North Sydney–Mosman, Chatswood–Lane Cove, and Sydney Inner City. The Warringah Freeway and surrounds study area is highly accessible by public transport from these locations and parking is discouraged within North Sydney CBD through pricing mechanisms.

[7] Journey to work data is based on information collected in the 2011 Census. Analysis of information collected in the 2016 Census was not available at the time of writing.

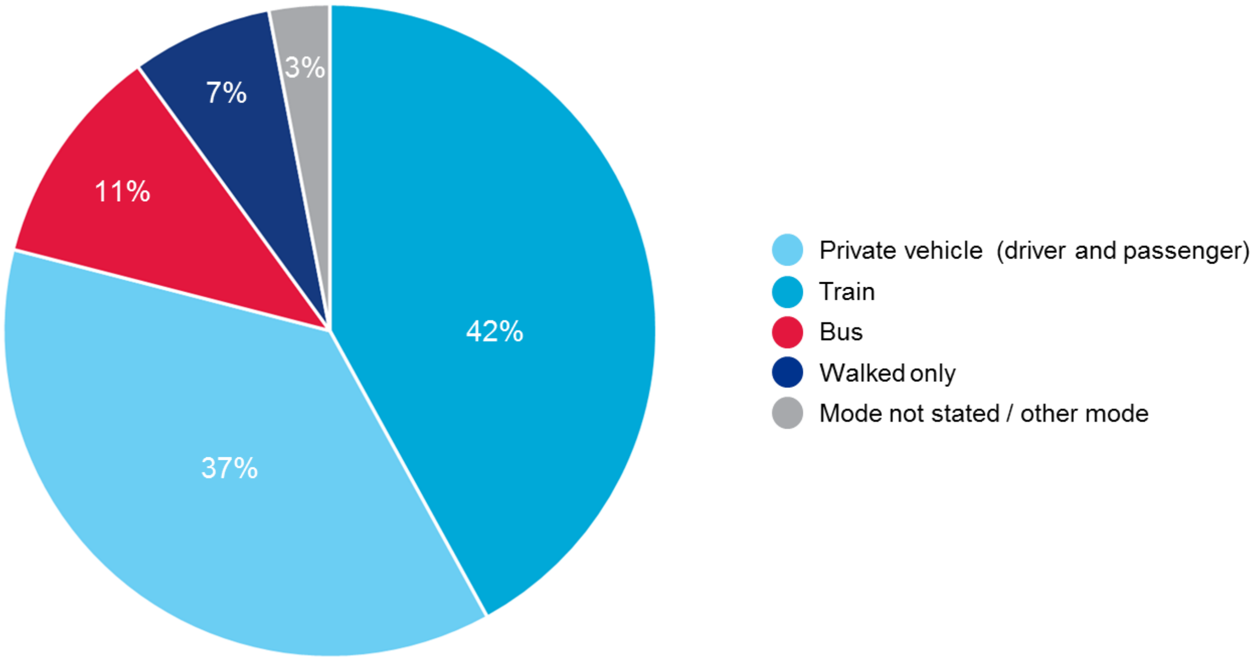

Figure 4-16 Mode share for workers travelling to employment in Warringah Freeway and surrounds

Source: Journey to Work 2011 (Transport for NSW, 2017)

4.3.2 Road network key features

Key roads in the Warringah Freeway and surrounds study area and their characteristics are summarised in Table 4-10.

Table 4-10 Summary of key roads – Warringah Freeway and surrounds

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
M1 Warringah Freeway	North Sydney, Cammeray	Motorway 80 km/h	Up to 16 (variable, depending on location)	Connectivity to the Sydney metropolitan area as part of the Sydney Orbital Network.	Major bus corridor. Services to Sydney CBD, Northern Beaches, North Shore and the Hills District. Southbound 24-hour bus lane.	Tidal flow in operation during weekday peak periods.
Sydney Harbour Bridge (Bradfield Highway/Cahill Expressway)	Sydney CBD, Milsons Point	Motorway 70 km/h	Eight (six lanes on Bradfield Highway, two lanes on Cahill Expressway)	Connectivity to the Sydney metropolitan area as part of the Sydney Orbital Network.	Major bus corridor. Services to Sydney CBD, Northern Beaches, North Shore, Hills District. Cahill Expressway southbound 24-hour bus lane.	Tidal flow in operation during weekday peak periods.

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
Sydney Harbour Tunnel	Sydney CBD, Milsons Point	Motorway 80 km/h	Four	Connectivity to the Sydney metropolitan area as part of the Sydney Orbital Network.	N/A	N/A
Pacific Highway	North Sydney, Waverton	Major arterial road 60 km/h	Six	St Leonards, Chatswood, Pymble, Hornsby, Central Coast and Newcastle (via M1 Pacific Motorway).	Major bus corridor. Services to Sydney CBD, Chatswood, Epping, Gladesville and the Hills District.	Clearways in operation during weekday peak periods.
Falcon Street/Military Road	North Sydney, Neutral Bay	Major arterial road 60 km/h	Up to ten (variable, depending on location)	Crows Nest, Mosman, Northern Beaches.	Major bus corridor. Services to Sydney CBD, Chatswood, Mosman and Northern Beaches. Westbound bus lane during weekday morning peak.	Clearways in operation during weekday peak periods.
Ernest Street	Cammeray, Neutral Bay	Sub-arterial road 50 km/h	Four	Crows Nest, Cremorne, Mosman.	Local services to Sydney CBD, Crows Nest and Chatswood.	Clearways in operation during weekday peak periods.
Miller Street	North Sydney, Cammeray	Sub-arterial road 40 km/h (in North Sydney CBD), 50 km/h elsewhere	Up to six (variable, depending on location)	Northbridge, Chatswood, Northern Beaches (via Eastern Valley Way/Warringah Road).	Services to Sydney CBD, Northbridge, Willoughby and East Lindfield.	Clearways in operation during weekday peak periods.
Brook Street/Flat Rock Drive	Crows Nest, Naremburn	Sub-arterial road 60 km/h	Four	St Leonards, Willoughby, Northern Beaches (via Eastern Valley Way/Warringah Road).	Services to Sydney CBD and the Forest District.	Clearways in operation during weekday peak periods.
Willoughby Road	Naremburn, Willoughby	Sub-arterial road 60 km/h	Up to four (variable, depending on location)	St Leonards, Crows Nest, Chatswood (via Mowbray Road).	Local services to Sydney CBD, Chatswood and Willoughby.	Clearways in operation during weekday peak periods.
Berry Street	North Sydney	Sub-arterial road 40 km/h	Up to four (variable depending on location)	Provides access from North Sydney to Warringah Freeway northbound and Bradfield Highway/Cahill Expressway southbound.	Services to Sydney CBD via Miller Street.	Clearways in operation during weekday peak periods.

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
Arthur Street	North Sydney	Sub-arterial road 40 km/h	Three	Provides access from North Sydney to Warringah Freeway southbound.	Services to Sydney CBD. Bus only lane south of Mount Street during weekday morning peak.	Clearways in operation during weekday peak periods. Tidal flow in operation south of Mount Street during weekday morning peak.
High Street	North Sydney	Sub-arterial road 60 km/h	Three	Provides access between North Sydney, Kirribilli and Neutral Bay.	Local services to Sydney CBD, Cremorne and Crows Nest.	Clearways in operation during weekday peak periods.
Mount Street	North Sydney	Local road 40 km/h	Two	North Sydney, Neutral Bay and access to Warringah Freeway.	Services to Sydney CBD from Arthur Street.	N/A
Walker Street	North Sydney	Local road 40 km/h	Up to three (variable depending on location)	North Sydney, Sydney CBD (via Berry Street/Warringah Freeway).	N/A	Clearways in operation during weekday peak periods.
Alfred Street North	Neutral Bay	Local road 60 km/h	Up to four (variable depending on location)	North Sydney, Neutral Bay.	N/A	N/A
Balls Head Drive/Balls Head Road	Waverton	Local road 10 km/h (Balls Head Drive), 50 km/h (Balls Head Road)	Two	Balls Head Reserve.	N/A	N/A
Bay Road	Waverton	Local road 50 km/h	Two	Waverton railway station.	Local services to Lane Cove and Crows Nest.	N/A
Ridge Street	North Sydney	Local road 50 km/h	Two	St Leonards Park. Pedestrian and cycle route linking North Sydney and Neutral Bay via Warringah Freeway overpass.	N/A	N/A
Amherst Street	Cammeray	Local road 50 km/h	Two	Cammeray Golf Club.	N/A	N/A
Belgrave Street	Cremorne	Sub-arterial road 50 km/h	Four	Cremorne, Mosman.	N/A	Clearways in operation during weekday peak periods.

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
Gerard Street	Cremorne	Sub-arterial road 50 km/h	Four	Cremorne, Mosman.	Local services between Sydney CBD and Spit Junction.	Clearways in operation during weekday peak periods.
Macpherson Street	Cremorne, Mosman	Sub-arterial road 50 km/h	Four	Cremorne, Mosman.	Local services between Sydney CBD and Spit Junction.	Clearways in operation during weekday peak periods.
Cowles Road	Mosman	Collector road 50 km/h	Two	Mosman, Spit Junction.	N/A	N/A

4.3.3 Traffic volumes and patterns

The Pacific Highway and Falcon Street are major arterial roads that carry high traffic volumes. The Pacific Highway south of Walker Street exhibits a northbound morning and evening peak direction as this section of the Pacific Highway accommodates trips from the Sydney Harbour Bridge to North Sydney. Falcon Street east of Miller Street carries traffic volumes greater than 1000 vehicles per hour in each direction. Falcon Street west of Merlin Street accommodates trips between the Warringah Freeway and the North Shore, resulting in higher traffic volumes of at least 2000 vehicles per hour in each direction.

Sub-arterial roads such as Berry Street, Miller Street, Ernest Street and Brook Street also carry high traffic volumes ranging between 1050 and 2390 vehicles per hour in the peak direction. Alfred Street north of Mount Street accommodates a high volume of traffic in the southbound direction during both peak hours, with the majority comprising vehicles that exit the Warringah Freeway to access North Sydney, Kirribilli and Milsons Point. Local roads including Bay Road, Ridge Street and Blue Street carry lower volumes of traffic, generally less than 500 vehicles per hour in each direction,

The midblock volumes on key access roads in the Warringah Freeway and surrounds study area are summarised in n Table 4-11.

Table 4-11 Year 2016 peak hour traffic volumes – Warringah Freeway and surrounds

Road	Direction	Morning peak hour		Evening peak hour	
		Volume (vehicles)	Heavy vehicle percentage	Volume (vehicles)	Heavy vehicle percentage
Pacific Highway south of Walker Street	Northbound	2100	4%	1410	11%
	Southbound	380	13%	580	6%
Pacific Highway south of Bay Road	Northbound	690	8%	800	7%
	Southbound	1100	7%	950	3%
Bay Road west of Pacific Highway	Eastbound	230	2%	260	1%
	Westbound	380	4%	280	2%
Berry Street east of Walker Street	Eastbound	1650	7%	2390	4%
	Westbound	-	-	-	-
Falcon Street east of Miller Street	Eastbound	1250	2%	1350	6%

Road	Direction	Morning peak hour		Evening peak hour	
		Volume (vehicles)	Heavy vehicle percentage	Volume (vehicles)	Heavy vehicle percentage
	Westbound	1170	6%	1110	5%
Ridge Street east of Miller Street	Eastbound	330	5%	130	2%
	Westbound	160	9%	260	4%
Miller Street north of Ernest Street	Northbound	470	6%	730	8%
	Southbound	1050	4%	1060	3%
Ernest Street east of Miller Street	Eastbound	1070	4%	1380	4%
	Westbound	1050	1%	870	2%
Ernest Street west of Merlin Street	Eastbound	650	3%	2000	1%
	Westbound	2070	1%	990	1%
Blue Street south of Pacific Highway	Northbound	330	3%	500	1%
	Southbound	290	3%	220	1%
Arthur Street north of Pacific Highway	Northbound	800	2%	610	1%
	Southbound	-	-	-	-
Alfred Street north of Mount Street	Northbound	40	9%	30	0%
	Southbound	1420	1%	730	3%
Falcon Street west of Merlin Street	Eastbound	2330	7%	2910	5%
	Westbound	3140	6%	2110	8%
Walker Street north of Pacific Highway	Northbound	830	3%	650	2%
	Southbound	290	2%	360	3%
Brook Street south of Merrenburn Avenue	Northbound	720	9%	1660	2%
	Southbound	2070	2%	1020	6%

4.3.4 Road network performance

The Warringah Freeway is the busiest section of motorway in NSW and provides access to and from the Sydney CBD, southern Sydney, Inner West, the Northern Beaches and North Shore of Sydney. Although the Warringah Freeway carries high traffic volumes at all times of the day, due to the highly directional nature of traffic flow during peak periods, the central carriageway of the Warringah Freeway, between Ernest Street and High Street, is reversible and operates in the southbound direction in the morning peak period and northbound at other times.

Congestion and delays on the Warringah Freeway are highest during the morning peak period, when southbound traffic travelling to both the Sydney Harbour Tunnel and Sydney Harbour Bridge is accommodated by the southbound permanent and reversible carriageways with queues frequently extending as far north as Miller Street. During the evening peak, queuing and congestion are frequently observed on the northbound off ramp to Falcon Street eastbound.

The North Sydney CBD is located to the west of the Warringah Freeway on either side of the Pacific Highway and has direct access to the Warringah Freeway at Berry Street, Mount Street, High Street and Pacific Highway. Queuing and congestion are frequently observed on these roads during both morning and evening peak periods, with queues on Berry Street frequently extending to the intersection of Pacific Highway and Bay Street.

Falcon Street provides access from the Lower North Shore to the Northern Beaches and from the Northern Beaches to the Warringah Freeway and the Sydney CBD. Falcon Street carries high traffic volumes at all times of the day and queuing is frequently observed in the westbound direction in the morning peak, with queues extending east of the intersection of Military Road and Ben Boyd Road, and in the eastbound direction in the evening peak due to downstream constraints along Military Road through Neutral Bay and Cremorne.

A summary of modelled network performance statistics for the Warringah Freeway and surrounds study area is provided in Table 4-12.

Table 4-12 Modelled 2016 morning and evening peak network performance – Warringah Freeway and surrounds

Network measure	Morning peak period	Evening peak period
Network statistics for all vehicles		
Total traffic demand (veh)	96,700	101,200
Total VKT through network	339,900	331,800
Total vehicle travel time through the network (hours)	9070	8550
Total number of stops	580,000	357,700
Average vehicle statistics		
Average vehicle trip length through the network (km)	3.6	3.3
Average vehicle trip time through the network (hours)	0:05:45	0:05:05
Average number of stops per trip	6.1	3.6
Average trip speed (km/hr)	37.5	38.8
Unreleased traffic		
Total unreleased trips	2090	370
% of demand unreleased	2%	<1%

4.3.5 Intersection performance

Modelled performance for key intersections in the Warringah Freeway and surrounds study area under 2016 travel demands are presented in Table 4-13. Modelled intersection performance indicates that the following intersections are currently performing at a poor Level of Service during peak periods:

- Mount Street and Arthur Street
- Clark Road and High Street.

The intersection of Mount Street and Arthur Street is the primary western access to the Warringah Freeway, where traffic heading to both the Sydney Harbour Bridge (Bradfield Highway) and Cahill Expressway lanes converges from Berry Street and Pacific Highway during the morning peak.

The intersection of Clark Road and High Street is the primary eastern access to the Sydney Harbour Bridge Cahill Expressway lane, where traffic from Kirribilli and Neutral Bay converge. Queues from the intersection of High Street and Alfred Street North occasionally extend back through this intersection.

Table 4-13 Modelled 2016 morning and evening peak hour intersection performance – Warringah Freeway and surrounds

Intersection	Morning peak		Evening peak	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
Willoughby Road/Gore Hill Freeway interchange	11	A	20	B
Brook Street/Warringah Freeway on ramp	31	C	16	B
Brook Street/Warringah Freeway off ramp	30	C	22	B
Brook Street/Merrenburn Avenue	31	C	12	A
Amherst Street/West Street	6	A	10	A
Amherst Street/Miller Street	19	B	15	B
Miller Street/Warringah Freeway on ramp	<5	A	6	A
Miller Street/Warringah Freeway off ramp	13	A	13	A
Miller Street/Ernest Street	34	C	31	C
Miller Street/Falcon Street	35	C	69	E
Ernest Street/Warringah Freeway on ramp	<5	A	15	B
Ernest Street/Warringah Freeway off ramp (off ramp in PM, on ramp in AM)	<5	A	18	B
Falcon Street/Warringah Freeway ramps	38	C	46	D
Watson Street/Military Road	16	B	29	C
Military Road/Ben Boyd Road	13	A	20	B
Falcon Street/Merlin Street	17	B	38	C
Berry Street/Walker Street	32	C	50	D
Berry Street/Miller Street	30	C	27	B
Mount Street/Arthur Street	84	F	32	C
Mount Street/Walker Street	43	D	31	C
Pacific Highway/High Street/Arthur Street	53	D	19	B
Pacific Highway/Walker Street/Blue Street	53	D	48	D
Pacific Highway/Miller Street/Mount Street	52	D	41	C
Pacific Highway/Berry Street	9	A	11	A
Pacific Highway/Bay Road	21	B	14	B
Miller Street/McLaren Street	24	B	17	B
Miller Street/Ridge Street	39	C	26	B
Miller Street/Carlow Street	14	B	29	C
High Street/Clark Road	>100	F	36	C
High Street/Alfred Street	60	E	18	B
Mount Street/Alfred Street	24	B	11	A
Ernest Street/Ben Boyd Road	11	A	16	B
Pedestrian crossing at Military Road	<5	A	20	B

4.3.6 Road safety and crash history

A summary of crash data for the five-year period between October 2012 and September 2017 on roads that would be substantially affected by the project (based on forecast traffic demand with and without the project) is presented in Table 4-14.

Key statistics include:

- Sixty-one per cent of crashes (472 crashes) resulted in at least one injury
- Three crashes resulted in a fatality, two on Warringah Freeway and one on Military Road
- Twenty-eight per cent of crashes (215 crashes) involved a heavy vehicle, with the majority occurring on Warringah Freeway, Bradfield Highway, Cahill Expressway and Military Road
- Seven per cent of crashes (51 crashes) involved a cyclist or pedestrian
- The three most common crash types involved vehicles travelling in the same direction (59 per cent), vehicles veering off path and onto a straight section of road (13 per cent), and vehicles veering off path and onto a curved section of road (nine per cent)
- Sixty-seven per cent of crashes occurred at a midblock, while 33 per cent of crashes occurred at an intersection.

Table 4-14 Crash history summary – Warringah Freeway and surrounds

Road segment	Number of crashes by severity				Top 3 crash types	Number of pedestrian and cyclist crashes	Number of heavy vehicle crashes	% of midblock and intersection crashes
	Fatality	Injury	Non-injury	Total				
Belgrave Street	0	8	12	20	• Opposing vehicles (35%) • Vehicles from same direction (20%) • Intersection, adjacent approaches (15%).	2 pedestrian crashes and 1 cyclist crash	4	90% intersection, 10% midblock
Bradfield Highway	0	88	49	137	• Vehicles from same direction (69%) • Veering off path on a straight (18%) • Opposing vehicles (5%).	2 pedestrian crashes and 1 cyclist crash	29	100% midblock
Cahill Expressway	0	34	16	50	• Vehicles from same direction (58%) • Veering off path on a curve (26%) • Veering off path on a straight (12%).	N/A	21	95% midblock, 5% intersection
Cowles Road	0	1	0	1	• Opposing vehicles (100%).	N/A	0	100% midblock
Ernest Street	0	10	5	15	• Vehicles from same direction (53%) • Intersection, adjacent approaches (13%) • Veering off path on a straight (13%).	1 cyclist crash	2	73% intersection, 27% midblock
Falcon Street	0	35	20	55	• Vehicles from same direction (65%) • Intersection, adjacent approaches (15%) • Veering off path on a curve (7%).	1 pedestrian crash	17	84% intersection, 16% midblock
Gerard Street	0	8	3	11	• Vehicles from same direction (27%) • Opposing vehicles (18%) • Pedestrian (18%).	2 pedestrian crashes	3	64% intersection, 36% midblock
Macpherson Street	0	6	3	9	• Vehicles from same direction (33%) • Opposing vehicles (22%) • Veering off path on a straight (22%).	N/A	1	67% intersection, 33% midblock
Military Road	1	108	55	164	• Vehicles from same direction (52%) • Pedestrian (13%)	24 pedestrian crashes and 5 cyclist crashes	47	70% intersection, 30% midblock

Road segment	Number of crashes by severity				Top 3 crash types	Number of pedestrian and cyclist crashes	Number of heavy vehicle crashes	% of midblock and intersection crashes
	Fatality	Injury	Non-injury	Total				
					• Veering off path on a straight (10%).			
Miller Street	0	18	10	28	• Opposing vehicles (21%) • Vehicles from same direction (18%) • Veering off path on a curve (18%).	5 pedestrian crashes and 1 cyclist crash	10	71% intersection, 29% midblock
Pacific Highway	0	1	2	3	• Vehicles from same direction (67%) • Veering off path on a curve (33%).	1 cyclist crash	0	100% midblock
Strathallen Avenue	0	7	8	15	• Vehicles from same direction (27%) • Veering off path on a straight (27%) • Intersection, adjacent approaches (20%).	1 cyclist crash	2	60% intersection, 40% midblock
Sydney Harbour Tunnel	0	32	18	50	• Vehicles from same direction (78%) • Veering off path on a straight (14%) • Veering off path on a curve (4%).	1 pedestrian crash	12	100% midblock
Warringah Freeway	2	113	89	204	• Vehicles from same direction (70%) • Veering off path on a straight (13%) • Veering off path on a curve (11%).	1 pedestrian crash and 2 cyclist crashes	65	97% midblock, 3% intersection
Willoughby Road	0	3	3	6	• Vehicles from same direction (33%) • Intersection, adjacent approaches (33%) • Opposing vehicles (17%).	N/A	2	67% intersection, 33% midblock
Total	3	472	293	768	• Vehicles from same direction (59%) • Veering off path on a straight (13%) • Veering off path on a curve (9%).	38 pedestrian crashes and 13 cyclist crashes	215	67% midblock, 33% intersection

A summary of casualty crashes for the five-year period between October 2012 and September 2017 on roads that would be substantially impacted by the project (based on forecast traffic demand with and without the project) is presented in Table 4-15.

The key road safety issues in the Warringah Freeway and surrounds study area include:

- High crash rates are observed on Belgrave Street (85.1 crashes per 100 million VKT), Falcon Street (70.4 crashes per 100 million VKT), Military Road (51.9 crashes per 100 million VKT), Miller Street (45.1 crashes per 100 million VKT), and Cahill Expressway (41.1 crashes per 100 million VKT)
- Casualty crash rates on the Bradfield Highway and Warringah Freeway exceed the Sydney region average, likely due to their high demands and complex road geometry which may require motorists to perform consecutive merge or weave manoeuvres across multiple lanes
- High traffic volumes in both directions on Falcon Street and Military Road which are major bus corridors, and the presence of parking lanes and lack of turning bays on Ernest Street and Belgrave Street, which provide an alternative route for drivers avoiding the Military Road/Spit Road corridor, would also contribute to the higher than average crash rates observed.

Table 4-15 Casualty crashes analysis – Warringah Freeway and surrounds

Road segment	Length (km)	AADT	Crash rate per 100 million VKT	Casualty crashes per km per year	Casualty crashes (Sydney average)[8]
Belgrave Street	0.4	29,700	85.1	3.9	2.6
Bradfield Highway	2.5	135,800	23.5	7.0	3.0
Cahill Expressway	1.7	36,900	41.1	3.9	4.1
Cowles Road	0.7	5700	16.6	0.3	0.5
Ernest Street	1.7	10,100	32.2	1.2	0.5
Falcon Street	0.8	24,700	70.4	5.0	4.1
Gerard Street	0.7	33,300	28.0	2.2	2.6
Macpherson Street	0.8	26,500	38.3	1.6	2.6
Military Road	3.6	72,100	51.9	6.0	3.0
Miller Street	2.6	11,400	45.1	1.4	2.6
Pacific Highway	1.3	24,000	7.5	0.2	4.1
Strathallen Avenue	0.9	26,100	36.2	1.6	2.6
Sydney Harbour Tunnel	2.6	98,500	10.7	2.5	3.0
Warringah Freeway	2.5	242,800	21.9	9.2	3.0
Willoughby Road	2.8	11,300	5.2	0.2	2.6

[8] Roads and Maritime Services, 2017

4.3.7 Public transport network

The Warringah Freeway and surrounds study area is highly accessible by public transport. Heavy rail services are provided at Milsons Point, North Sydney, Waverton and Wollstonecraft railway stations, which are located on the T1 North Shore and T9 Northern Lines providing direct connections to the Sydney CBD, Chatswood, Macquarie Park, Epping, Hornsby, Parramatta, Blacktown, Penrith and Richmond. Direct services are also provided to and from the Central Coast from North Sydney during weekday peak periods.

The Warringah Freeway and surrounds study area is a major thoroughfare for buses, with 109 routes and about 4900 timetabled services on weekdays, 2300 services on Saturdays and 1900 services on Sundays and public holidays. Bus services are operated by Sydney Buses, Transit Systems NSW, Forest Coach Lines, Hillsbus and Transdev NSW. Major bus corridors in the Warringah Freeway and surrounds study area include:

- Warringah Freeway – for services to the Sydney CBD, Northern Beaches, North Shore and the Hills District
- Military Road – for services to Mosman and the Northern Beaches
- Miller Street – for services to and from North Sydney CBD
- Pacific Highway – for services to Chatswood, Epping, Gladesville and the Hills District.

Bus route maps are shown in Figure 4-17 (Sydney Buses), Figure 4-18 (Transit Systems NSW), Figure 4-19 (Forest Coach Lines), Figure 4-20 (Hillsbus) and Figure 4-21 (Transdev NSW).

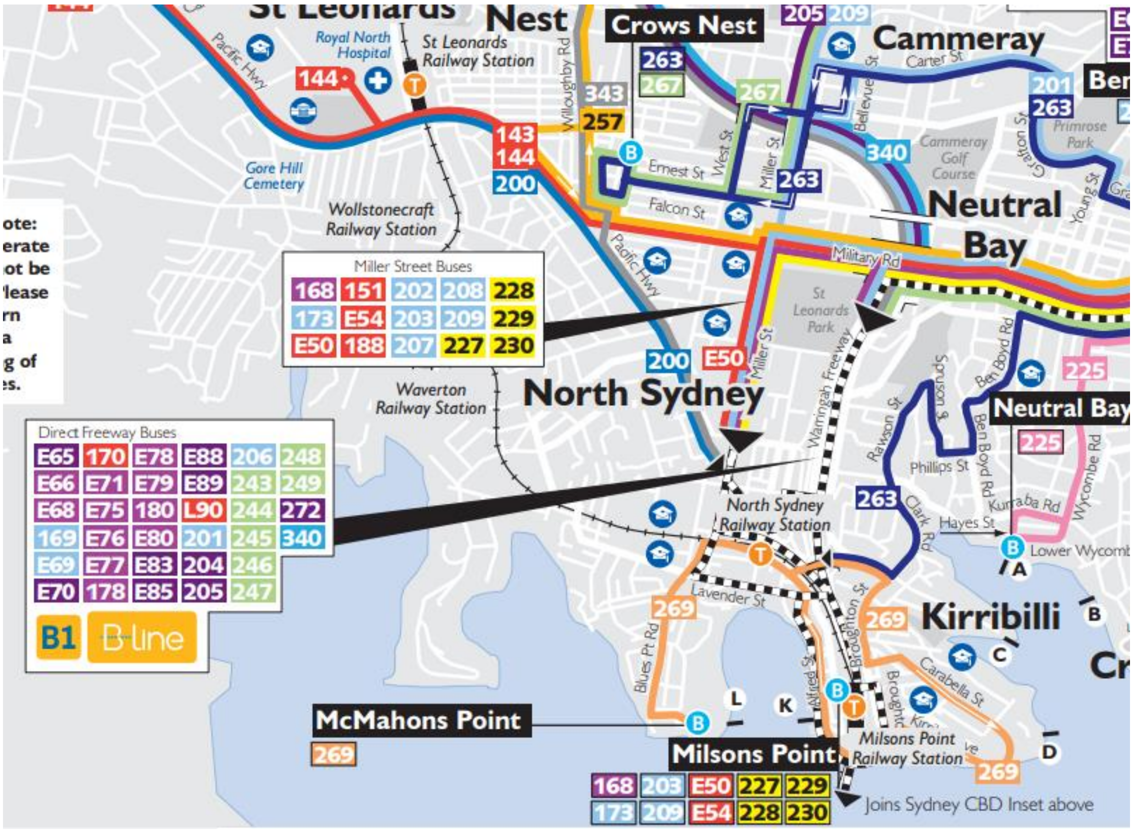

Figure 4-17 Bus routes – Warringah Freeway and surrounds – Sydney Buses

Source: Northern Beaches & Lower North Shore region guide (Transport for NSW, 2019b)

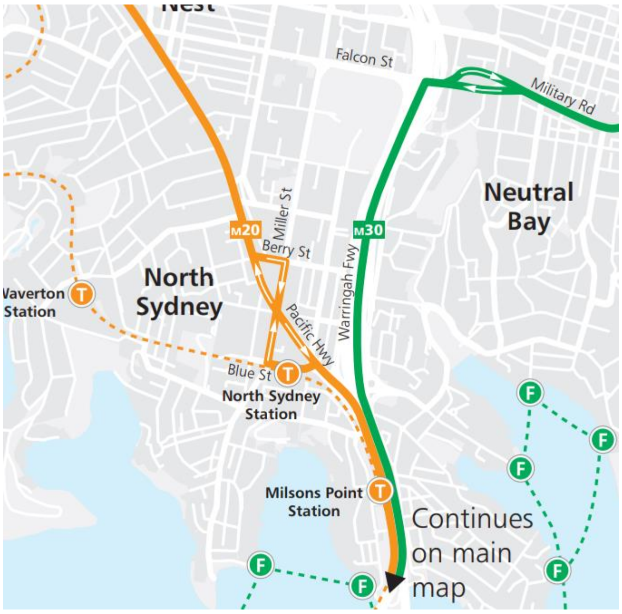

Figure 4-18 Bus routes – Warringah Freeway and surrounds – Transit Systems NSW

Source: Inner West and Southern region network (Transit Systems NSW, 2019)

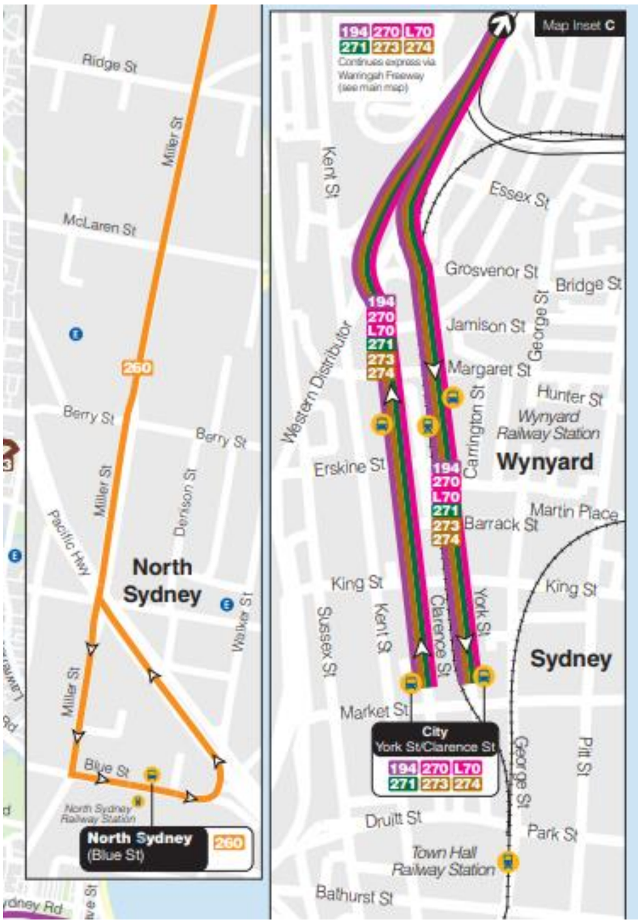

Figure 4-19 Bus routes – Warringah Freeway and surrounds – Forest Coach Lines

Source: Forest Coach Lines Sydney Region Network Map (Forest Coach Lines, 2019)

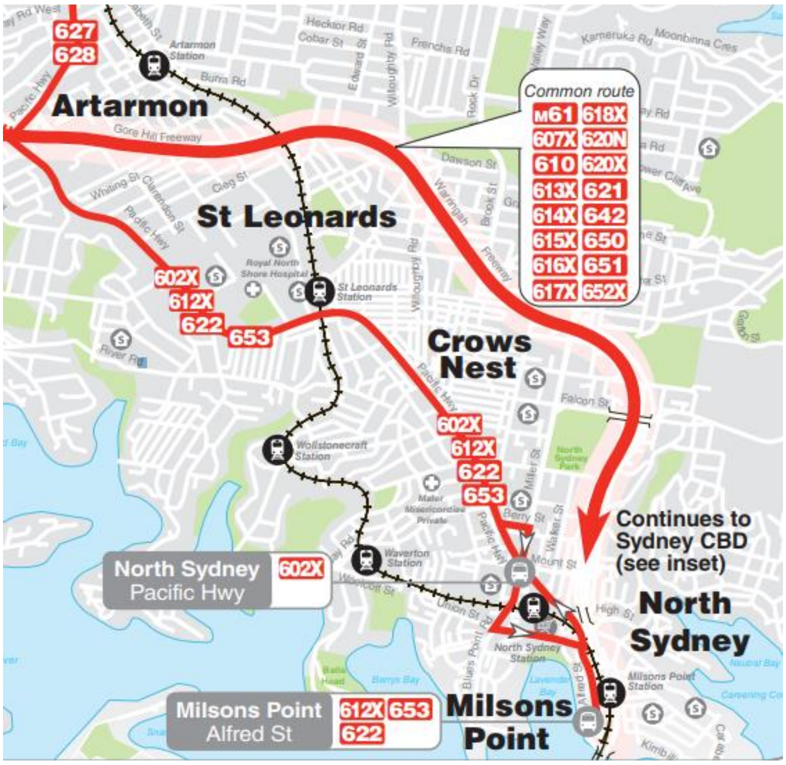

Figure 4-20 Bus routes – Warringah Freeway and surrounds – Hillsbus

Source: Hills District Bus Guide (Hillsbus, 2019)

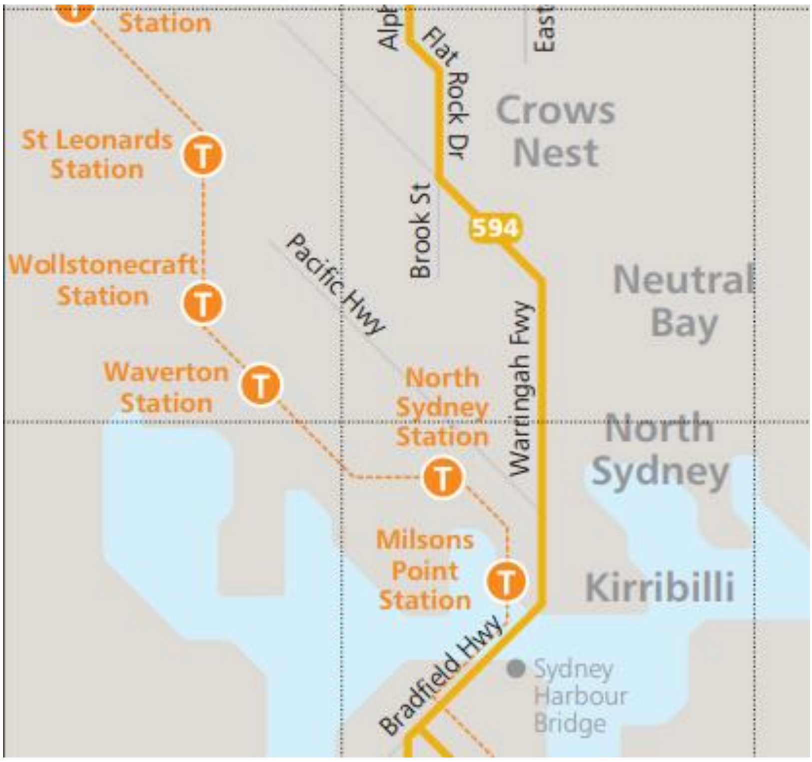

Figure 4-21 Bus routes – Warringah Freeway and surrounds – Transdev NSW

Source: Upper North Shore network map (Transdev NSW, 2019)

4.3.8 Active transport network

The pedestrian network in the Warringah Freeway and surrounds study area is well developed with footpaths provided alongside the vast majority of roads and controlled crossings provided at most signalised intersections. Pedestrians are prohibited from walking along the Warringah Freeway. High levels of pedestrian activity associated with retail and commercial land uses occur within North Sydney CBD, in the vicinity of the numerous schools located west of the Pacific Highway and along Miller Street. Balls Head Reserve is also a major generator of pedestrian activity, associated with people exercising.

The cycle network in the Warringah Freeway and surrounds study area is shown in Figure 4-22 and consists mostly of on-road cycle routes on local, collector and sub-arterial roads. The regional strategic cycle network provides connections between the study area and the Sydney CBD, Cremorne, Mosman, Crows Nest, St Leonards, Lane Cove and Macquarie Park. Secure bicycle lockers are located on Mount Street in North Sydney, and O-ring cycle stands and bicycle rails for cycle parking are located throughout North Sydney CBD.

The Warringah Freeway presents a barrier to east–west and north–south movements for pedestrians and cyclists, with crossings available at select locations including:

- West Street
- Miller Street
- Ernest Street
- Shared user bridge connecting Falcon Street in North Sydney and Merlin Street in Neutral Bay
- Falcon Street
- Shared user bridge connecting Ridge Street in North Sydney and Alfred Street North in Neutral Bay
- Mount Street
- High Street.

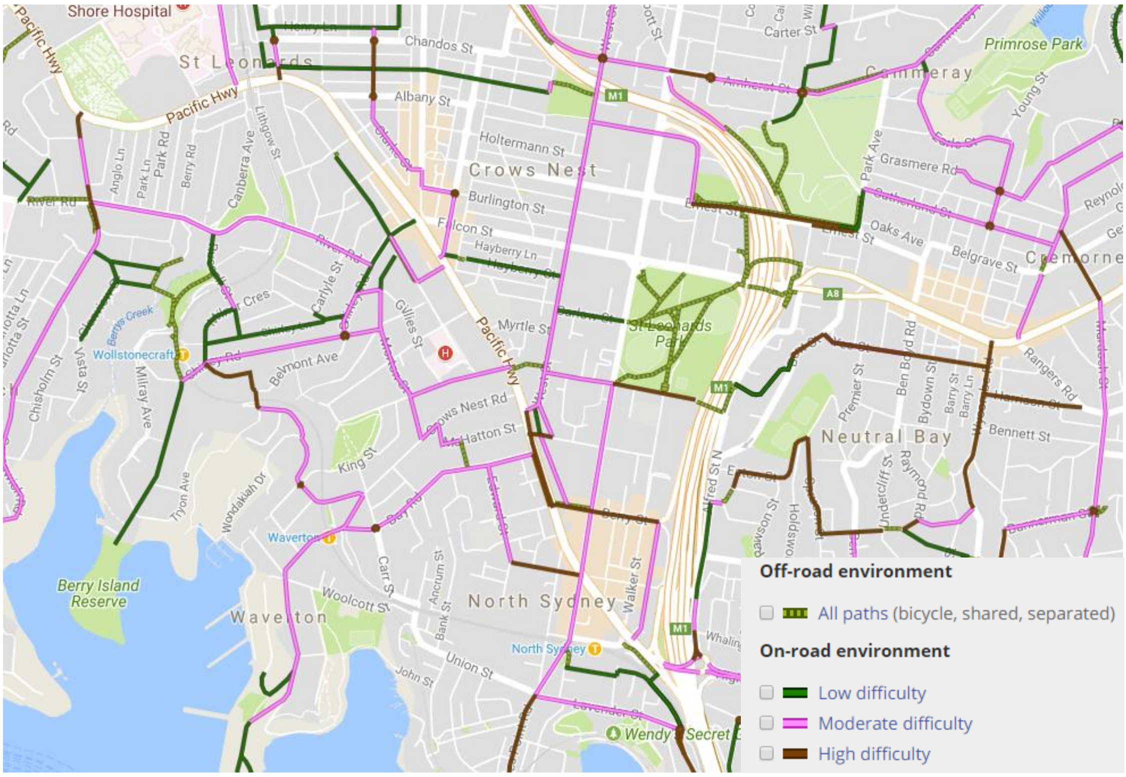

Figure 4-22 Cycle network – Warringah Freeway and surrounds

Source: Cycleway Finder (Roads and Maritime, 2018)

Pedestrian and cyclist surveys were carried out on Thursday 20 July 2017 between 6.30am and 6.30pm at the eight crossings of the Warringah Freeway. The survey results are summarised in Table 4-16. Over all eight crossings of the Warringah Freeway, there were a total of about 8760 pedestrians and 830 cyclists. Mount Street was the most used crossing for pedestrians, which can be attributed to its proximity to North Sydney CBD. West Street was the most used crossing for cyclists, as it is a marked on-road cycle route providing connectivity between North Sydney, Crows Nest and Willoughby.

Table 4-16 Pedestrian and cyclist survey results – Warringah Freeway crossings

Location	Time period	Number of pedestrians	Number of cyclists	Total number of pedestrians and cyclists
West Street	Morning peak (6.30am to 9.30am)	330	140	470
	Interpeak (9.30am to 3.30pm)	490	30	520
	Evening peak (3.30pm to 6.30pm)	280	150	430
	Total (6.30am to 6.30pm)	1100	320	1420
Miller Street	Morning peak (6.30am to 9.30am)	480	20	500
	Interpeak (9.30am to 3.30pm)	380	20	400
	Evening peak (3.30pm to 6.30pm)	360	30	390
	Total (6.30am to 6.30pm)	1220	70	1290
Ernest Street	Morning peak (6.30am to 9.30am)	60	30	90

Location	Time period	Number of pedestrians	Number of cyclists	Total number of pedestrians and cyclists
	Interpeak (9.30am to 3.30pm)	70	20	90
	Evening peak (3.30pm to 6.30pm)	70	20	90
	Total (6.30am to 6.30pm)	200	70	270
Shared user bridge connecting Falcon Street and Merlin Street	Morning peak (6.30am to 9.30am)	240	40	280
	Interpeak (9.30am to 3.30pm)	350	20	370
	Evening peak (3.30pm to 6.30pm)	210	30	240
	Total (6.30am to 6.30pm)	800	90	890
Falcon Street	Morning peak (6.30am to 9.30am)	110	20	130
	Interpeak (9.30am to 3.30pm)	120	10	130
	Evening peak (3.30pm to 6.30pm)	80	20	100
	Total (6.30am to 6.30pm)	310	50	360
Shared user bridge connecting Ridge Street and Alfred Street North	Morning peak (6.30am to 9.30am)	310	10	320
	Interpeak (9.30am to 3.30pm)	240	<10	250
	Evening peak (3.30pm to 6.30pm)	200	<10	210
	Total (6.30am to 6.30pm)	750	30	780
Mount Street	Morning peak (6.30am to 9.30am)	990	<10	1000
	Interpeak (9.30am to 3.30pm)	1510	20	1530
	Evening peak (3.30pm to 6.30pm)	930	10	940
	Total (6.30am to 6.30pm)	3430	40	3470
High Street	Morning peak (6.30am to 9.30am)	280	140	420
	Interpeak (9.30am to 3.30pm)	400	<10	410
	Evening peak (3.30pm to 6.30pm)	270	<10	280
	Total (6.30am to 6.30pm)	950	160	1110
Total at all sites	Morning peak (6.30am to 9.30am)	2800	410	3210
	Interpeak (9.30am to 3.30pm)	3560	140	3700
	Evening peak (3.30pm to 6.30pm)	2400	280	2680
	Total (6.30am to 6.30pm)	8760	830	9590

A pedestrian and cyclist survey was also completed on Tuesday 28 November 2017, Saturday 2 December 2017 and Sunday 3 December 2017 between 6am and 8pm at the Falcon Street underpass adjacent to the eastern side of the Warringah Freeway. The survey results are provided in Figure 4-23 to Figure 4-25.

The surveys indicate that the underpass is underutilised, with fewer than 12 pedestrians and cyclists per hour using the underpass on the weekday, and fewer than six pedestrians and cyclists per hour using the underpass on the weekend.

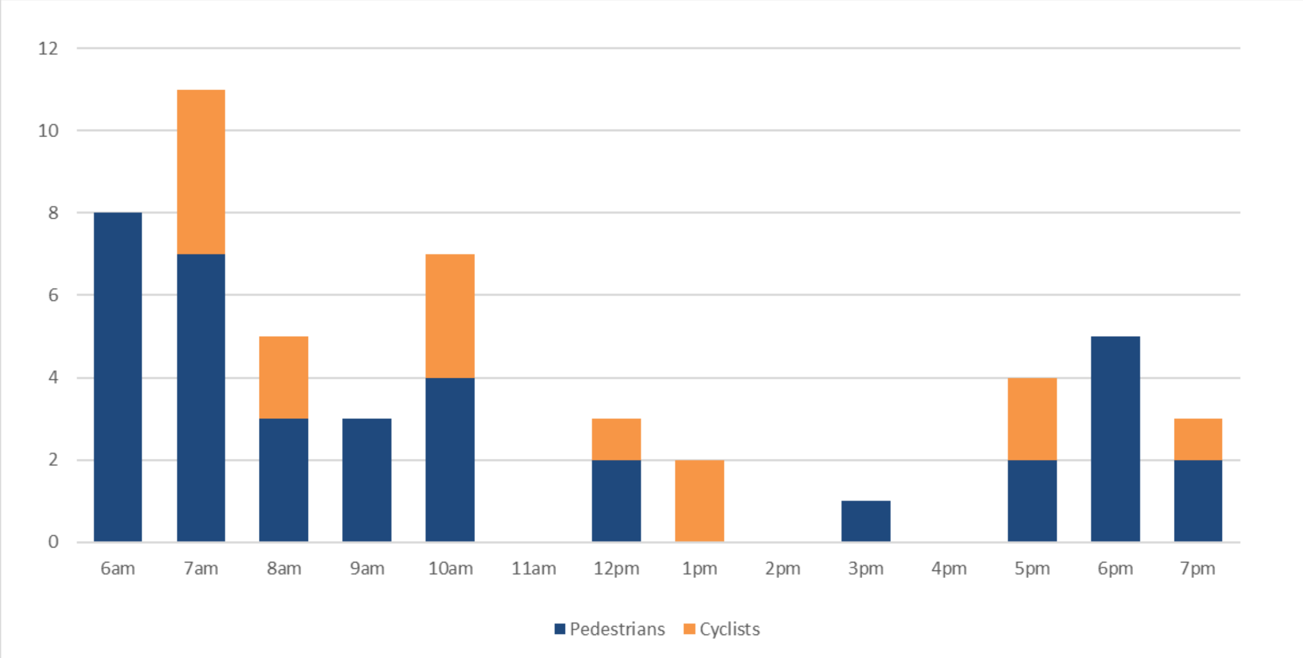

Figure 4-23 Weekday pedestrian and cyclist survey results – Falcon Street underpass

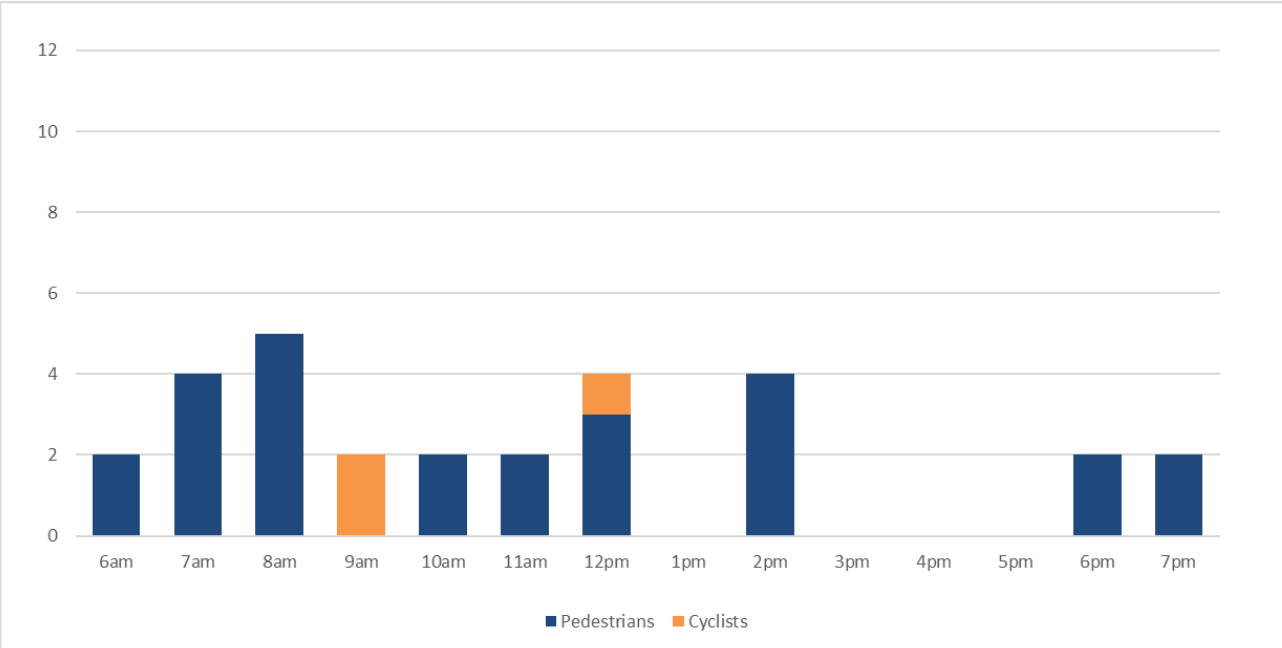

Figure 4-24 Saturday pedestrian and cyclist survey results – Falcon Street underpass

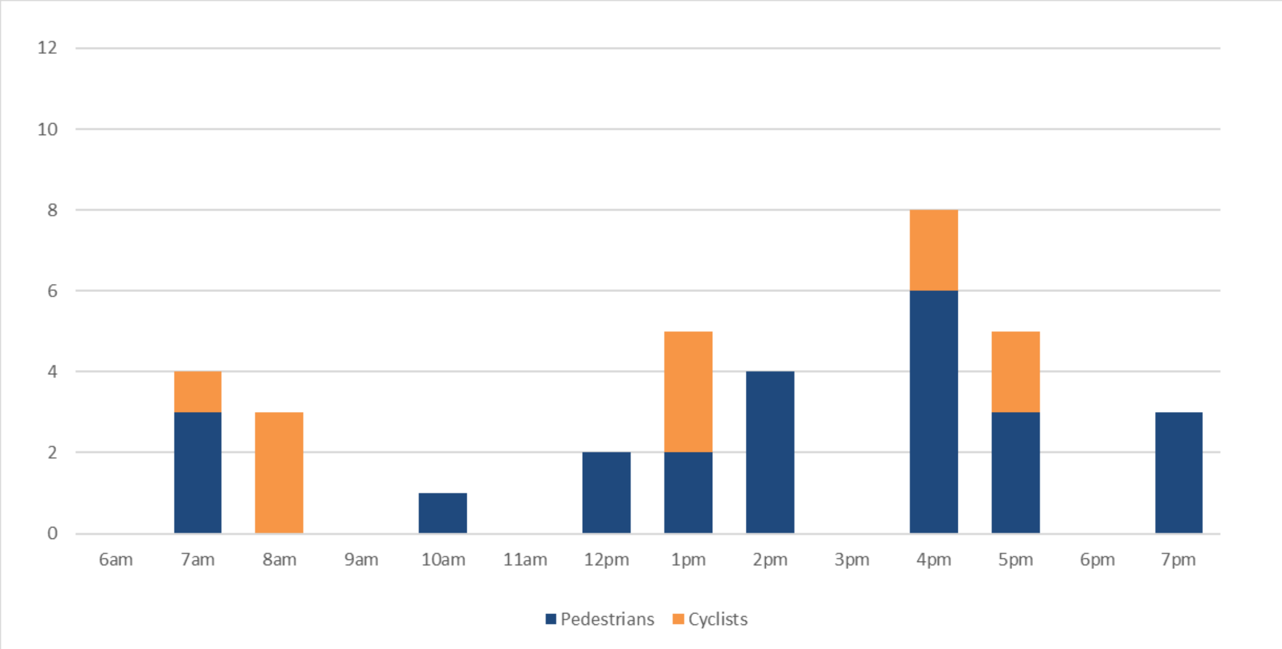

Figure 4-25 Sunday pedestrian and cyclist survey results – Falcon Street underpass

Pedestrian and cycle surveys were also carried out on Wednesday 10 April 2019, Saturday 13 April 2019 and Sunday 14 April 2019 between 6am and 8pm at the shared user path in Jeaffreson Jackson Reserve.
The survey results are provided in Figure 4-26 to Figure 4-28. The surveys indicate that the shared user path is used by a moderate number of pedestrians, particularly on weekdays where a maximum hourly volume of 45 pedestrians was observed. Minimal cyclists used the shared user path, with fewer than seven cyclists per hour recorded on the weekday and weekend.

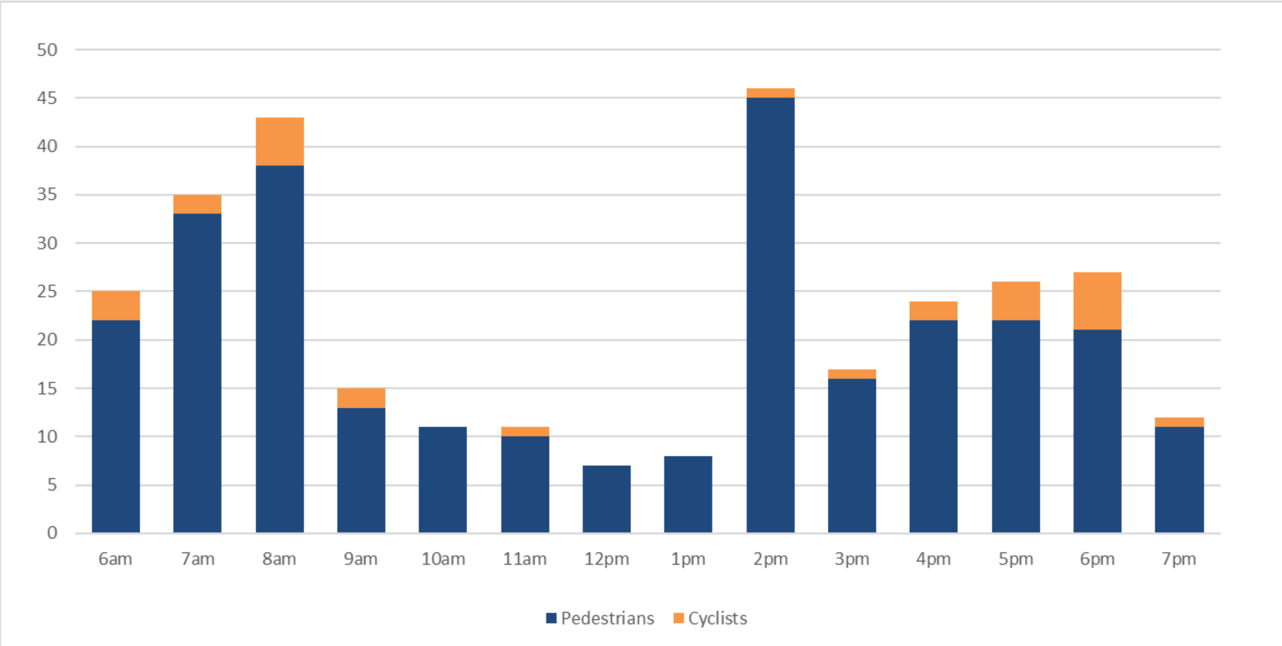

Figure 4-26 Weekday pedestrian and cyclist survey results – Jeaffreson Jackson Reserve shared user path

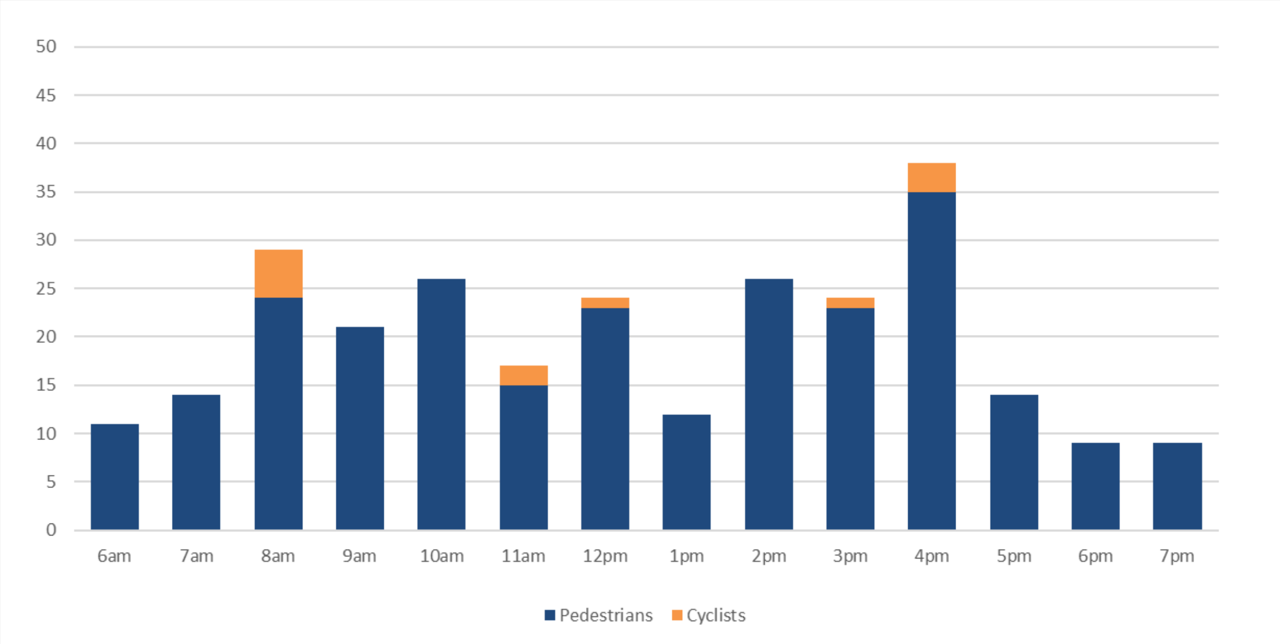

Figure 4-27 Saturday pedestrian and cyclist survey results – Jeaffreson Jackson Reserve shared user path

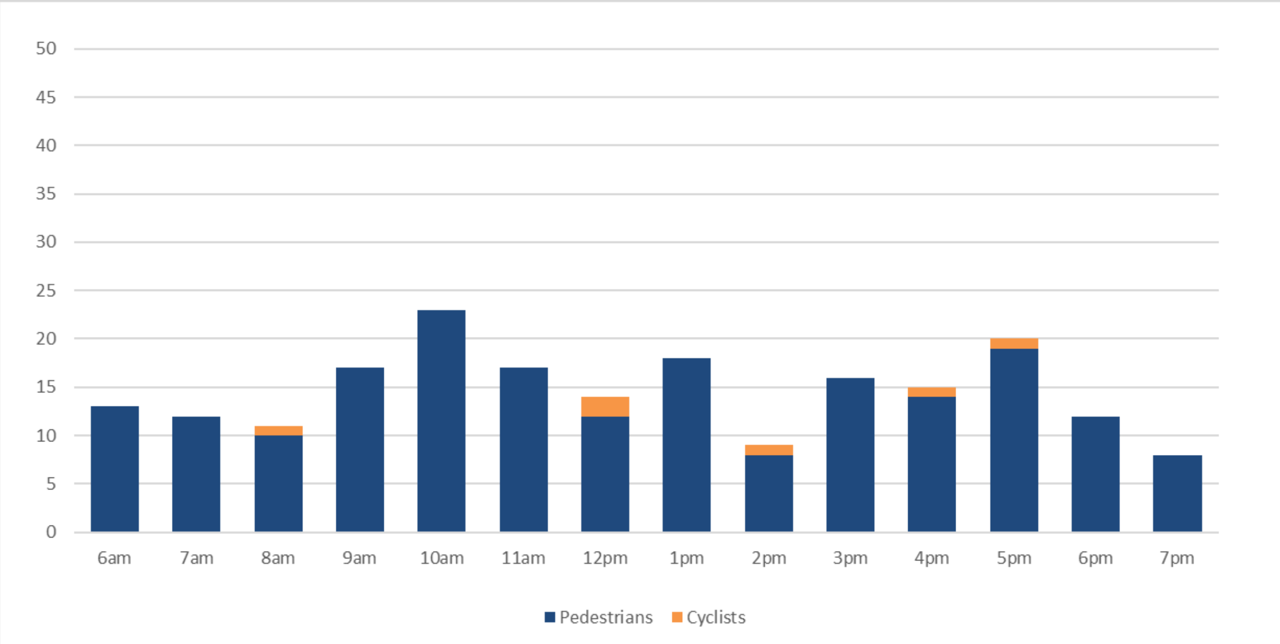

Figure 4-28 Sunday pedestrian and cyclist survey results – Jeaffreson Jackson Reserve shared user path

4.4 Gore Hill Freeway and Artarmon

The broad study area for the traffic and transport assessment of Gore Hill Freeway and Artarmon is shown in Figure 4-29 and includes the suburbs of Artarmon, Crows Nest, St Leonards, Cammeray, Lane Cove, Naremburn and Willoughby.

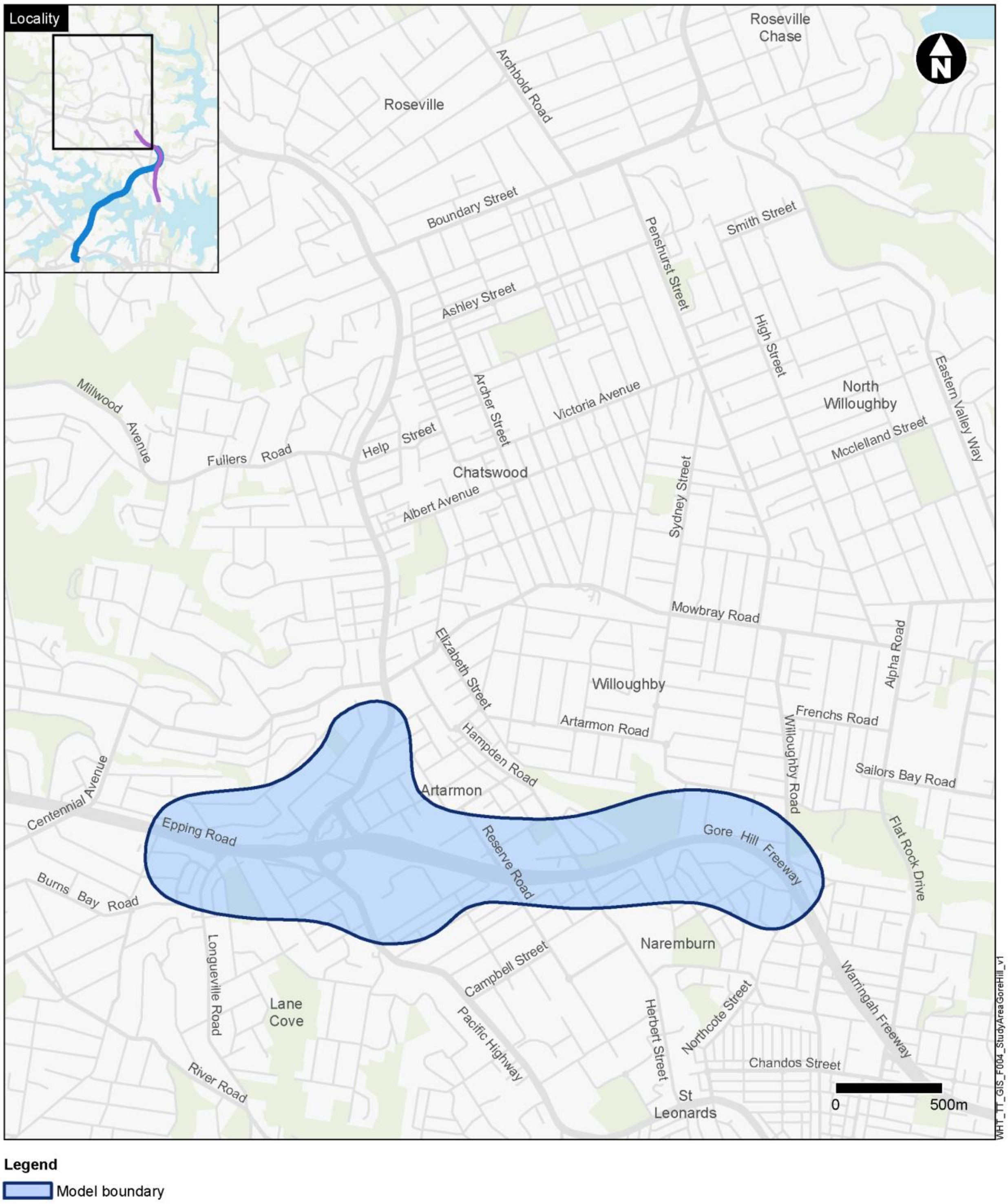

Figure 4-29 Gore Hill Freeway and Artarmon study area and operational model boundary

4.4.1 Modes of travel

Journey to work data for the Gore Hill Freeway and Artarmon study area (based on travel zones within the geographical suburb boundary) was analysed to determine travel patterns for residents and workers.

In 2011[9] the population in the Gore Hill Freeway and Artarmon study area was 9900. The mode share for residents travelling to their employment destinations is shown in Figure 4-30. Private vehicles accounted for 49 per cent of trips, with 45 per cent as vehicle drivers and four per cent as passengers. Public transport accounted for 40 per cent of trips with 27 per cent by train and 13 per cent by bus. Walking accounted for seven per cent of trips. When compared to the Sydney average, the public transport mode share is relatively high and the private vehicle mode share is relatively low. This can be attributed to the locations where the majority of residents work, which are Sydney Inner City, Chatswood–Lane Cove, and North Sydney–Mosman. These locations are highly accessible by public transport from the study area, and in the Sydney CBD parking is discouraged through pricing mechanisms.

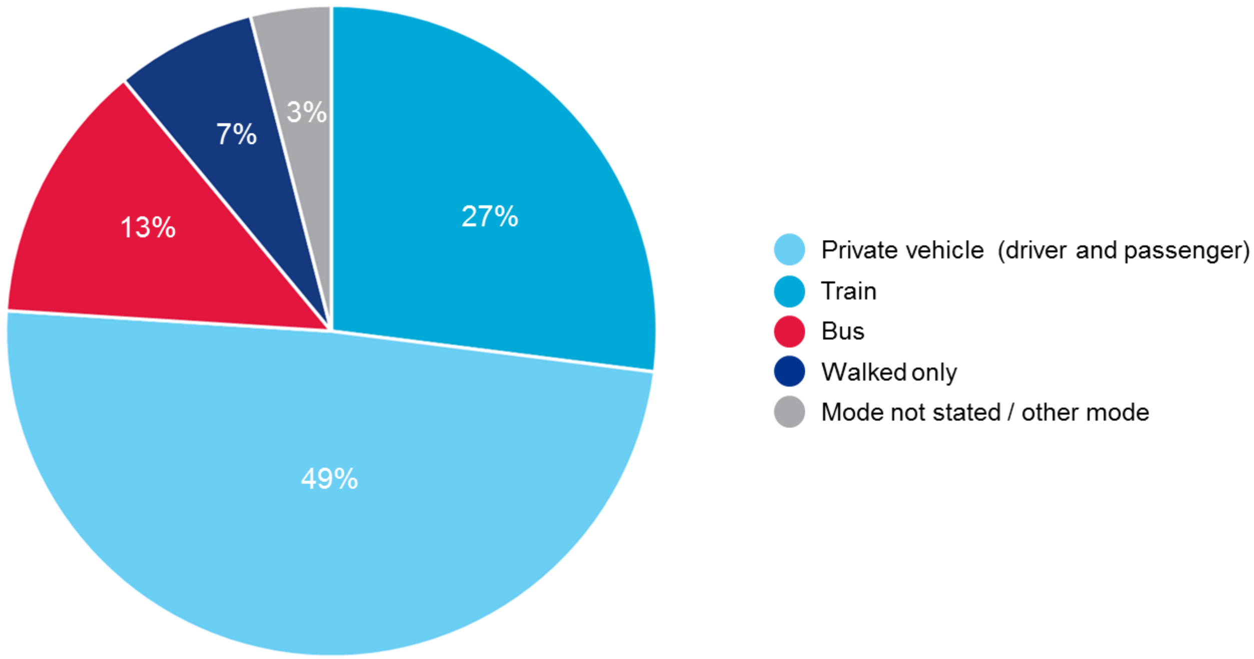

Figure 4-30 Mode share for residents in Gore Hill Freeway and Artarmon travelling to their relative employment destinations

Source: Journey to Work 2011 (Transport for NSW, 2017)

In 2011 there were 12,200 workers in the Gore Hill Freeway and Artarmon study area. The mode share for workers travelling to employment is shown in Figure 4-31. Private vehicles accounted for 75 per cent of trips, with 71 per cent as vehicle drivers and four per cent as passengers. Public transport accounted for 19 per cent of trips, with 15 per cent by train and four per cent by bus. Walking accounted for four per cent of trips. When compared to the Sydney average, the public transport and private vehicle mode shares are relatively high. This can be attributed to the disparate locations across northern Sydney where workers live and the abundance of public transport services accessible to and from the Gore Hill Freeway and Artarmon study area.

[9] Journey to work data is based on information collected in the 2011 Census. Analysis of information collected in the 2016 Census was not available at the time of writing.

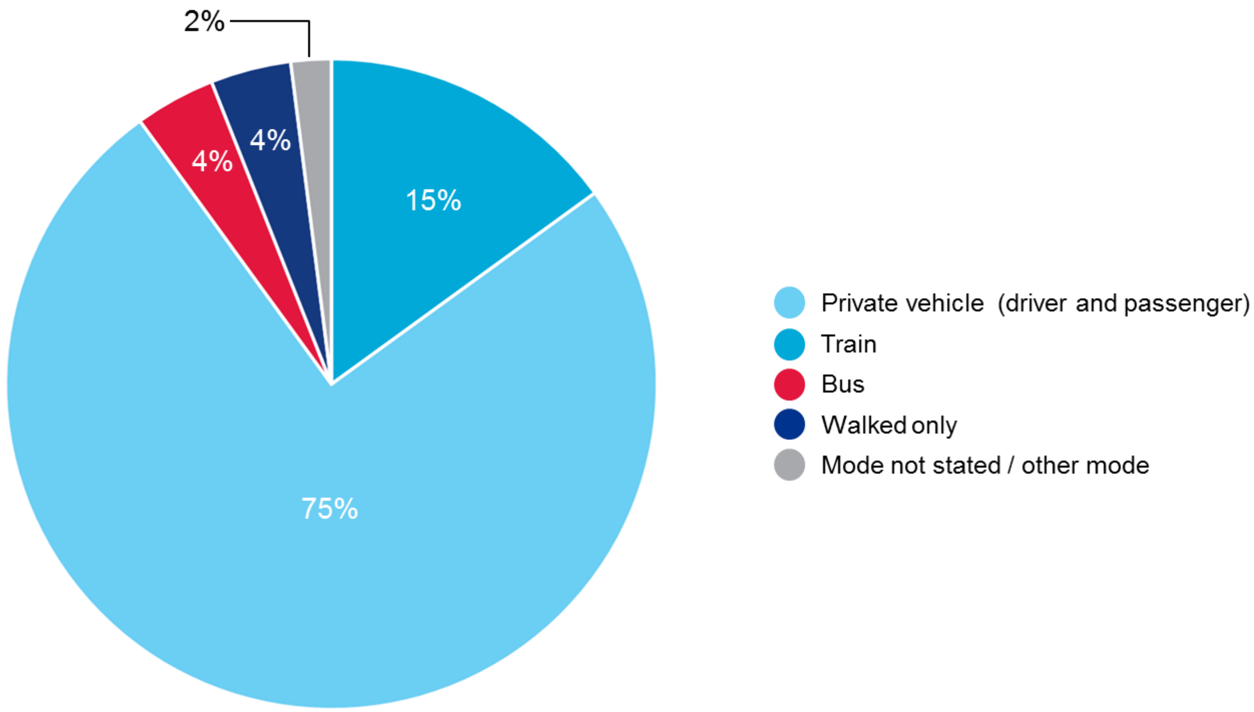

Figure 4-31 Mode share for workers travelling to employment in Gore Hill Freeway and Artarmon

Source: Journey to Work 2011 (Transport for NSW, 2017)

4.4.2 Road network key features

Key roads in the Gore Hill Freeway and Artarmon study area and their characteristics are summarised in Table 4-17.

Table 4-17 Summary of key roads – Gore Hill Freeway and Artarmon

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
M1 Gore Hill Freeway	Artarmon, Naremburn, Willoughby	Motorway 80 km/h	Six	Connectivity to the Sydney metropolitan area as part of the Sydney Orbital Network.	Major bus corridor. Services to Sydney CBD, Lane Cove, Marsfield and the Hills District.	24-hour T2 transit lanes in operation.
M2 Lane Cove Tunnel	Artarmon	Motorway 80 km/h	Up to six (variable, depending on location)	Connectivity to the Sydney metropolitan area as part of the Sydney Orbital Network.	Major bus corridor. Services to Sydney CBD, Lane Cove, Marsfield and the Hills District.	24-hour T2 transit lanes in operation.
Pacific Highway	Artarmon	Major arterial road 60 km/h	Up to six (variable, depending on location)	St Leonards, Chatswood, Pymble, Hornsby, Central Coast and Newcastle (via M1 Pacific Motorway).	Major bus corridor. Services to Sydney CBD, Chatswood, Epping, Gladesville and the Hills District.	Clearways in operation during weekday peak periods.

Road	Location	Road type and speed limit	Total number of lanes	Key destinations	On-road public transport	Operational arrangements
Longueville Road/Epping Road	Lane Cove	Major arterial road 60 km/h	Up to six (variable, depending on location)	Artarmon, North Ryde, Macquarie Park, Sydney CBD (via Sydney Orbital Network).	Major bus corridor. Services to Sydney CBD, Lane Cove, Marsfield and Epping. 24-hour bus lanes in both directions.	N/A
Sailors Bay Road	Northbridge	Sub-arterial 50 km/h	Up to four (variable, depending on location)	Northbridge, Willoughby, Northern Beaches (via Eastern Valley Way/Warringah Road).	Services to Sydney CBD, North Sydney, Northbridge and East Lindfield.	Clearways in operation during weekday peak periods.
Eastern Valley Way/Clive Street	Northbridge, Willoughby	Sub-arterial road 60 km/h	Four	Northbridge, Castlecrag, Castle Cove, Willoughby, Northern Beaches.	Major bus corridor, Services to Sydney CBD, North Sydney, Northbridge and East Lindfield.	Clearways in operation during weekday peak periods.
Reserve Road	Artarmon	Collector road 50 km/h	Up to four (variable, depending on location)	Artarmon commercial areas, Royal North Shore Hospital.	N/A	N/A
Hampden Road	Artarmon	Collector road 50 km/h	Two	St Leonards, Artarmon railway station, Royal North Shore Hospital.	NightRide bus services between Sydney CBD and Hornsby.	N/A
Herbert Street	Artarmon	Collector road 50 km/h	Two	St Leonards railway station, Royal North Shore Hospital.	N/A	N/A
Dickson Avenue	Artarmon	Local road 50 km/h	Two	Provides access to commercial properties in Artarmon.	N/A	N/A
Punch Street	Artarmon	Local road 50 km/h	Two	Provides access to commercial properties in Artarmon.	N/A	N/A
Cleg Street	Artarmon	Local road 50 km/h	Two	Provides access to commercial properties in Artarmon.	N/A	N/A

4.4.3 Traffic volumes and patterns

Reserve Road is a collector road that exhibits a southbound morning peak direction and a northbound evening peak direction. Traffic volumes are higher on Reserve Road near the Gore Hill Freeway, with peak direction traffic volumes north of Dickson Avenue generally greater than 1000 vehicles per hour. Herbert Street and Frederick Street are also collector roads that carry slightly lower traffic volumes ranging between 250 and 560 vehicles per hour in each direction during peak periods.

Low traffic volumes are experienced on Cleg Street and Dickson Avenue, which are both local roads.

The midblock volumes on key access roads in the Gore Hill Freeway and Artarmon study area are summarised in Table 4-18.

Table 4-18 Year 2016 peak hour traffic volumes - Gore Hill Freeway and Artarmon

Road	Direction	Morning peak hour		Evening peak hour	
		Volume (vehicles)	Heavy vehicle percentage	Volume (vehicles)	Heavy vehicle percentage
Reserve Road north of Dickson Avenue	Northbound	520	8%	1140	1%
	Southbound	1210	3%	610	2%
Reserve Road north of Frederick Street	Northbound	320	10%	670	3%
	Southbound	690	3%	490	1%
Frederick Street east of Reserve Road	Eastbound	440	5%	560	1%
	Westbound	360	8%	420	5%
Herbert Street north of Frederick Street	Northbound	250	3%	440	1%
	Southbound	530	3%	500	2%
Cleg Street east of Herbert Street	Eastbound	110	1%	190	1%
	Westbound	120	2%	180	2%
Dickson Avenue east of Reserve Road	Eastbound	250	3%	150	0%
	Westbound	130	5%	30	2%
Reserve Road south of Barton Road	Northbound	350	3%	640	1%
	Southbound	470	2%	410	1%

4.4.4 Road network performance

The Gore Hill Freeway connects the M2 Motorway corridor with the M1 Motorway corridor through Artarmon and Willoughby. Although the Gore Hill Freeway carries high traffic volumes at all times of the day, traffic volumes are highest heading southbound in the morning peak and northbound in the evening peak, as a result of trips heading into and out of central Sydney from north-west Sydney via the M2 Motorway and from the North Shore via Pacific Highway, as well as more local traffic from Lane Cove and Ryde.

The Artarmon industrial area is located directly to the south of the Gore Hill Freeway, bounded by the Pacific Highway and northern railway line, with Royal North Shore Hospital further south. Traffic to and from this employment area travels predominantly via Reserve Road from the south, while directly north of Gore Hill Freeway traffic generated by Artarmon and its surrounding high-density residential development also travels predominantly via Reserve Road. The majority of traffic on Reserve Road travels to and from Gore Hill Freeway; consequently, the operation of this interchange is limited by the double-point arrangement, which limits capacity for the off ramps that often operate at or close to capacity during the morning peak.

Lane Cove town centre is located immediately to the west of the Gore Hill Freeway, at the confluence of Pacific Highway, Longueville Road and Epping Road. The intersection of Longueville Road and Epping Road is the primary surface road constraint in the corridor due to the high volumes of traffic travelling to and from Lane Cove and Riverview. In the morning peak, high traffic volumes along Epping Road conflict with high right turning traffic volumes from south to east on Longueville Road as well as pedestrians across Epping Road. In the evening peak, high traffic volumes from Pacific Highway and Gore Hill Freeway merge into a single left turn lane into Lane Cove that is frequently blocked by buses travelling westbound at Lane Cove interchange.
Traffic turning right into Parklands Avenue from Pacific Highway must weave across two lanes of heavy traffic over a short 200 metre section, often resulting in westbound delays on Gore Hill Freeway.

Longueville Road and Epping Road are key bus corridors with routes travelling to Lane Cove, Ryde and the Hills Shire stopping at Lane Cove Interchange. Bus priority is provided on Epping Road west of Longueville Road in the form of signal priority for westbound traffic at Longueville Road and continuous bus lanes on Epping Road. Signal priority for buses is also provided for eastbound buses on Longueville Road at Pacific Highway while eastbound buses on the Gore Hill Freeway use the 24-hour T2 transit lane that extends to Willoughby Road.

A summary of modelled network performance statistics for the Gore Hill Freeway and Artarmon study area is provided in Table 4-19.

Table 4-19 Modelled 2016 morning and evening peak network performance – Gore Hill Freeway and Artarmon

Network measure	Morning peak period	Evening peak period
Network statistics for all vehicles		
Total traffic demand (veh)	29,700	29,700
Total VKT through network	79,500	77,600
Total vehicle travel time through the network (hours)	1620	1510
Total number of stops	35,800	33,400
Average vehicle statistics		
Average vehicle trip length through the network (km)	2.5	2.5
Average vehicle trip time through the network (hours)	0:03:05	0:02:53
Average number of stops per trip	1.1	1.1
Average trip speed (km/hr)	49.0	51.4
Unreleased traffic		
Total unreleased trips	<10	<10
% of demand unreleased	<1%	<1%

4.4.5 Intersection performance

Modelled performance for key intersections in the Gore Hill Freeway and Artarmon study area under 2016 travel demands are presented in Table 4-20. Modelled intersection performance indicates that the Epping Road/Longueville Road/Parklands Avenue intersection is currently performing at a relatively poor Level of Service during peak periods. This intersection has limited capacity due to the high volume of eastbound traffic that conflicts with right turn traffic from Longueville Road south. Delays on the eastern approach of this intersection are also exacerbated by buses stopping at Lane Cove interchange that block traffic turning left into Longueville Road.

Table 4-20 Modelled 2016 morning and evening peak intersection performance – Gore Hill Freeway and Artarmon

Intersection	Morning peak (8am-9am)		Evening peak (5pm-6pm)	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
Epping Road/Longueville Road/Parklands Avenue	48	D	63	E
Longueville Road/Pacific Highway	42	C	36	C
Pacific Highway/Howarth Road/Norton Lane	7	A	7	A
Pacific Highway/Gore Hill Freeway interchange	23	B	23	B
Reserve Road/Gore Hill Freeway interchange	47	D	29	C
Reserve Road/Dickson Road	14	A	19	B
Reserve Road/Barton Road	11	A	6	A

4.4.6 Road safety and crash history

A summary of crash data for the five-year period between October 2012 and September 2017 on roads that would be substantially affected by the project (based on forecast traffic demand with and without the project) is presented in Table 4-21.

Key statistics include:

- Fifty-six per cent of crashes (71 crashes) resulted in at least one injury
- Twenty per cent of crashes (25 crashes) involved a heavy vehicle, with the majority occurring on Eastern Valley Way
- Five per cent of crashes (six crashes) involved a cyclist or pedestrian
- The three most common crash types involved vehicles travelling in the same direction (50 per cent), vehicles travelling in the opposite direction (15 per cent), and vehicles veering off path and onto a curved section of road (10 per cent)
- Fifty-nine per cent of crashes occurred at a midblock, while 41 per cent of crashes occurred at an intersection.

Table 4-21 Crash history summary – Gore Hill Freeway and Artarmon

Road segment	Number of crashes by severity				Top three crash types	Number of pedestrian and cyclist crashes	Number of heavy vehicle crashes	% of midblock and intersection crashes
	Fatality	Injury	Non-injury	Total				
Clive Street	0	2	1	3	• Vehicles from same direction (100%).	N/A	1	67% intersection, 33% midblock
Eastern Valley Way	0	54	34	88	• Vehicles from same direction (42%) • Opposing vehicles (20%) • Veering off path on a curve (13%).	Four pedestrian crashes	17	51% intersection, 49% midblock
Gore Hill Freeway	0	11	15	26	• Vehicles from same direction (73%) • Objects on path (12%) • Veering off path on a straight (8%).	One pedestrian crash	5	100% midblock
Lane Cove Tunnel	0	1	0	1	• Vehicles from same direction (100%).	N/A	0	100% midblock
Sailors Bay Road	0	3	5	8	• Vehicles from same direction (38%) • Manoeuvring (25%) • Opposing vehicles (13%).	One pedestrian crash	2	50% intersection, 50% midblock
Total	0	71	55	126	• Vehicles from same direction (50%) • Opposing vehicles (15%) • Veering off path on a curve (10%).	Six pedestrian crashes	25	59% midblock, 41% intersection

A summary of casualty crashes for the five-year period between October 2012 and September 2017 on roads that would be substantially impacted by the project (based on forecast traffic demand with and without the project) is presented in Table 4-22.

The key road safety issues in the Gore Hill Freeway and Artarmon study area include:

- High crash rates are observed on Eastern Valley Way (59.3 crashes per 100 million VKT), Clive Street (38.6 crashes per 100 million VKT), and Sailors Bay Road (32.7 crashes per 100 million VKT)
- Casualty crash rates on Clive Street and Eastern Valley Way exceed the Sydney region average for their respective similar type of road. These roads are often congested during peak periods and carry high traffic volumes as they provide connectivity between the Northern Beaches and Northbridge, Castlecrag, Castle Cove and Willoughby. Both these roads are sub-arterial however the presence of parking lanes, curved road alignment and lack of turning bays at a number of intersections in conjunction with their function as an arterial route would contribute to the higher crash rates observed.

Table 4-22 Casualty crashes analysis – Gore Hill Freeway and Artarmon

Road segment	Length (km)	AADT	Crash rate per 100 million VKT	Casualty crashes per km per year	Casualty crashes (Sydney average)[10]
Clive Street	0.2	25,000	38.6	2.4	1.7
Eastern Valley Way	3.4	22,100	59.3	3.2	1.7
Gore Hill Freeway	2.0	127,400	3.7	1.1	1.8
Lane Cove Tunnel	4.0	75,900	0.2	0.0	1.8
Sailors Bay Road	2.3	22,900	32.7	0.2	1.7

4.4.7 Public transport network

The Gore Hill Freeway and Artarmon study area is highly accessible by public transport. Heavy rail services are provided at Artarmon and St Leonards railway stations, which are located on the T1 North Shore and T9 Northern Lines providing direct connections to the Sydney CBD, Chatswood, Macquarie Park, Epping, Hornsby, Parramatta, Blacktown, Penrith and Richmond. Direct services are also provided to and from the Central Coast from Artarmon and St Leonards during the weekday peak periods.

The Gore Hill Freeway and Artarmon study area is a major thoroughfare for buses with 67 bus routes and about 3100 timetabled services on weekdays, 1500 services on Saturdays and 1200 services on Sundays and public holidays. Bus services are operated by Sydney Buses, Transit Systems NSW, Forest Coach Lines, Hillsbus and Transdev NSW. Major bus corridors in the Gore Hill Freeway and Artarmon study area include:

- Gore Hill Freeway/Lane Cove Tunnel – for services to the Sydney CBD, Lane Cove, Marsfield and the Hills District
- Pacific Highway – for services to the Sydney CBD, Chatswood, Epping, Gladesville and the Hills District.

Bus route maps are shown in Figure 4-32 (Sydney Buses), Figure 4-33 (Transit Systems NSW), Figure 4-34 (Forest Coach Lines), Figure 4-35 (Hillsbus) and Figure 4-36 (Transdev NSW).

[10] Roads and Maritime Services, 2017

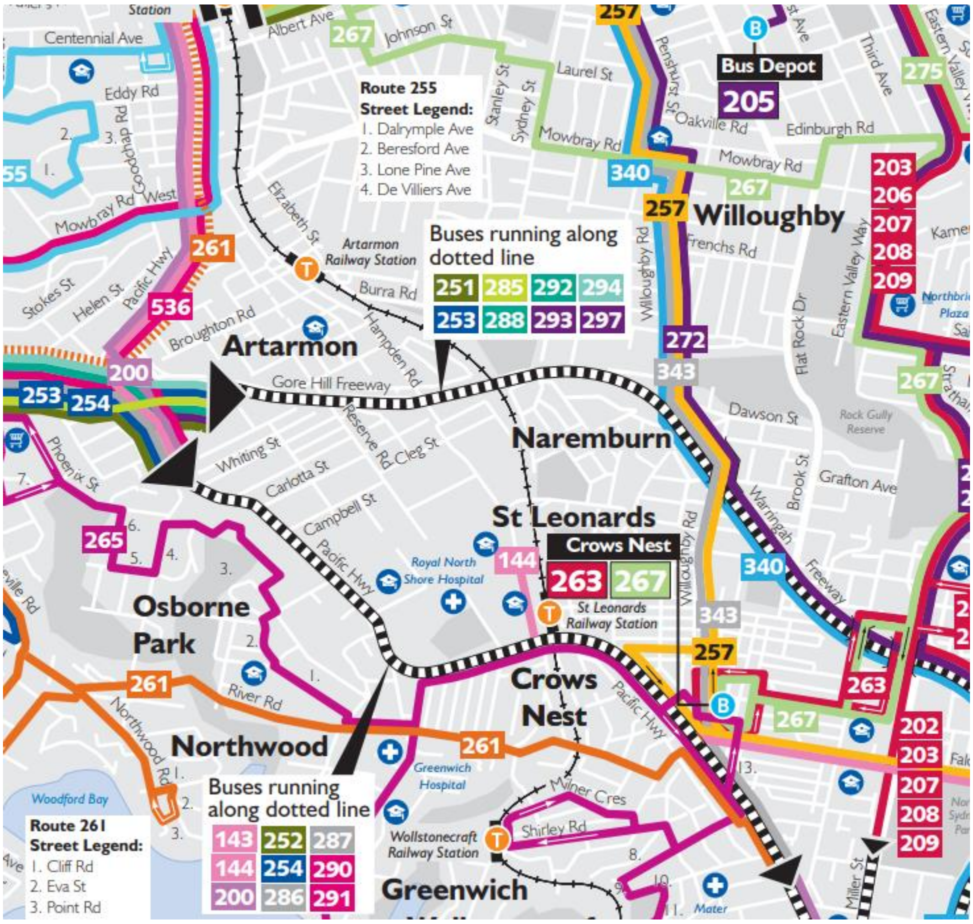

Figure 4-32 Bus routes – Gore Hill Freeway and Artarmon – Sydney Buses

Source: North Shore & West region guide (Transport for NSW, 2019a)

Figure 4-33 Bus routes – Gore Hill Freeway and Artarmon – Transit Systems NSW

Source: Inner West and Southern region network (Transit Systems NSW, 2019)

Figure 4-34 Bus routes – Gore Hill Freeway and Artarmon – Forest Coach Lines

Source: Forest Coach Lines Sydney Region Network Map (Forest Coach Lines, 2019)

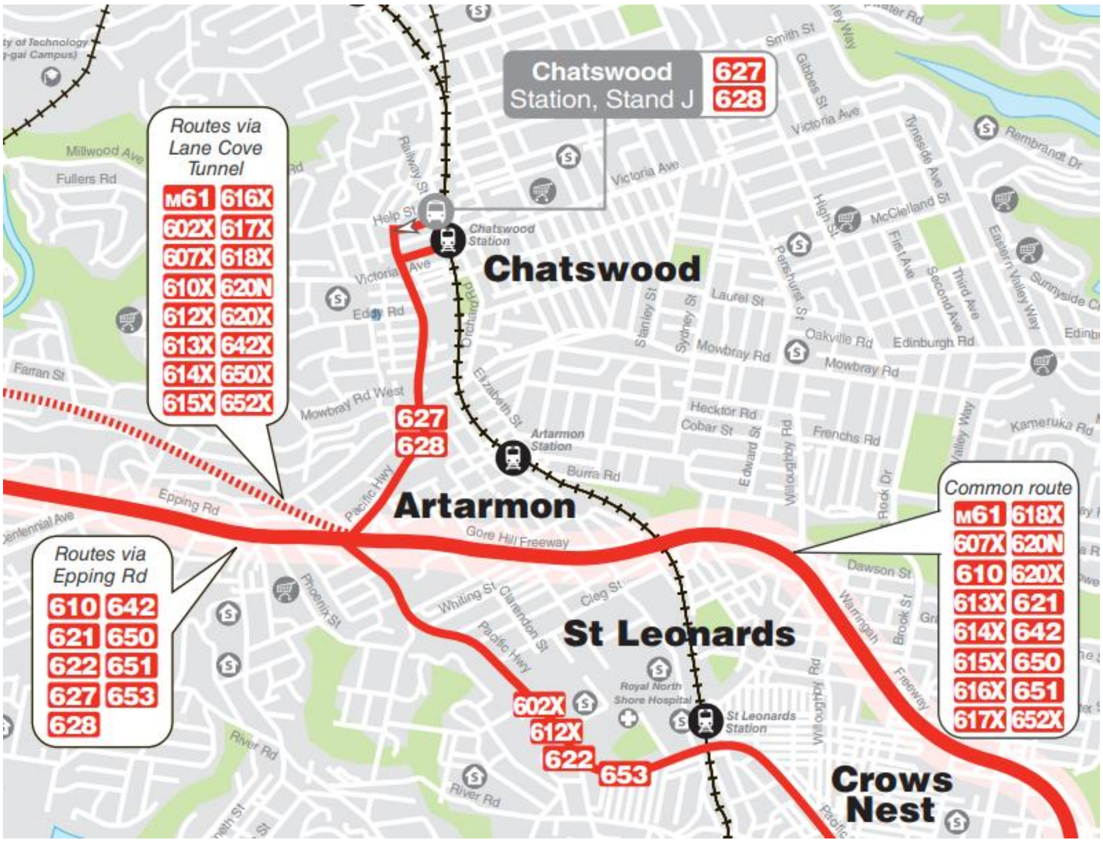

Figure 4-35 Bus routes – Gore Hill Freeway and Artarmon – Hillsbus

Source: Hills District Bus Guide (Hillsbus, 2019)

Figure 4-36 Bus routes – Gore Hill Freeway and Artarmon – Transdev NSW

Source: Upper North Shore network map (Transdev NSW, 2019)

4.4.8 Active transport network

The pedestrian network in the Gore Hill Freeway and Artarmon study area is well developed, with footpaths provided alongside the vast majority of roads and controlled crossings provided at most signalised intersections. Pedestrians are prohibited from walking along the Gore Hill Freeway and Lane Cove Tunnel. However, a shared user path is provided adjacent to the southern side of the Gore Hill Freeway. A high level of pedestrian activity occurs along Hampden Road within the vicinity of Artarmon railway station, around the commercial area of Artarmon, and around the health, educational and commercial land uses in St Leonards.

The cycle network in the Gore Hill Freeway and Artarmon study area is shown in Figure 4-37 and consists of a mixture of off-road shared user paths and on-road cycle routes on local and collector roads. The regional strategic cycle network provides connections between the study area and the Sydney CBD, St Ives, Castle Cove, Willoughby, Chatswood, St Leonards, Lane Cove and Macquarie Park. Bicycle parking facilities are available at Artarmon and St Leonards railway stations. Off-road shared user paths are provided at the following locations:

- Along the southern side of the Gore Hill Freeway
- Adjacent to Flat Rock Creek between Weedon Road and Flat Rock Drive
- Around Artarmon Reserve, Naremburn Park, Bicentennial Reserve and the Willoughby Leisure Centre.

The Gore Hill Freeway presents a barrier to north–south movements for pedestrians and cyclists, with crossings only available at select locations including:

- Shared user bridge connecting Willoughby Road and Slade Street in Naremburn
- Underpass connecting Park Road and Northcote Street in Naremburn to Willoughby Road in Willoughby
- Underpass connecting Chelmsford Avenue in Naremburn and Willoughby
- Hampden Road
- Reserve Road
- Pacific Highway.

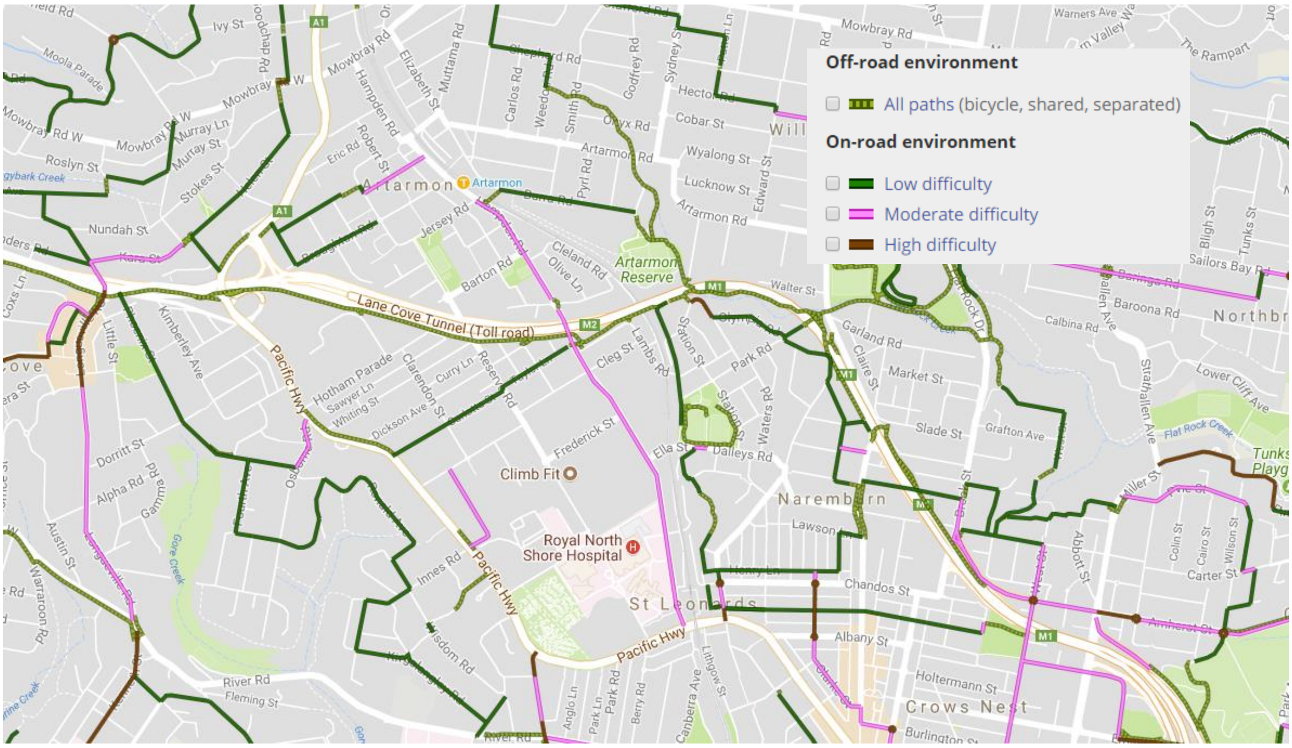

Figure 4-37 Cycle network in Gore Hill Freeway and Artarmon

Source: Cycleway Finder (Roads and Maritime, 2018)

A pedestrian and cyclist survey was carried out on Tuesday 28 November 2017, Saturday 2 December 2017 and Sunday 3 December 2017 between 6am and 8pm at the shared user path adjacent to the southern side of the Gore Hill Freeway, near Hampden Road in Artarmon. The survey results are provided in Figure 4-38 to Figure 4-40.

The survey results indicate that the shared user path is used by a high number of cyclists during the weekday morning and evening peak periods, with up to 125 cyclists recorded per hour between 7am and 9am. This can be attributed to the shared user path forming part of a regional cycle route connecting Naremburn, Lane Cove and Macquarie Park, with the majority of cyclists likely to be commuting to and from work. Weekday pedestrian volumes were substantially lower, with fewer than 25 pedestrians recorded during each hour surveyed. Pedestrian volumes remained low during the weekend, while weekend cyclist volumes were substantially lower compared to the weekday, with fewer than 25 cyclists recorded during each hour surveyed on Saturday and Sunday.

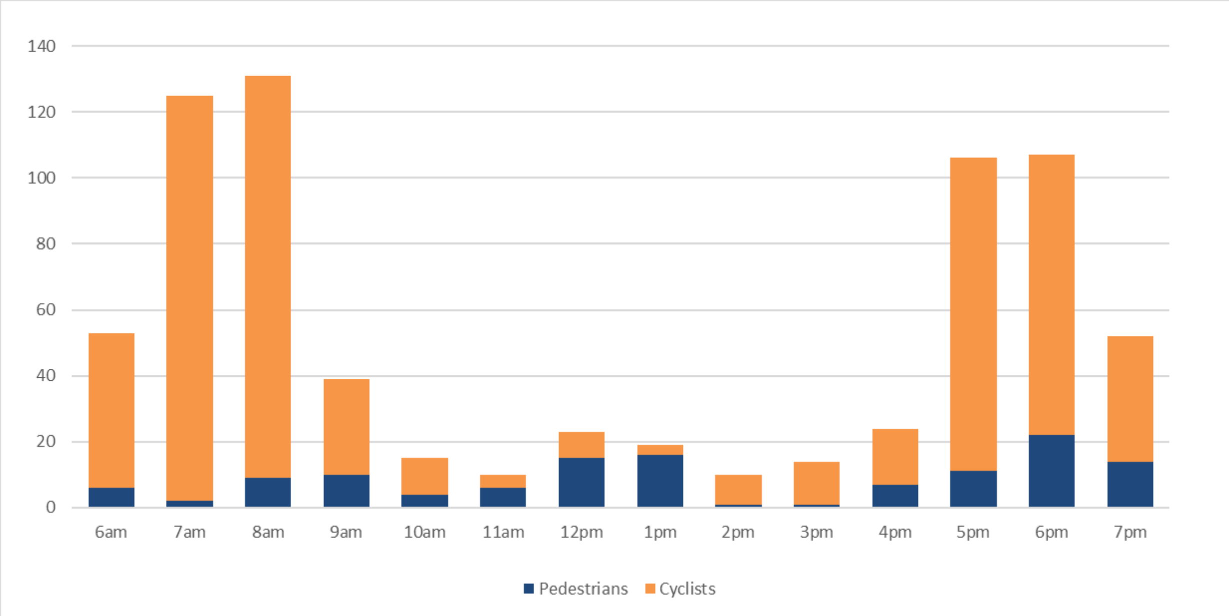

Figure 4-38 Weekday pedestrian and cyclist survey results – Gore Hill Freeway shared user path

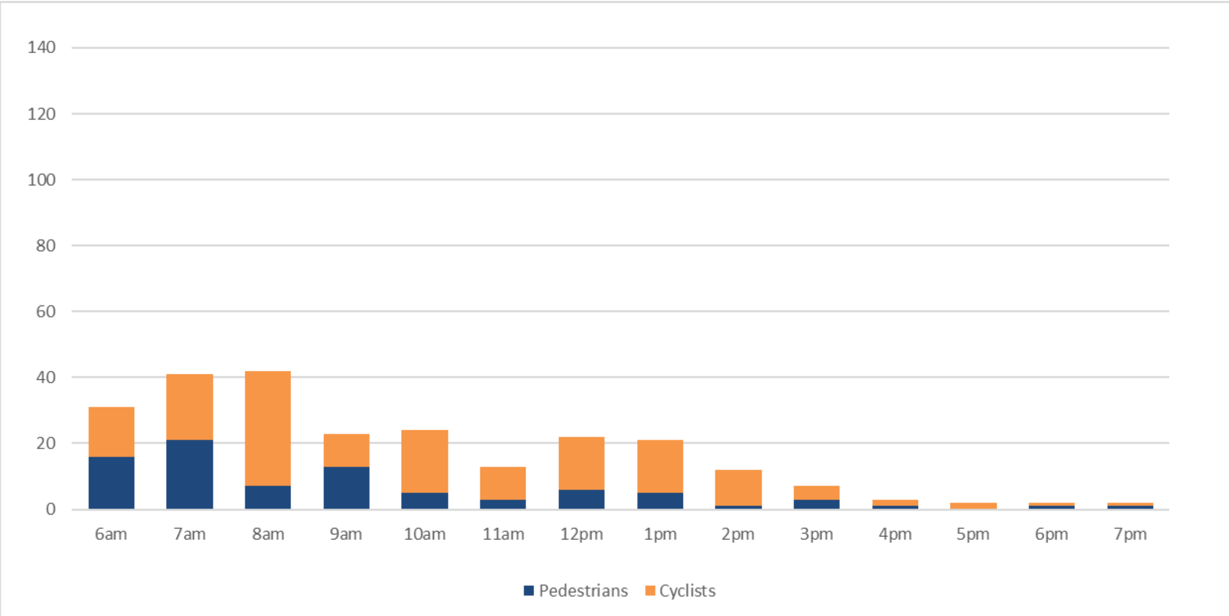

Figure 4-39 Saturday pedestrian and cyclist survey results – Gore Hill Freeway shared user path

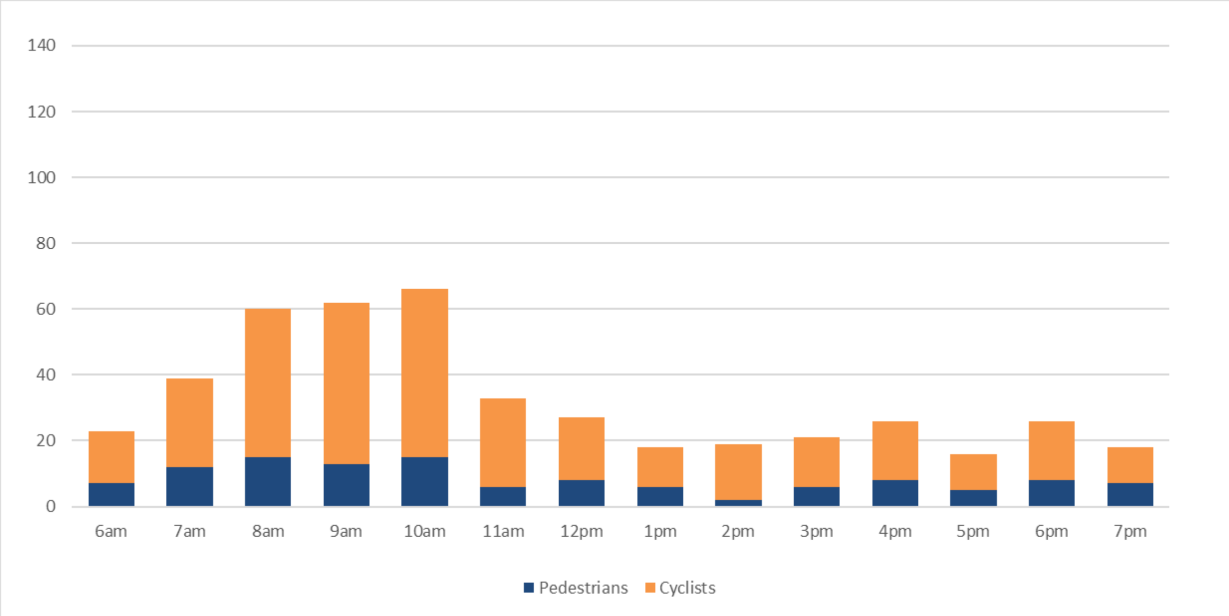

Figure 4-40 Sunday pedestrian and cyclist survey results – Gore Hill Freeway shared user path

4.5 Existing maritime activities

This section presents a summary of the existing maritime environment, described in more detail in the navigation impact assessment completed by Royal HaskoningDHV (provided in Appendix A).

The broad maritime footprint adopted for the traffic and transport assessment includes three areas of Port Jackson, which is a natural harbour of Sydney. These areas are:

- Outer Sydney Harbour: a wide waterway between Sydney Heads, the Opera House at Bennelong Point and Admiralty House at Kirribilli Point
- Inner Sydney Harbour: a high traffic area between the Outer Sydney Harbour, Yurulbin Point and Manns Point. The Harbour includes Circular Quay, Darling Harbour and the Bays Precinct
- Parramatta River and Lane Cove River: rivers that extend upstream of Yurulbin Point and merge at Greenwich Point.

4.5.1 Bathymetry and navigation widths

The Outer Sydney Harbour is relatively deep and wide, with water depths generally exceeding 15 metres below Chart Datum (CD) (expressed as -15 metres CD). In the vicinity of Bennelong Point and Kirribilli Point, the navigable width of the water is about 450 metres. Sow and Pigs Reef, located between Middle Head and South Head at the entrance to Sydney Harbour is shallow and has dredge channels on either side, with a minimum depth of -13.7 metres CD.

The Inner Sydney Harbour is narrower than the Outer Sydney Harbour with water depths typically ranging between -12 and -14 metres CD and navigable widths between 310 and 360 metres. Deep holes are located near McMahons Point (-44 metres CD), Balls Head (-31 metres CD) and Yurulbin Point (-18 metres CD). Between Birchgrove and Berrys Bay, the depth of the channel averages about -15 metres CD, with a navigable width of about 620 metres.

Navigation widths in Darling Harbour and Johnstons Bay on approach to White Bay and Glebe Island are also relatively narrow, with a minimum width of about 240 metres. Defined turning basins are provided for vessels accessing White Bay and Glebe Island.

A detailed bathymetry map is provided in the navigation impact assessment (Appendix A).

4.5.2 Ferries

Ferry services are provided from wharves located in Balmain, Balmain East, Birchgrove, McMahons Point and Milsons Point. The F3 Parramatta River route that provides direct connections to Circular Quay, Barangaroo and locations along the Parramatta River is accessible from the Balmain, Balmain East, McMahons Point and Milsons Point wharves, and the F8 Cockatoo Island route that provides direct connection between Circular Quay and Cockatoo Island is accessible from the Balmain and Birchgrove wharves. Balmain East, McMahons Point and Milsons Point wharves are also served by the F4 Cross Harbour route that provides direct connections to Circular Quay, Barangaroo, Pyrmont Bay, Rose Bay and Watsons Bay. There are about 100 timetabled services on the F3 Parramatta River route on weekdays and 80 services on weekends and public holidays. There are about 80 timetabled services on the F4 Cross Harbour route on weekdays and 90 services on weekends and public holidays. There are about 50 timetabled services on the F8 Cockatoo Island route on weekdays and 30 services on weekends and public holidays.

Captain Cook Cruises operates a Lane Cove to City service, which operates Monday to Friday, with six services in the morning and three in the evening. The service stops at Birchgrove Ferry Wharf during the private school term only; twice in the morning and twice in the evening.

Five other ferry services operate throughout Sydney Harbour, but do not service areas within the immediate vicinity of the proposed works for the project. Figure 4-41 shows the existing Sydney Ferries network.

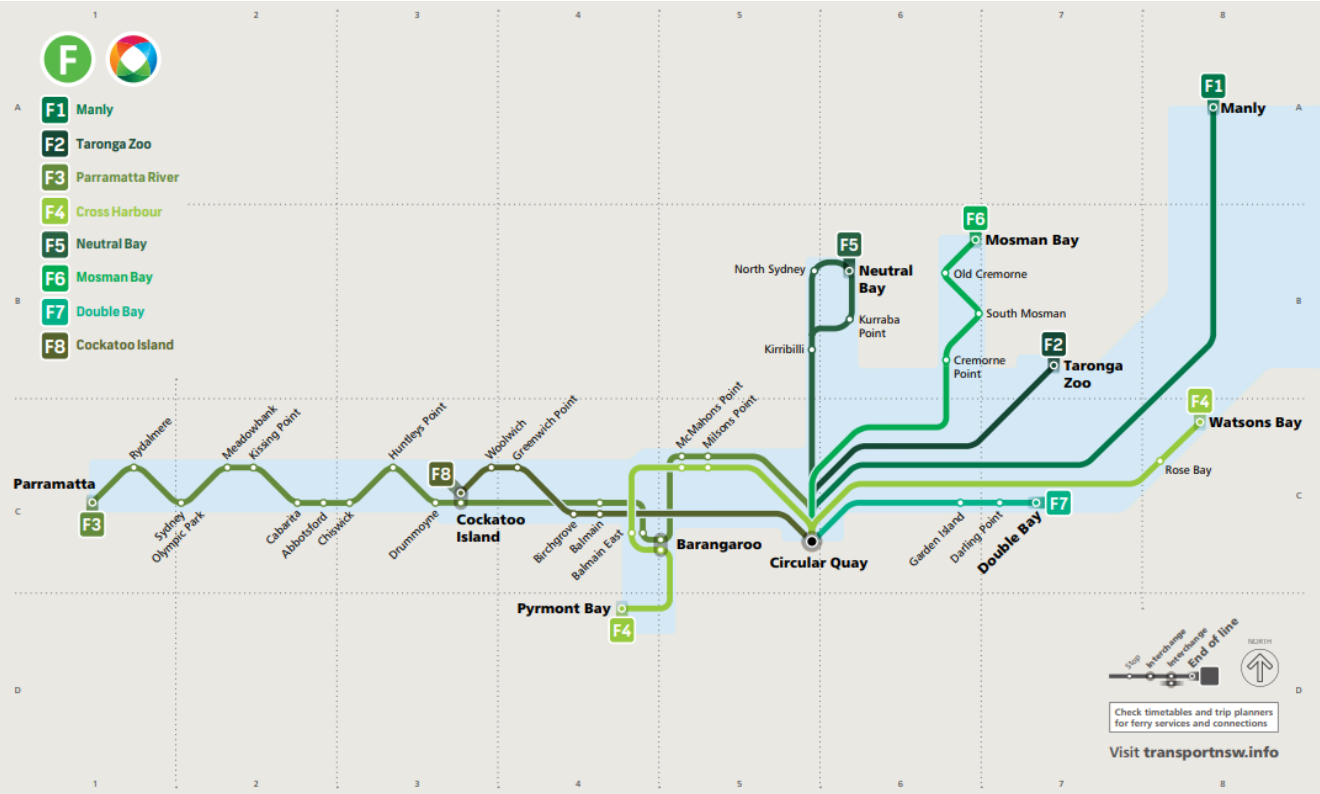

Figure 4-41 Existing Sydney Ferries network

Source: Sydney Ferries Network (Transport for NSW, 2018c)

4.5.3 Commercial operations

The majority of commercial operations in Sydney Harbour are located in the Bays Precinct, which has been retained as a working harbour, or nearby Darling Harbour and Balmain.

Commercial operations in these areas include:

- Pleasure craft and cruising around landmarks
- Commercial tankers and bulk carriers
- Water taxis
- Commercial adventure vessels
- International cruise ships
- Naval activities
- Seaplane operations.

Cruise, container and bulk shipping terminals

Sydney Harbour is an important destination for cruise ships and the only port in Australia with two dedicated cruise facilities; the Overseas Passenger Terminal at Circular Quay and White Bay Cruise Terminal in Balmain. The Overseas Passenger Terminal is Sydney's primary cruise ship terminal, with the White Bay Cruise Terminal used when the former is occupied. The White Bay Cruise Terminal also services small cruise ships that can pass under the Harbour Bridge.

A summary of scheduled cruise ship movements at each terminal in 2018 and 2019 is shown in Table 4-23. The Overseas Passenger Terminal is unavailable each year during special events such as the New Year's Eve fireworks, Australia Day, the Sydney Harbour 10K run and the Blackmores Running Festival.

Table 4-23 Cruise ship movements (2018/2019)

Terminal	2018	2019
Overseas Passenger Terminal	234	245
White Bay Cruise Terminal	123	126

Source: Cruise Schedule (Port Authority of NSW, 2017)

In addition to the Overseas Passenger Terminal and White Bay Cruise Terminal, berths are also provided at Glebe Island, White Bay and Gore Cove (private facilities). The Sydney Harbour port precinct, focused around Glebe Island and White Bay, accommodates dry bulk imports, general cargo, the cruise industry and common user berth movements. Common user berth movements include refuelling activities, servicing marine construction, emergency and planned maintenance, and facilitating major harbour events and functions. There is also a fuel terminal at Gore Cove, which supplies fuel to the Sydney and NSW markets.

White Bay and Glebe Island form part of the Bays Precinct. This precinct consists of waterways and the foreshores of Johnstons Bay, White Bay, Rozelle Bay and Blackwattle Bay. The Bays Precinct plays an important role in supporting Sydney Harbour as a working harbour and accommodates maritime uses from the public and private sectors. All vessels access Rozelle Bay and Blackwattle Bay through the swing section of Glebe Island Bridge, as well as underneath the ANZAC Bridge.

Approximately 80 movements of tankers have been registered over a period of one year. However, numerous additional movements of bunkering barges have not been registered.

Figure 4-42 shows the Sydney Harbour port precinct and main shipping channels through the harbour.

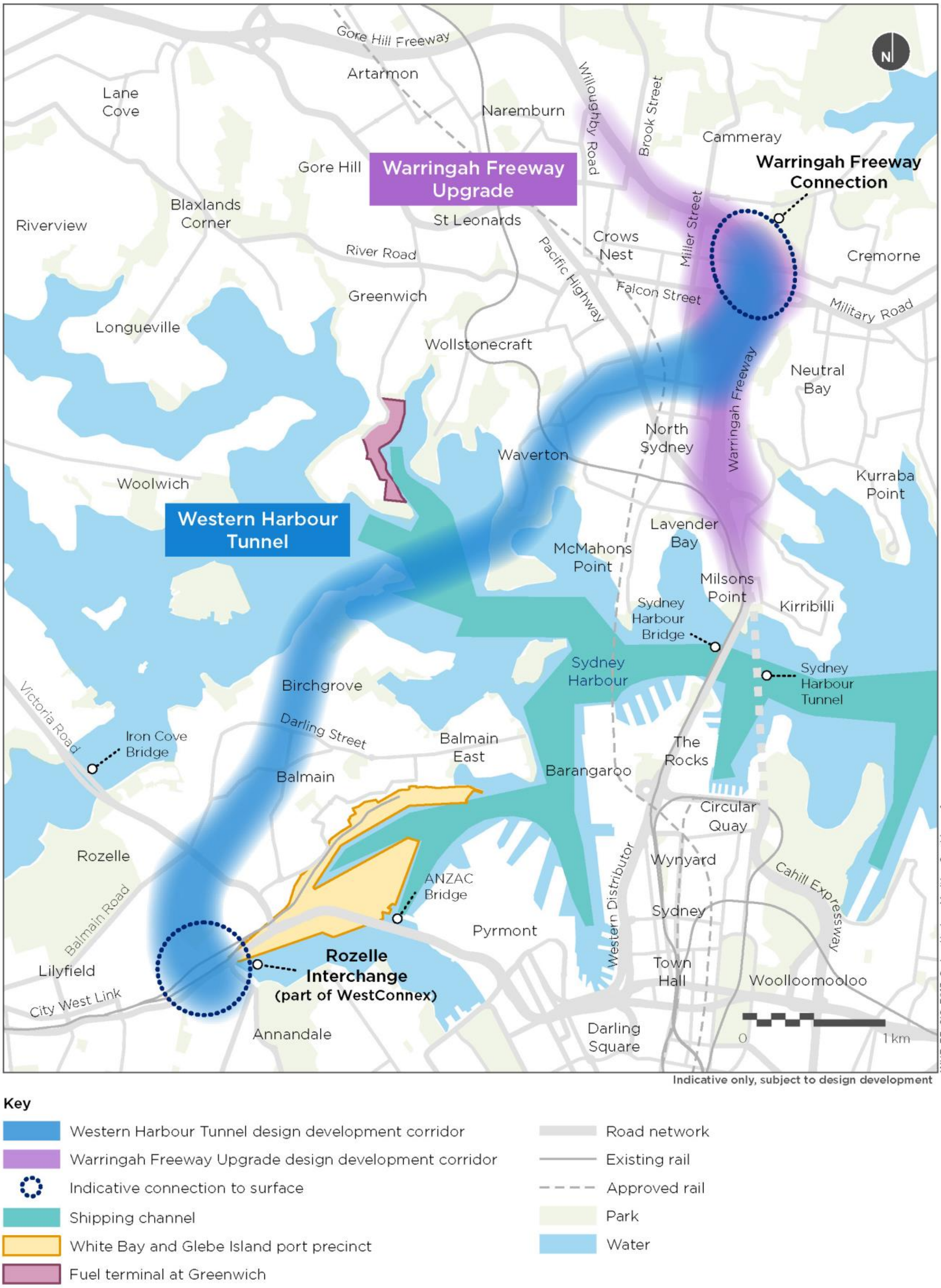

Figure 4-42 Maritime corridors in Sydney Harbour

Charter companies

Yacht charter, deep sea fishing charter and boat hire companies are located in Sydney Harbour and its estuaries. Due to fishing restrictions in Sydney Harbour, fishing charter companies generally operate offshore. Charter companies include:

- Liquid Edge Yacht Charters in Balmain
- Deep Blue Charters in Balmain
- SailCorp Yacht Charters in McMahons Point
- Sydney Harbour Yacht Charter in Berrys Bay
- Sydney Motor Yacht Charters in Darling Harbour
- Australian Superyachts in Pyrmont.

In addition, Blackwattle Bay is a designated berthing area for charter vessels.

Government organisations

A number of government organisations operate around Sydney Harbour. These include:

- Royal Australian Navy
  - HMAS Waterhen, located at the western side of Balls Head, is the Navy's lead establishment for mine warfare
  - Naval base at Garden Island, which is also referred to as Fleet Base East or HMAS Kuttabul
  - Designated naval waters at Spectacle Island on the Parramatta River, Chowder Bay, Rose Bay near Steele Point and Shark Island, and Man of War Anchorage near Garden Island and Clark Island
- NSW Department of Planning, Industry and Environment (Regions, Industry, Agriculture & Resources) in Wollstonecraft, east of Gore Bay
- Water Police, operating from Camerons Cove immediately east of White Bay
- Roads and Maritime's maritime division based in Rozelle Bay.

4.5.4 Recreational activity

Sydney Harbour and the Parramatta and Lane Cove Rivers cater to a wide-range of recreational activities including:

- Rowing
- Sailing
- Dragon boating
- Kayaking
- Swimming and diving.

Foreshore recreation activities are numerous in the Outer Sydney Harbour, with many reserves and sandy beaches suitable for swimming and bathing. In contrast, foreshore recreation in the Inner Sydney Harbour and Parramatta and Lane Cove Rivers is limited due to the majority of foreshore areas being steep and rocky, privately owned, or well-developed.

Restrictions are enforced within some areas of the Harbour for superyachts. Restricted areas include Cockle Bay (during times when a closure notice is displayed), Circular Quay (which is for ferry and passenger ships), and Campbells Cove (unless permission is granted by Roads and Maritime).

Community groups and clubs that use the Harbour include:

- Paddle craft clubs
- Fishing clubs
- Sailing and yacht clubs
- Scout and guide clubs
- Marine Rescue NSW.

Additional details of these user groups, including course maps for these clubs, are provided in Appendix A.

The *Regional Boating Plan – Sydney Harbour Region* (Transport for NSW, 2015) states that about 20,000 recreational vessels are registered within Sydney Harbour. In recent years, more than one million people participated in boating annually as a form of recreation.

4.5.5 Maritime facilities

Facilities such as moorings, dry dock storage facilities, marinas and boat ramps are provided throughout the Harbour for commercial operators and recreational user groups. Locations of these moorings are shown in Figure 4-43 while the dry dock storage, marinas and boat ramps are outlined in Table 4-24. Additional information is provided in the navigation impact assessment (Appendix A).

Within the immediate vicinity of the project's proposed Sydney Harbour crossing, the foreshore at Yurulbin Park is lined by a sandstone block seawall, with a number of jetties, pontoons and mooring pens adjoining private residences. At Balls Head, the foreshore is undeveloped, and is the site of the former Coal Loader Wharf and HMAS Waterhen to the west and the former British Petroleum (BP) fuel terminal to the east. In addition, there are some disused marinas and jetties, including Woodleys Marina.

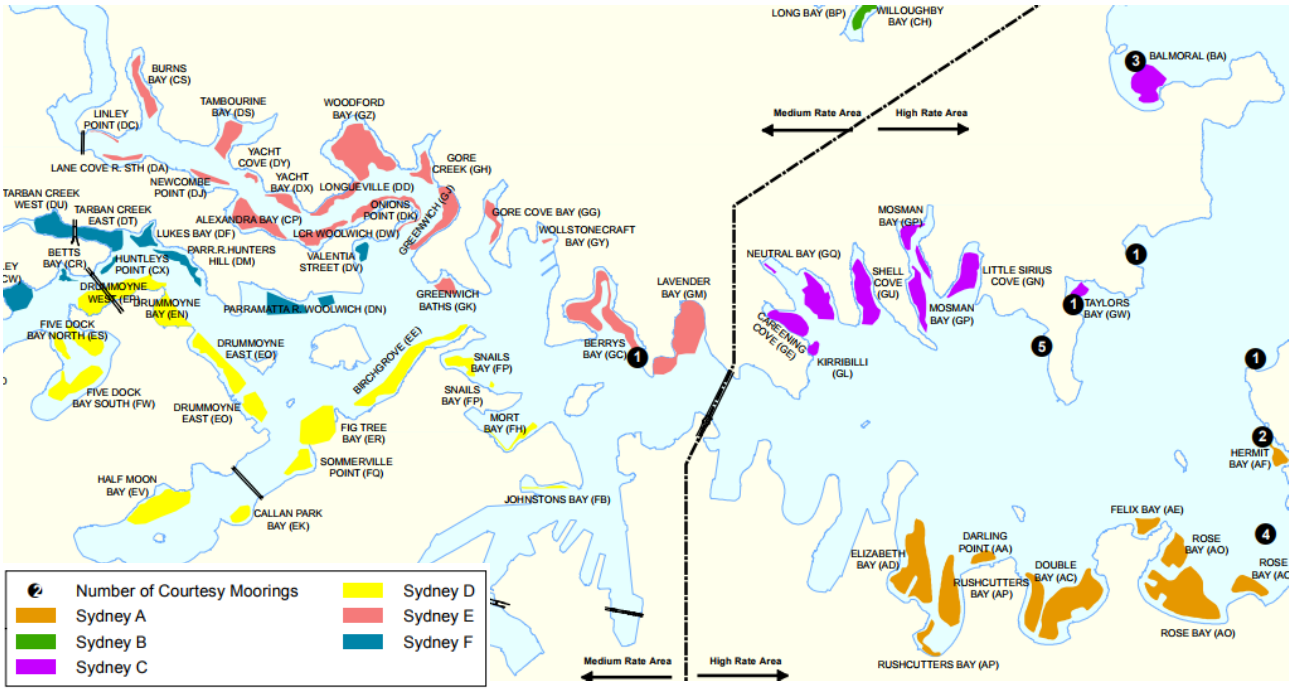

Figure 4-43 Moorings within Sydney Harbour

Source: Sydney Harbour mooring map (Roads and Maritime, 2016)

Table 4-24 Marinas, boat ramps and dry dock facilities within Sydney Harbour

Facility	Location
Marina	• Private marinas in Birchgrove, Rozelle and Wollstonecraft • Balmain Marina and Camerons Marina in Balmain • Birkenhead Point Marina in Birkenhead • Gladesville Bridge Marina in Drummoyne • D'Albora Marinas Cabarita Point in Cabarita • Pulpit Point Marina in Hunters Hill • Woolwich Marina in Woolwich • Sydney Superyacht Marina in Rozelle • Mosman Bay Marina in Mosman • Rose Bay Marina in Rose Bay • Point Piper Marina and Royal Yacht Club Marina in Point Piper • Double Bay Marina in Double Bay • D'Albora Marina and Cruising Yacht Club of Australia (CYCA) Marina in Darling Point.
Boat ramp and dry storage	• Small boat ramps in Lilyfield, Cabarita Park and Greenwich • Talpin Park boat ramp in Drummoyne • Bayview Park boat ramp in Concord • Blaxland Road boat ramp in Rhodes • Silverwater Park boat ramp in Silverwater • Wharf Road boat ramp in Ermington • Kissing Point boat ramp in Putney • Woolwich boat ramp in Woolwich • Burns Bay Reserve boat ramp in Riverview • Lyne Park boat ramp in Rose Bay • Sydney Boathouse dry boat storage in Rozelle • Sydney Harbour Boat Storage in Balmain.

4.5.6 Navigation restrictions

Navigation restrictions that apply to vessels travelling within the project footprint during construction include:

- Gore Cove fuel terminal, operated by Viva Energy Australia – Vessels must be at least 100 metres from the wharf face or 50 metres from a tanker berthed at the terminal
- HMAS Waterhen, an Australian Defence Force facility – Vessels are required to keep clear of the facility by staying outside the yellow buoys
- All land and structures including moorings and dolphin berths at Snails Bay – Vessels travelling more than six knots are required to maintain a distance of 30 metres from vessels, land or structures
- Sydney Harbour Bridge transit zone between Millers Point and Blues Point to the west, extending to between Kirribilli Point and Bennelong Point to the east – Vessels must not exceed 15 knots in the transit zone and they are not permitted to stop, anchor or drift
- Darling Harbour speed limit area, upstream of a line between Barangaroo Point and Balmain East Ferry Wharf – A speed limit of eight knots is imposed and is reduced to four knots upstream of ANZAC Bridge and upstream of King Street Wharf

- Waters between a line from Inner South Head to Inner North Head and a line from the stone pillar at Bradleys Head to Hermit Point – A speed limit of 12 knots is imposed for vessels exceeding 30 metres
- Waters between a line from the stone pillar at Bradleys Head to Hermit Point and a line from Balls Head to Ballast Point – A speed limit of 12 knots is imposed for vessels exceeding 30 metres
- Waters between a line from Balls Head to Ballast Point – A speed limit of 10 knots is imposed for vessels exceeding 30 metres
- Waters upstream of a line between Balls Head and Ballast Point – A speed limit of six knots is imposed for vessels exceeding 30 metres
- Aquatic events – Additional restrictions may be imposed by an Aquatic Event such as a race, competition or exhibition, and an aquatic licence issued by Roads and Maritime may be required for organised activities on navigable waters that restrict the availability of those waters for normal use by the public. Roads and Maritime may elect to establish an exclusion zone around the activity.

5. Construction impact assessment

This section provides an assessment of the potential traffic and transport impacts associated with construction of the project and addresses the following issues:

- Summary of construction activities
- Location of construction activities and worksites
- Impacts of changed conditions as a result of construction activities on traffic (road and maritime), public transport, pedestrians and cyclists
- Impacts of additional traffic associated with construction activities.

The assessment conservatively focusses on the impacts during peak construction activities to demonstrate the maximum potential impact of the project. For example, the traffic performance effects of the highest potential construction site traffic generation per hour. These peak construction activities assessed are likely to be relatively short in duration; they would only occur for a small proportion of the overall construction program. Therefore, generally, typical site traffic generated per hour would be lower than the peak site traffic numbers which were assessed to demonstrate the maximum potential expected impacts.

5.1 Construction overview

5.1.1 Construction stages and program

Subject to planning approval, construction of the Western Harbour Tunnel and Warringah Freeway Upgrade project is planned to commence in 2020, with completion of construction in 2026. The total period of construction works would be about six years. Key stages and an indicative program for the construction of the Western Harbour Tunnel and Warringah Freeway Upgrade are shown in Table 5-1. Typical activities for each stage of construction are described in Table 5-2.

The construction delivery method for the project would depend on future project decisions.

Where feasible and reasonable, some aspects of the Western Harbour Tunnel component of the project could be delivered by the Warringah Freeway Upgrade construction contractor to minimise disruption to the Warringah Freeway.

It is assumed that the project would commence construction before the Beaches Link and Gore Hill Freeway Connection project which is subject to separate assessment and approval. Should timeframes for the Beaches Link component of the Beaches Link and Gore Hill Freeway Connection project be advanced, some elements would be delivered to safeguard delivery of either surface connections or tunnel-to-tunnel connections for the Western Harbour Tunnel and Warringah Freeway Upgrade project or the Beaches Link components. Should the Beaches Link and Gore Hill Freeway Connection project be constructed before the Western Harbour Tunnel component, the Beaches Link component would construct stub tunnels at Cammeray to connect to the Western Harbour Tunnel component in the future.

Table 5-1 Construction stages and indicative timing

Construction activity	Indicative construction program																											
	2020				2021				2022				2023				2024				2025				2026			
Western Harbour Tunnel and Warringah Freeway Upgrade early works and site establishment				■	■	■	■	■	■																			
Construction of the Warringah Freeway Upgrade component						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■						
Construction of driven tunnels								■	■	■	■	■	■	■	■													
Immersed tube tunnel preparatory works, construction, installation, fitout and reinstatement works								■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
Tunnel fitout and finishing													■	■	■	■	■	■	■	■	■	■	■	■				
Construction of operational facilities												■	■	■	■	■	■	■	■									
Testing and commissioning																		■	■	■	■	■	■	■	■			
Site clean-up and demobilisation																			■	■	■	■	■	■	■			

Table 5-2 Overview of construction activities

Component	Typical activities
Early works and site establishment	• Property acquisitions and condition surveys • Utilities installation, protection, adjustments and relocation • Land remediation, heritage salvage and conservation works (where required) • Installation of site fencing, environmental controls (including noise attenuation) and traffic management measures • Vegetation clearing, earthworks and demolition of structures • Temporary relocation of swing moorings where required • Relocation of the historic Baragoola and M.V. Cape Don, with reasonable notice for the vessel owners to find a suitable alternate berth within Sydney Harbour prior to the start of construction. • Relocation of bus stops • Establishment of construction support sites (including site access and acoustic sheds, where required).

Component	Typical activities
Construction of Western Harbour Tunnel component	• Excavation of tunnel construction accesses • Construction of driven tunnels and surface connections • Construction of cut and cover and trough structures • Cofferdam construction and dredging activities in preparation for the installation of immersed tube tunnels • Casting and installation of immersed tube tunnels (crossing of Sydney Harbour) • Civil finishing and tunnel fitout • Construction of operational facilities including: - A motorway control centre at Artarmon - Motorway facilities, tunnel support facilities and ventilation outlet at Cammeray for the Western Harbour Tunnel component. The civil construction of the Beaches Link ventilation outlet at the Warringah Freeway would be carried out as part of the project to minimise future disruption to the Warringah Freeway corridor and maximise construction efficiency. Fitout of the Beaches Link ventilation outlet would form part of the Beaches Link and Gore Hill Freeway Connection project - Construction and fitout of the Western Harbour Tunnel operational facilities that form part of the M4-M5 Link Rozelle East Motorway Operations Complex - A wastewater treatment plant at Rozelle - Installation of motorway tolling infrastructure.
Surface road works	• Earthworks • Bridgeworks • Construction of retaining walls • Construction and installation of stormwater drainage • Pavement works and linemarking • Installation of road furniture, lighting, signage and noise barriers.
Testing, commissioning and site rehabilitation	• Testing of plant and equipment • Commissioning of the project • Backfill of access declines and shafts • Removal of construction support sites • Landscaping and rehabilitation of disturbed areas • Removal of environmental and traffic controls.

5.1.2 Construction footprint

The total area required for construction of the project is referred to as the construction footprint. The construction footprint consists of the anticipated area needed for the project and includes construction support sites and additional areas where work would be required to construct the project.

Most of the construction would be underground (the mainline and ramp tunnels). However, surface areas would be required to support tunnelling activities and to construct the surface connections, tunnel portals, surface road works, shared user paths and operational facilities.

An overview of the construction footprint is shown in Figure 5-1 to Figure 5-6.

To facilitate construction for Western Harbour Tunnel component, 11 construction support sites would be required. An additional nine construction support sites would also be required for the Warringah Freeway Upgrade component. These sites are summarised in Table 5-3 and Table 5-4, respectively.

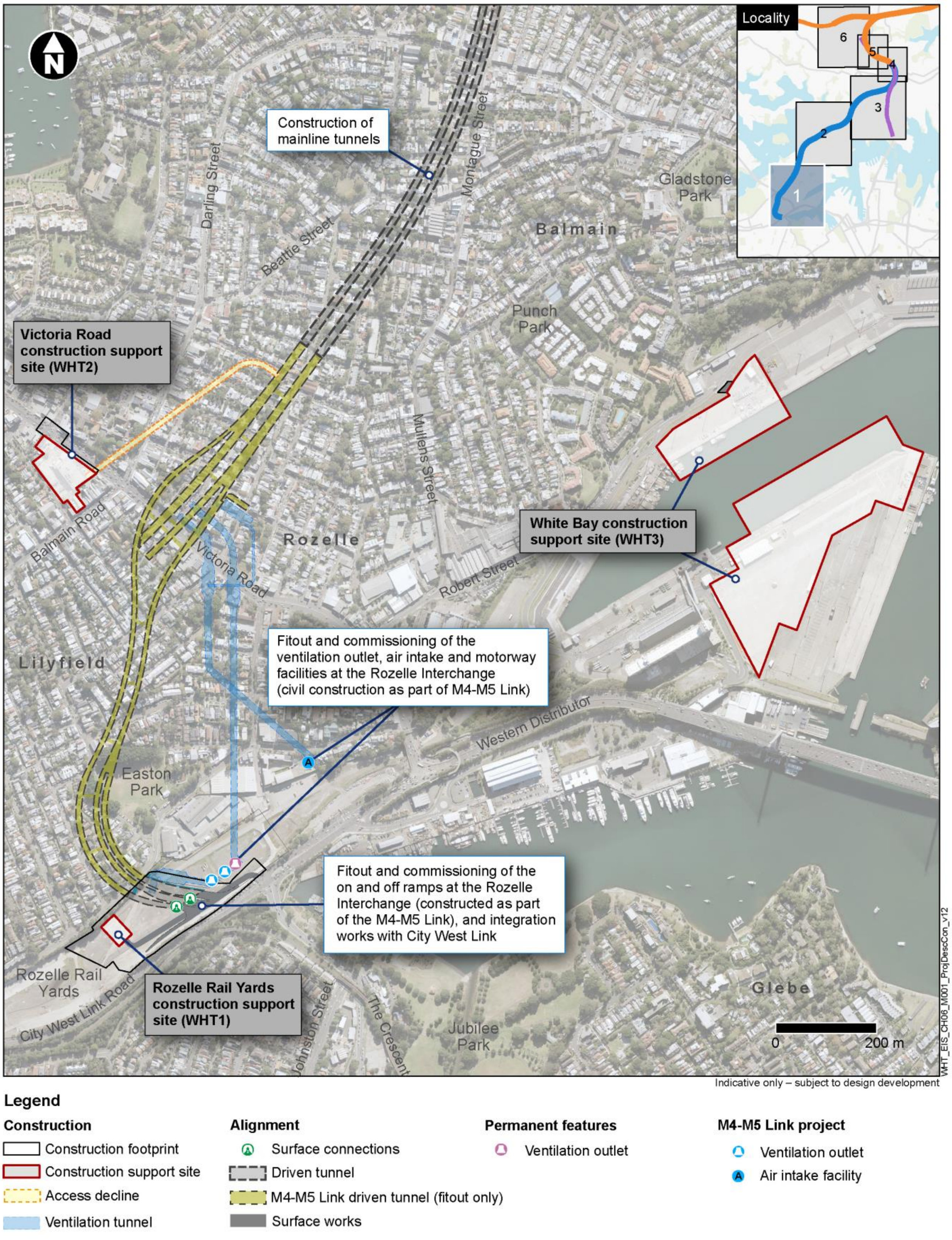

Figure 5-1 Construction footprint around Rozelle (map 1)

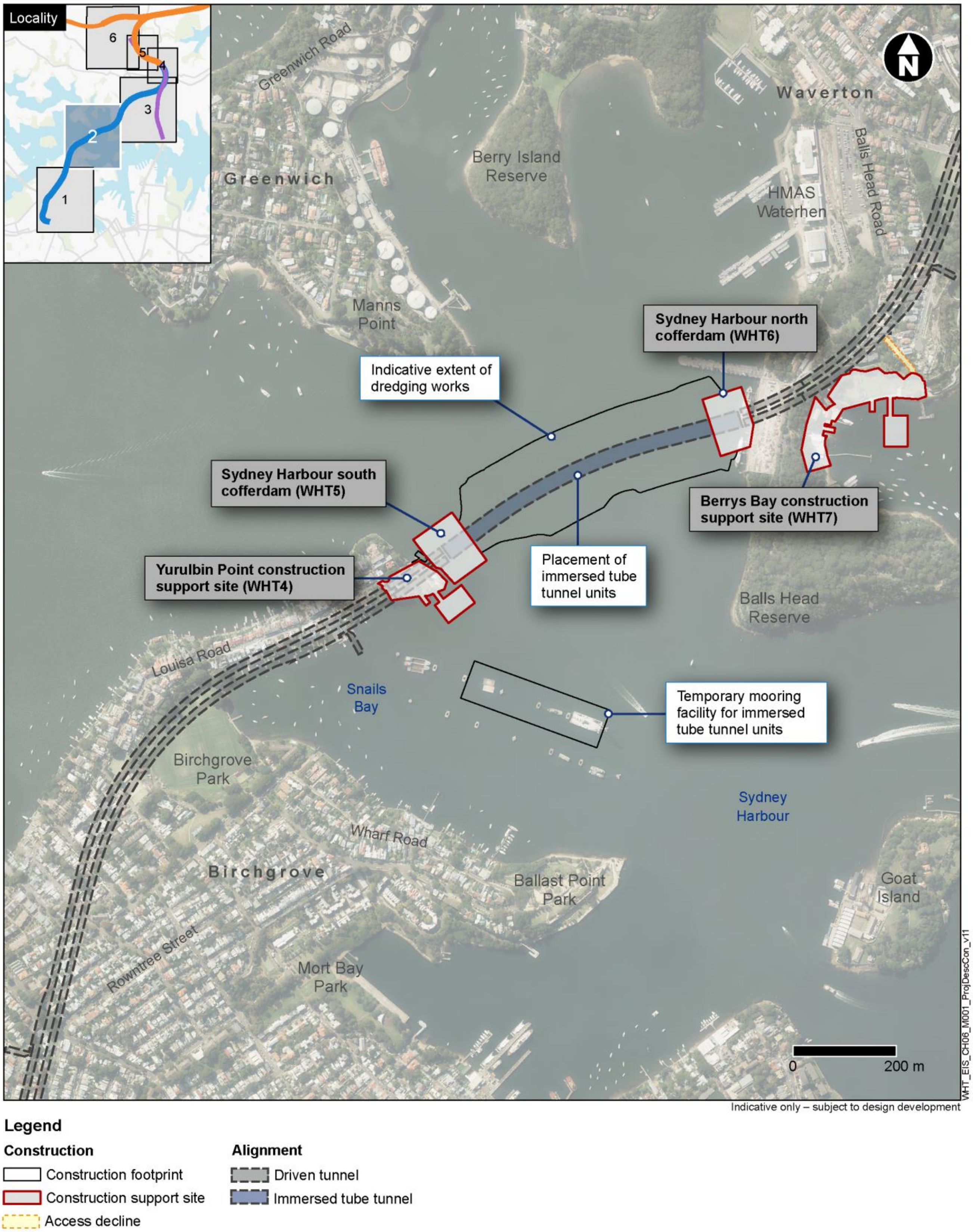

Figure 5-2 Construction footprint around Sydney Harbour (map 2)

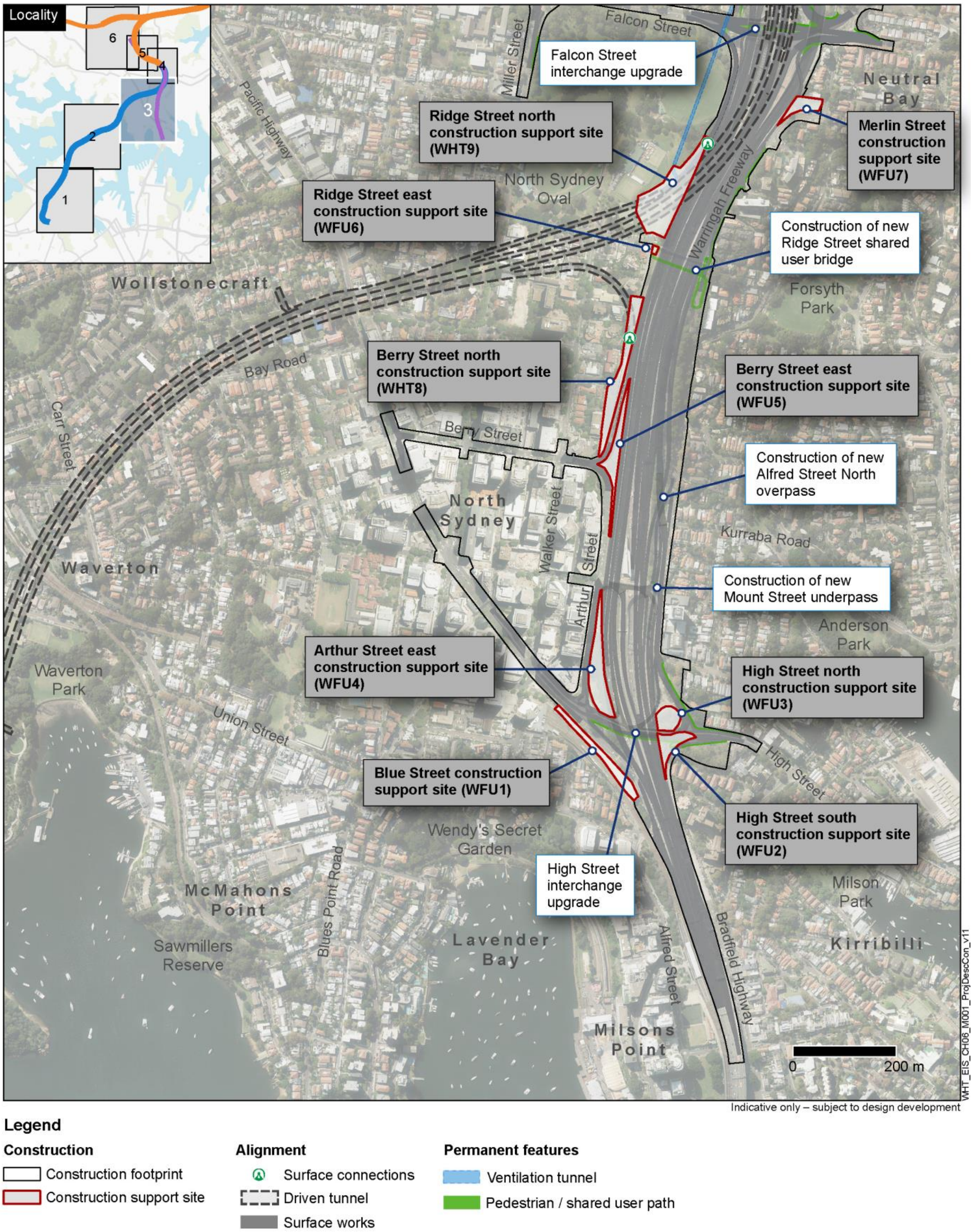

Figure 5-3 Construction footprint around North Sydney (map 3)

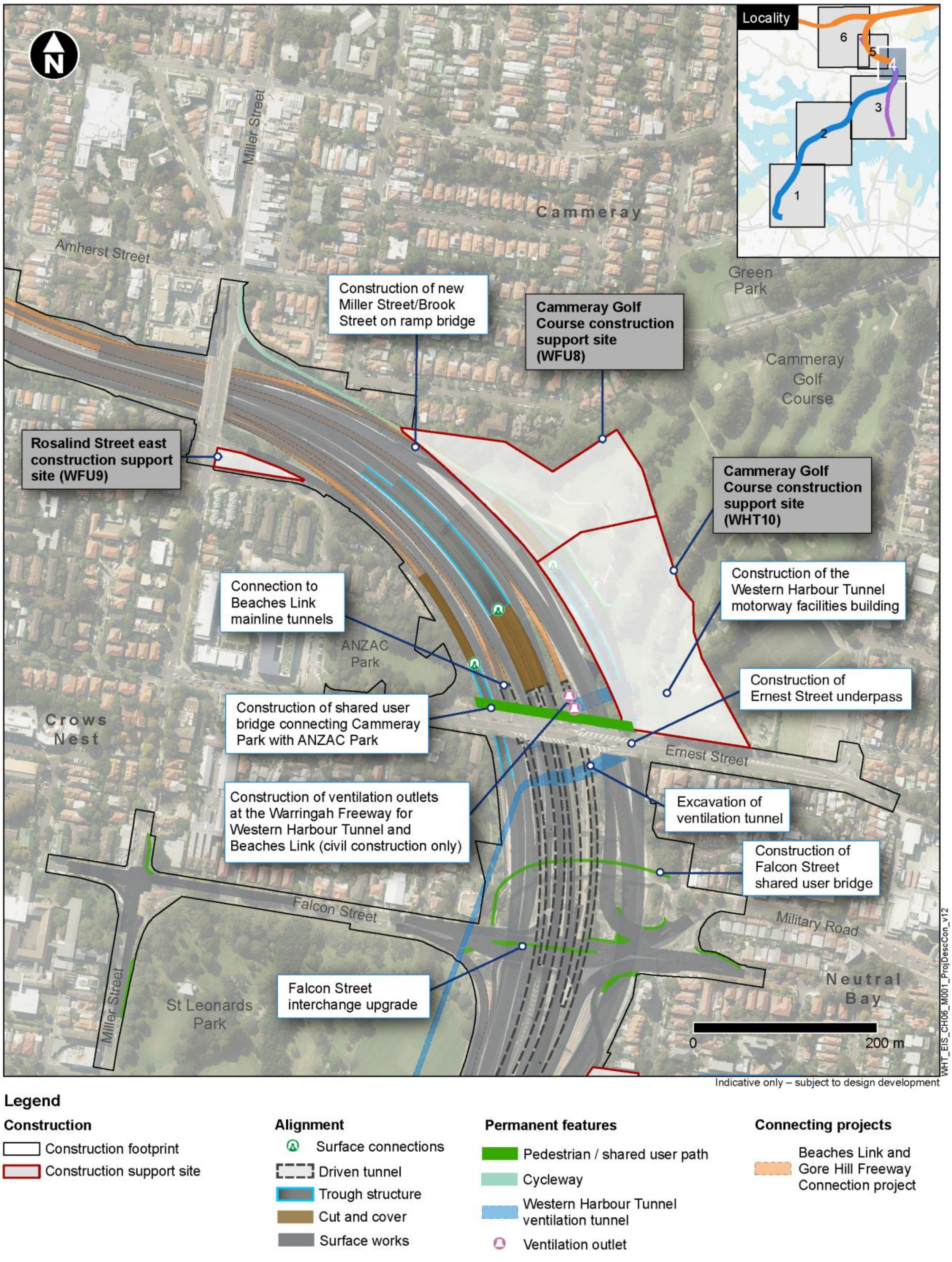

Figure 5-4 Construction footprint around Cammeray (map 4)

Figure 5-5 Construction footprint around Naremburn (map 5)

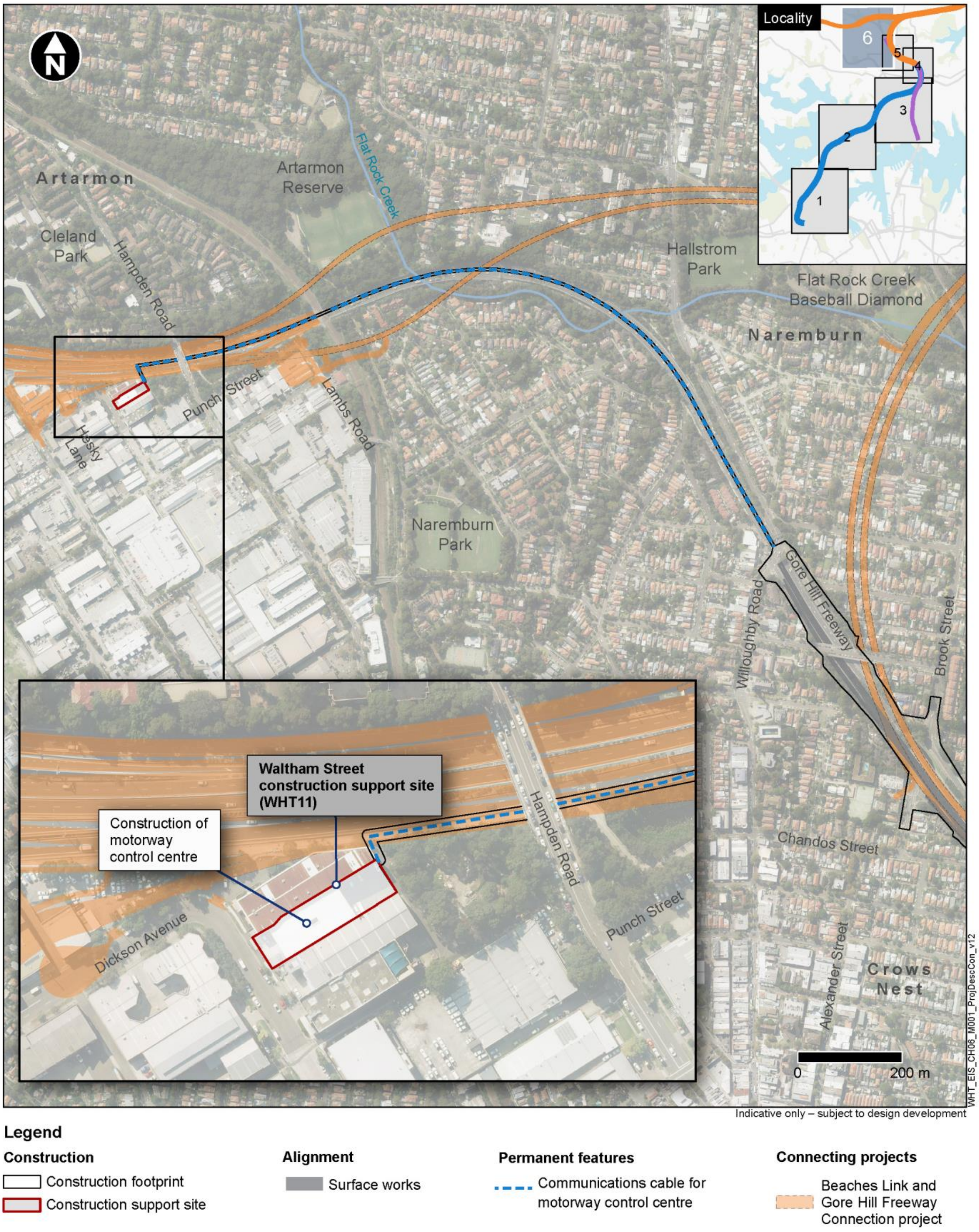

Figure 5-6 Construction footprint around Artarmon (map 6)

Table 5-3 Summary of activities proposed at the Western Harbour Tunnel construction support sites

No.	Site	Study area	Temporary site facilities/uses												Peak vehicle movements per day (worst case)		Peak vessel movements per day (worst-case)	
			Site offices	Staff amenities	Tunnelling launch and support	Workshop	Car park	Laydown facilities	Sediment pond	Spoil shed	Water treatment plant	Substation	Ventilation plant	Mooring of pontoon facilities	Light	Heavy	Light	Heavy
WHT1	Rozelle Rail Yards	Rozelle and surrounds	X	X	X	X	X	X	X	X	X		X		305	165	-	-
WHT2	Victoria Road	Rozelle and surrounds	X	X	X	X	X	X	X	X	X				230	420	-	-
WHT3	White Bay	Rozelle and surrounds	X	X		X	X		X					X	530	700	22	48
WHT4	Yurulbin Point	Rozelle and surrounds	X	X	X	X	X		X	X	X			X	-	-	8	16
WHT5	Sydney Harbour south cofferdam	-	X			X		X						X	-	-	8	18
WHT6	Sydney Harbour north cofferdam	-	X			X		X						X	-	-		
WHT7	Berrys Bay	Warringah Freeway and surrounds	X	X	X	X			X	X	X			X	210	55	6	12
WHT8	Berry Street north	Warringah Freeway and surrounds	X	X			X	X							130	30	-	-
WHT9	Ridge Street north	Warringah Freeway and surrounds					X	X							165	200	-	-

No.	Site	Study area	Temporary site facilities/uses												Peak vehicle movements per day (worst case)		Peak vessel movements per day (worst-case)	
			Site offices	Staff amenities	Tunnelling launch and support	Workshop	Car park	Laydown facilities	Sediment pond	Spoil shed	Water treatment plant	Substation	Ventilation plant	Mooring of pontoon facilities	Light	Heavy	Light	Heavy
WHT10	Cammeray Golf Course	Warringah Freeway and surrounds	X	X	X	X	X	X	X	X	X	X	X		480	485	-	-
WHT11	Waltham Street	Gore Hill Freeway and Artarmon													180	65	-	-

An application for offshore disposal of suitable dredged material has been submitted to the Commonwealth Department of the Environment and Energy. An additional four barge movements would be generated per day, transporting dredged material suitable for offshore disposal from the Sydney Harbour dredge area to the designated offshore disposal site.

Table 5-4 Summary of activities proposed at the Warringah Freeway Upgrade construction support sites

No.	Site	Study area	Temporary site facilities/uses						Peak vehicle movements per day (worst case)	
			Site offices	Project management compound	Staff amenities	Workshop/store	Car park	Laydown facilities	Light	Heavy
WFU1	Blue Street	Warringah Freeway and surrounds	X	X	X		X	X	315	10
WFU2	High Street south	Warringah Freeway and surrounds	X		X		X	X	80	15
WFU3	High Street north	Warringah Freeway and surrounds			X		X	X	65	10
WFU4	Arthur Street east	Warringah Freeway and surrounds	X		X		X	X	135	10
WFU5	Berry Street east	Warringah Freeway and surrounds					X	X	30	30
WFU6	Ridge Street east	Warringah Freeway and surrounds	X		X			X	70	20
WFU7	Merlin Street	Warringah Freeway and surrounds	X		X		X	X	150	0
WFU8	Cammeray Golf Course	Warringah Freeway and surrounds	X	X	X	X	X	X	865	40
WFU9	Rosalind Street east	Warringah Freeway and surrounds	X		X		X	X	205	15

In addition, ANZAC Park in North Sydney would also be used to facilitate construction of the project, generating 75 light vehicle and 30 heavy vehicle movements per day.

5.1.3 Construction traffic management

For each construction support site, temporary partial or complete road closures of local streets would be required. These closures would generally be short-term and subject to local traffic management. In the instances of localised road closures, access for general traffic and emergency vehicles would be provided either by an alternative detour route, or under traffic control. Management of these day to day road closures and associated traffic management measures would be outlined in a Construction Traffic Management Plan (CTMP) for each work site. Changes to parking arrangements would be outlined in the CTMP, which would require approval prior to the start of works. The construction workforce would be encouraged to use public transport where feasible, but where this is impractical, the CTMP would outline the changes to local parking required to accommodate the workforce, plant and equipment. The CTMP would also include measures to ensure public safety, including for pedestrians, such as the provision of safety barriers or fencing, along with signage that would be implemented throughout construction to provide separation of active construction areas from pedestrian or shared user paths.

5.2 Rozelle and surrounds

5.2.1 Construction support site locations

The assessment of construction impacts in the Rozelle and surrounds study area (including the proposed Rozelle Connection integration works) includes the following construction support sites:

- WHT1 – Rozelle Rail Yards
- WHT2 – Victoria Road
- WHT3 – White Bay
- WHT4 – Yurulbin Point.

Indicative construction support site layouts are shown in Figure 5-7 to Figure 5-10.

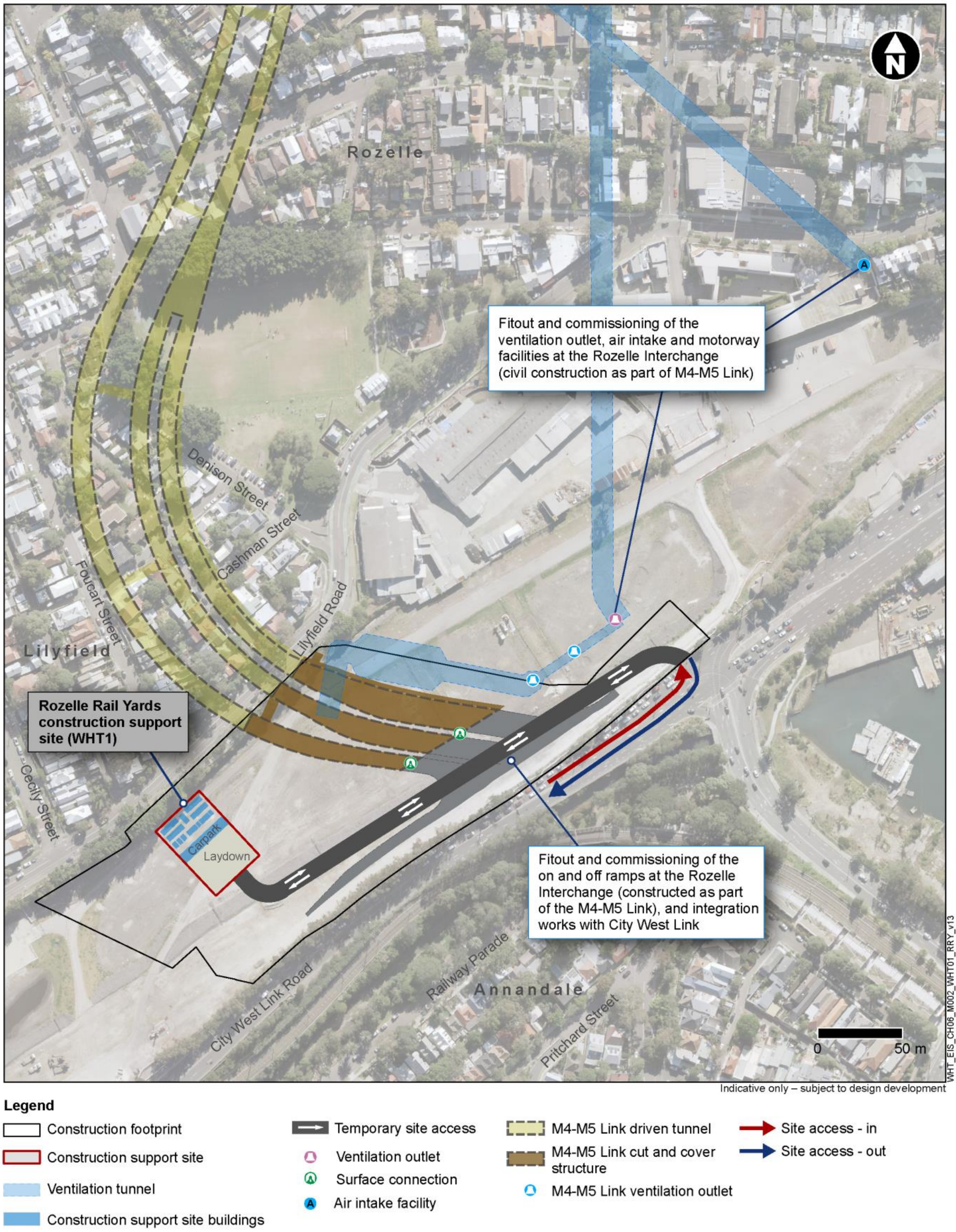

Figure 5-7 Indicative construction support site layout – WHT1 – Rozelle Rail Yards

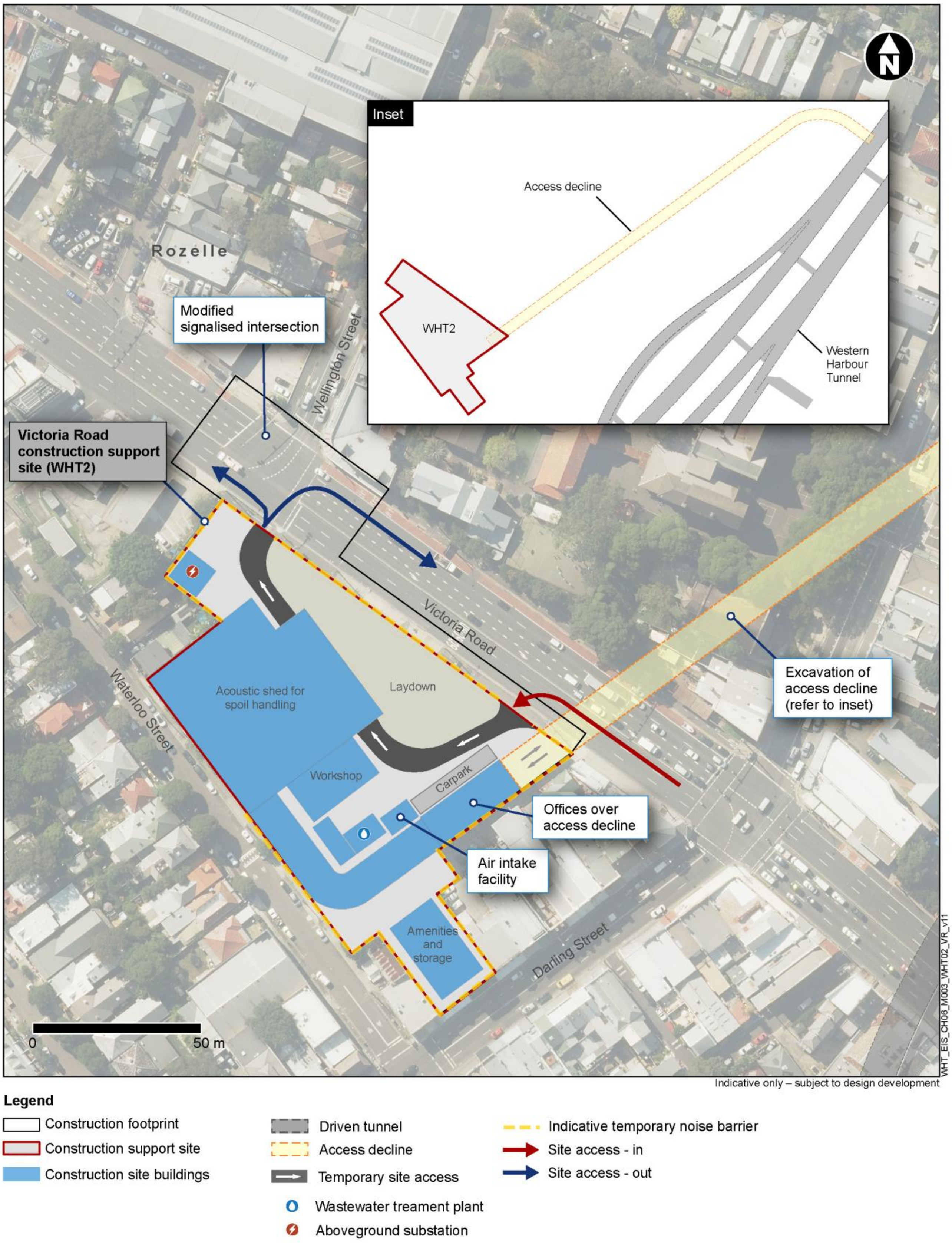

Figure 5-8 Indicative construction support site layout – WHT2 – Victoria Road

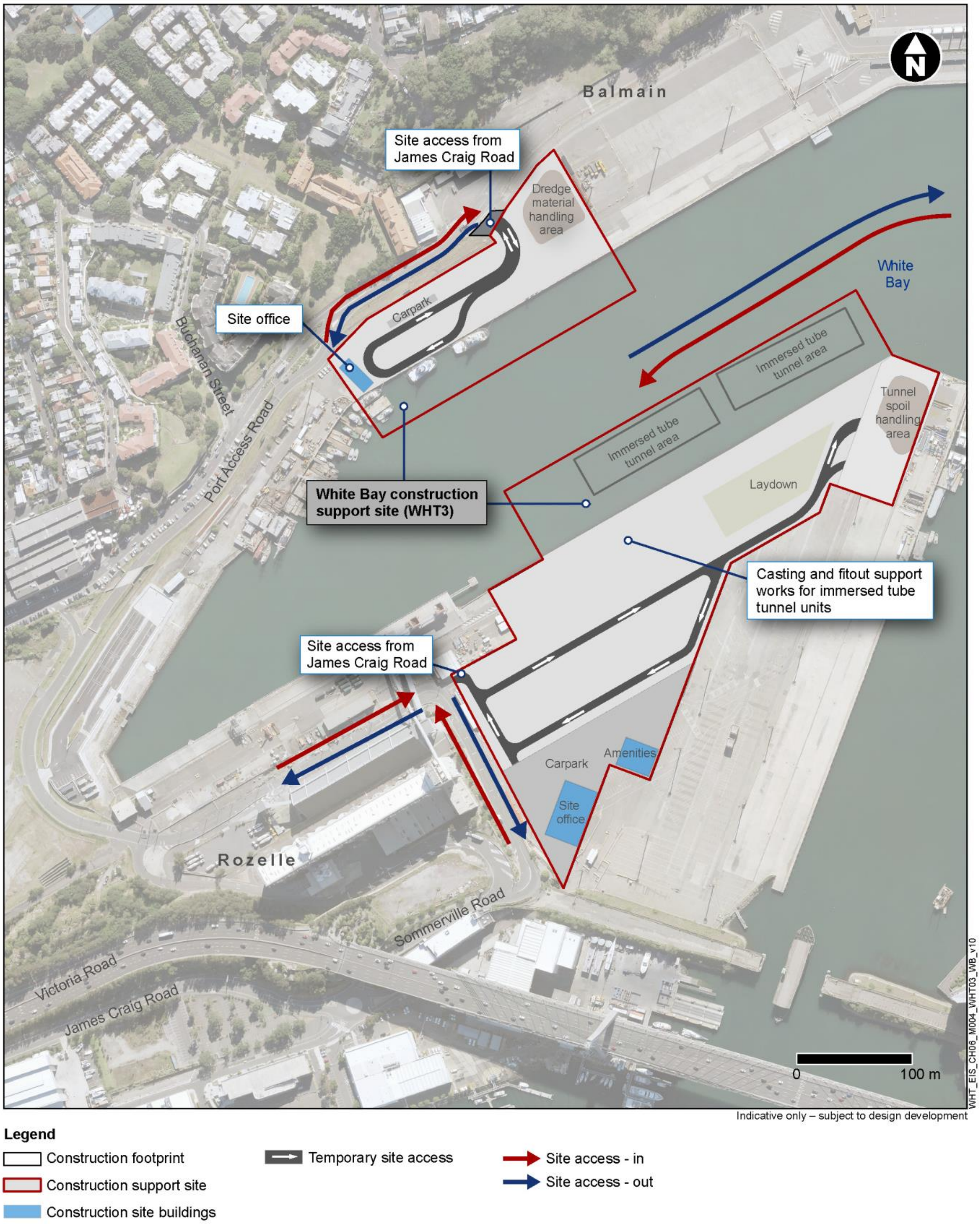

Figure 5-9 Indicative construction support site layout – WHT3 – White Bay

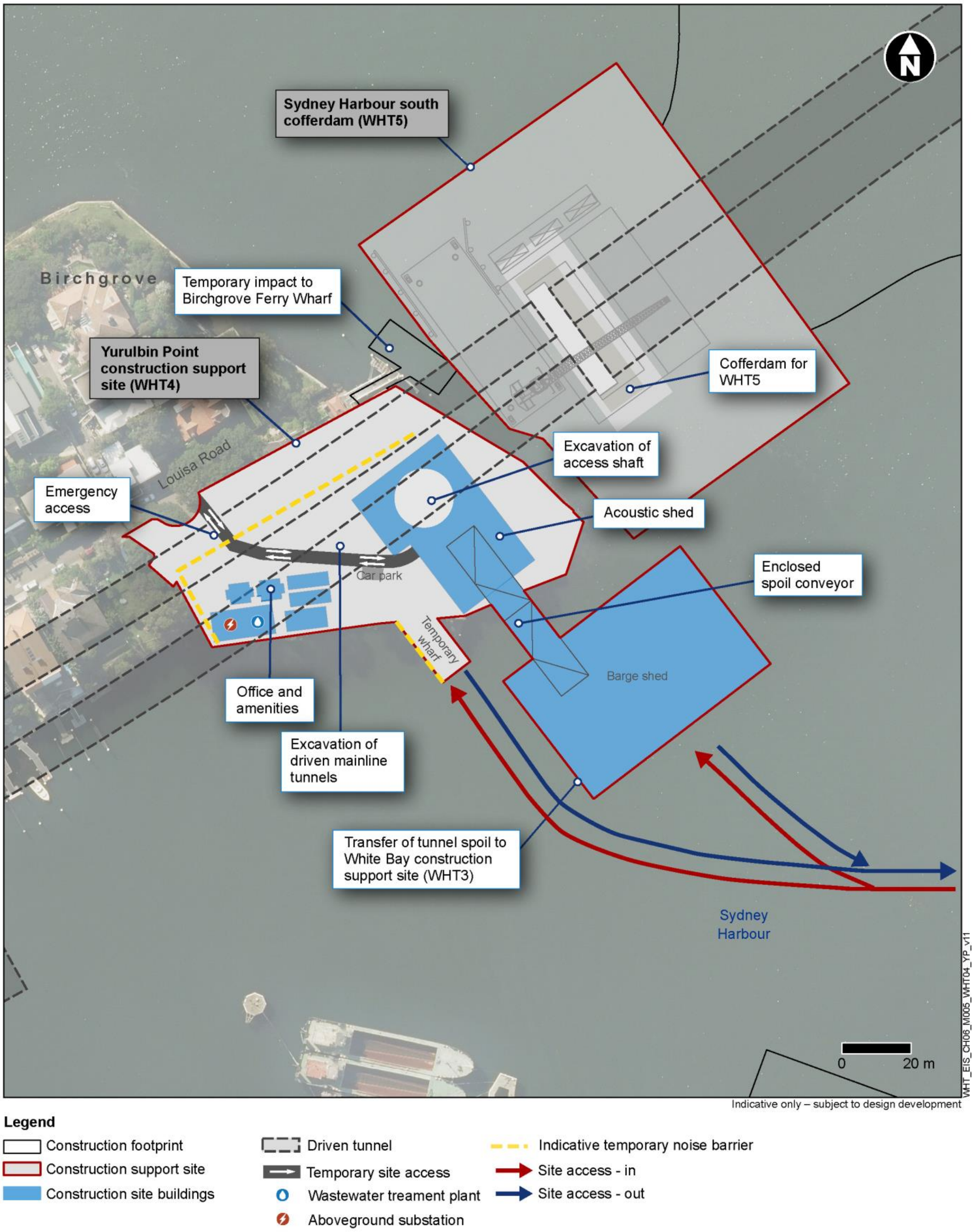

Figure 5-10 Indicative construction support site layout – WHT4 – Yurulbin Point

5.2.2 Construction support site access and traffic generation

The proposed routes to and from each construction support site are summarised in Table 5-5 and Figure 5-11. Access routes are proposed to be from major arterial roads rather than local roads where reasonable and feasible. Daily peak light vehicle and heavy vehicle numbers associated with spoil and waste removal, material deliveries and arrival and departure of construction personnel are also summarised in Table 5-5. Construction road traffic would not be generated at the Yurulbin Point construction support site (WHT4). Maritime access and egress routes for this site are outlined in Section 5.5.3.

Table 5-5 Proposed access routes and peak traffic generation for each construction support site – Rozelle and surrounds

No.	Construction support site	Proposed access routes	Peak vehicle movements per day		Morning peak vehicle movements (6am to 10am)		Evening peak vehicle movements (3pm to 7pm)	
			Light	Heavy	Light	Heavy	Light	Heavy
WHT1	Rozelle Rail Yards	City West Link	305	165	134	42	137	43
WHT2	Victoria Road	Victoria Road	230	420	62	111	128	111
WHT3	White Bay	James Craig Road, Port Access Road	530	700	205	189	255	189
WHT4	Yurulbin Point	Sydney Harbour	-	-	-	-	-	-

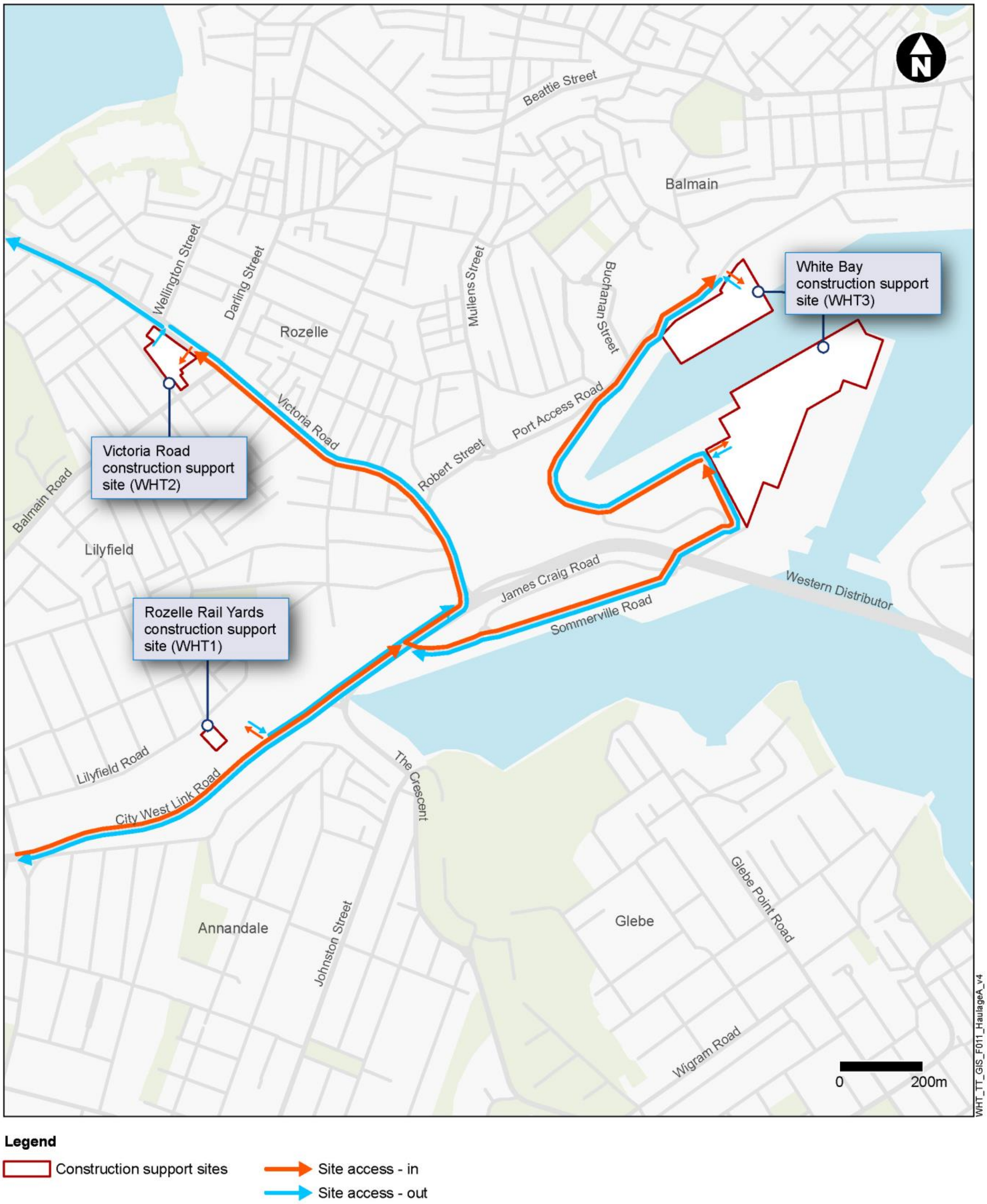

Figure 5-11 Indicative construction vehicle routes – WHT1 to WHT3

5.2.3 Timing of construction support site use

The indicative timing of the use of each construction support site is summarised in Table 5-6 and includes site establishment and site rehabilitation.

Table 5-6 Timing of construction support site use – Rozelle and surrounds

No.	Site	Indicative timing of construction support site use																											
		2020				2021				2022				2023				2024				2025				2026			
WHT1	Rozelle Rail Yards														■	■	■	■	■	■	■	■	■	■	■	■			
WHT2	Victoria Road							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
WHT3	White Bay						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
WHT4	Yurulbin Point						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					

5.2.4 Impact on traffic flows

Intersection performance

SIDRA intersection modelling has been carried out to determine the relative impacts of construction traffic at key access points to and from construction sites when compared to conditions without construction of the project.

The intersection performance results for the road network under the 'base' (without construction vehicles) and 'construction' (with construction vehicles and proposed intersection modifications during construction) scenarios are summarised in Table 5-7 for the morning and evening peak hours, respectively.

Table 5-7 Modelled base and construction morning and evening peak hour intersection performance – Rozelle and surrounds

Intersection/peak period	2022 base						2022 construction					
	Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	Level of Service	Degree of Saturation	Maximum queue length by directional approach (metres)		Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	Level of Service	Degree of Saturation	Maximum queue length by directional approach (metres)	
City West Link/The Crescent												
Morning peak	6720	90	F	>1	Northbound	>500	6860	>100	F	>1	Northbound	>500
					Eastbound	-					Eastbound	
					Southbound	320					Southbound	335
					Westbound	425					Westbound	460
Evening peak	6380	24	B	0.80	Northbound	300	6630	24	B	0.84	Northbound	360
					Eastbound	-					Eastbound	-
					Southbound	335					Southbound	365
					Westbound	140					Westbound	140
The Crescent/James Craig Road												
Morning peak	6870	>100	F	>1	Northbound	>500	7000	>100	F	>1	Northbound	>500
					Eastbound	-					Eastbound	-
					Southbound	270					Southbound	335
					Westbound	30					Westbound	65

<table>
<tr><th rowspan="2">Intersection/peak period</th><th colspan="6">2022 base</th><th colspan="6">2022 construction</th></tr>
<tr><th>Demand flow (vehicles per hour)</th><th>Average delay (seconds per vehicle)</th><th>Level of Service</th><th>Degree of Saturation</th><th colspan="2">Maximum queue length by directional approach (metres)</th><th>Demand flow (vehicles per hour)</th><th>Average delay (seconds per vehicle)</th><th>Level of Service</th><th>Degree of Saturation</th><th colspan="2">Maximum queue length by directional approach (metres)</th></tr>
<tr><td rowspan="4">Evening peak</td><td rowspan="4">6270</td><td rowspan="4">48</td><td rowspan="4">D</td><td rowspan="4">1.00</td><td>Northbound</td><td>210</td><td rowspan="4">6520</td><td rowspan="4">61</td><td rowspan="4">E</td><td rowspan="4">>1</td><td>Northbound</td><td>225</td></tr>
<tr><td>Eastbound</td><td>-</td><td>Eastbound</td><td>-</td></tr>
<tr><td>Southbound</td><td>>500</td><td>Southbound</td><td>>500</td></tr>
<tr><td>Westbound</td><td>35</td><td>Westbound</td><td>105</td></tr>
<tr><td colspan="13">Victoria Road/Wellington Street/WHT2 construction support site access</td></tr>
<tr><td rowspan="4">Morning peak</td><td rowspan="4">5620</td><td rowspan="4">12</td><td rowspan="4">A</td><td rowspan="4">0.69</td><td>Northbound</td><td>-</td><td rowspan="4">5660</td><td rowspan="4">13</td><td rowspan="4">A</td><td rowspan="4">0.69</td><td>Northbound</td><td>20</td></tr>
<tr><td>Eastbound</td><td>160</td><td>Eastbound</td><td>160</td></tr>
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<tr><td rowspan="4">Evening peak</td><td rowspan="4">6180</td><td rowspan="4">14</td><td rowspan="4">A</td><td rowspan="4">0.67</td><td>Northbound</td><td>-</td><td rowspan="4">6230</td><td rowspan="4">15</td><td rowspan="4">B</td><td rowspan="4">0.67</td><td>Northbound</td><td>30</td></tr>
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<tr><td>Westbound</td><td>235</td><td>Westbound</td><td>235</td></tr>
</table>

Pre-construction performance

Intersections that would operate at LoS D or worse without construction vehicles include:

- City West Link/The Crescent (morning peak)
- The Crescent/James Craig Road (morning and evening peak).

These intersections also operate with a degree of saturation greater than one during the morning peak hour, meaning that they would be operating at or over capacity during these times.

City West Link/The Crescent during the evening peak and Victoria Road/Wellington Street during both peaks operate at LoS B or better.

Construction performance

With construction traffic included on the road network, City West Link/The Crescent would continue to operate at a comparable Level of Service during both peak periods. The intersection is already operating at capacity during the morning peak and this would not substantially change with the addition of the forecast construction traffic. This is also the case at The Crescent/James Craig Road which would operate at capacity with and without construction vehicles during the morning peak. In the evening peak, the intersection operation would deteriorate from LoS D to LoS E with an increase in average vehicle delay of 13 seconds. Similar to the morning peak, the intersection is already at capacity without construction vehicles and this would not substantially change with additional construction traffic.

The addition of construction vehicles and provision of site access at Victoria Road/Wellington Street would have minimal impact on the overall performance of the intersection, assuming that site egress is positioned at a location where construction vehicles turning right would not conflict with vehicles turning right from Wellington Street and would occur during the same phase in each signal cycle.

Midblock performance

In the Rozelle and surrounds study area, the capacity and operation of intersections is generally the constraining factor for network performance. Notwithstanding this, midblock performance has been assessed to determine the potential relative impacts of construction traffic on key routes.

The midblock performance results for the road network under the ‘base’ (without construction vehicles) and ‘construction’ (with construction vehicles and proposed intersection modifications during construction) scenarios are summarised in Table 5-8 for the morning and evening peak hours, respectively.

Table 5-8 Base and construction morning and evening peak hour midblock performance – Rozelle and surrounds

Location/ direction	Capacity (PCU)	Morning peak						Evening peak					
		2022 base			2022 construction			2022 base			2022 construction		
		Vol (PCU)	V/C	LoS	Vol (PCU)	V/C	LoS	Vol (PCU)	V/C	LoS	Vol (PCU)	V/C	LoS
City West Link west of The Crescent													
Eastbound	1900	2830	>1	F	2950	>1	F	2440	>1	F	2630	>1	F
Westbound	1900	1940	>1	F	2030	>1	F	2330	>1	F	2470	>1	F
James Craig Road south of The Crescent													
Eastbound	900	300	0.34	B	390	0.43	C	120	0.14	A	260	0.29	B
Westbound	1900	170	0.09	A	250	0.13	A	150	0.08	A	280	0.15	A

Location/ direction	Capacity (PCU)	Morning peak						Evening peak					
		2022 base			2022 construction			2022 base			2022 construction		
		Vol (PCU)	V/C	LoS	Vol (PCU)	V/C	LoS	Vol (PCU)	V/C	LoS	Vol (PCU)	V/C	LoS
The Crescent west of Victoria Road													
Eastbound	1900	4420	>1	F	4460	>1	F	3110	>1	F	3170	>1	F
Westbound	1900	2970	>1	F	2970	>1	F	3280	>1	F	3280	>1	F
Victoria Road north of The Crescent													
Northbound	2900	2580	0.89	E	2640	0.91	E	3990	>1	F	4060	>1	F
Southbound	3900	4600	>1	F	4660	>1	F	3220	0.83	E	3290	0.84	E

Pre-construction performance

Without construction traffic, traffic demand is forecast to be at or above capacity at the following locations:

- City West Link west of The Crescent in both directions (morning and evening peak)
- The Crescent west of Victoria Road in both directions (morning and evening peak)
- Victoria Road north of The Crescent in the northbound direction (evening peak)
- Victoria Road north of The Crescent in the southbound direction (morning peak).

Construction performance

The addition of construction traffic is forecast to change the midblock Level of Service at James Craig Road south of The Crescent in the eastbound direction from LoS B to LoS C (morning peak) and from LoS A to LoS B (evening peak). This road would continue to operate with spare capacity and at an acceptable Level of Service during construction.

Local road impacts

James Craig Road is a local road that is accessible to general traffic from The Crescent and via Robert Street for authorised vehicles only. About 270 light vehicles and 350 heavy vehicles per day would access the White Bay construction support site (WHT3) from James Craig Road and Port Access Road, with haulage vehicles travelling on the internal road network within the Sydney Ports precinct. These traffic volumes would have a minor impact as James Craig Road would operate with spare capacity during construction as shown in Table 5-8.

The Victoria Road/Wellington Street intersection would be modified during construction, with an additional approach allowing vehicles to exit the Victoria Road construction support site (WHT2) onto Victoria Road southbound. This additional traffic would have minimal impact on Wellington Street as construction vehicles are required to give way to vehicles turning left from Wellington Street when exiting the construction support site and would not conflict with vehicles turning right.

The Yurulbin Park car park would be temporarily closed due to the Yurulbin Point construction support site (WHT4), resulting in the loss of about 10 parking spaces. The surrounding local road network including Louisa Road could accommodate these lost parking spaces and therefore parking impacts would be minor and manageable.

Construction workforce parking

A car parking area would be provided at the White Bay construction support site (WHT3). Where required, shuttle bus transfers between construction support sites would also be provided. Where on-site parking is not provided or where provision of on-site parking cannot accommodate the full construction workforce, the workforce would be required to park on the surrounding road network. Impacts on these roads would be detailed in the CTMP. To minimise the potential parking impacts on the road network, the construction workforce would be encouraged to use public transport where feasible, with key bus corridors including Victoria Road and ANZAC Bridge. In addition, the L1 Dulwich Hill Line is accessible from the Rozelle Bay light rail stop.

Rozelle construction impact summary

Assessment of the performance of key locations in the road network affected by construction activities indicates that the road network in the Rozelle and surrounds study area would perform marginally worse under construction, with no noticeable impact when compared to traffic conditions without the project. City West Link/The Crescent intersection and The Crescent/James Craig Road intersection would continue to operate at a comparable LoS during both peak periods. These intersections are already operating above capacity during peak periods and this would not substantially change with the addition of the forecast construction traffic. Midblock volumes on City West Link, The Crescent and Victoria Road would continue to perform at a relatively poor LoS during construction with or without the project.

5.3 Warringah Freeway and surrounds

5.3.1 Construction support site locations

The assessment of construction impacts in the Warringah Freeway and surrounds study area includes the following construction support sites:

- WHT7 – Berrys Bay
- WHT8 – Berry Street north
- WHT9 – Ridge Street north
- WHT10 and WFU8 – Cammeray Golf Course
- WFU1 – Blue Street
- WFU2 – High Street south
- WFU3 – High Street north
- WFU4 – Arthur Street east
- WFU5 – Berry Street east
- WFU6 – Ridge Street east
- WFU7 – Merlin Street
- WFU9 – Rosalind Street east.

Indicative construction support site layouts for each Western Harbour Tunnel site are shown in Figure 5-12 to Figure 5-15, while construction support site location and construction vehicle access routes for the Warringah Freeway Upgrade are shown in Figure 5-16 and Figure 5-17.

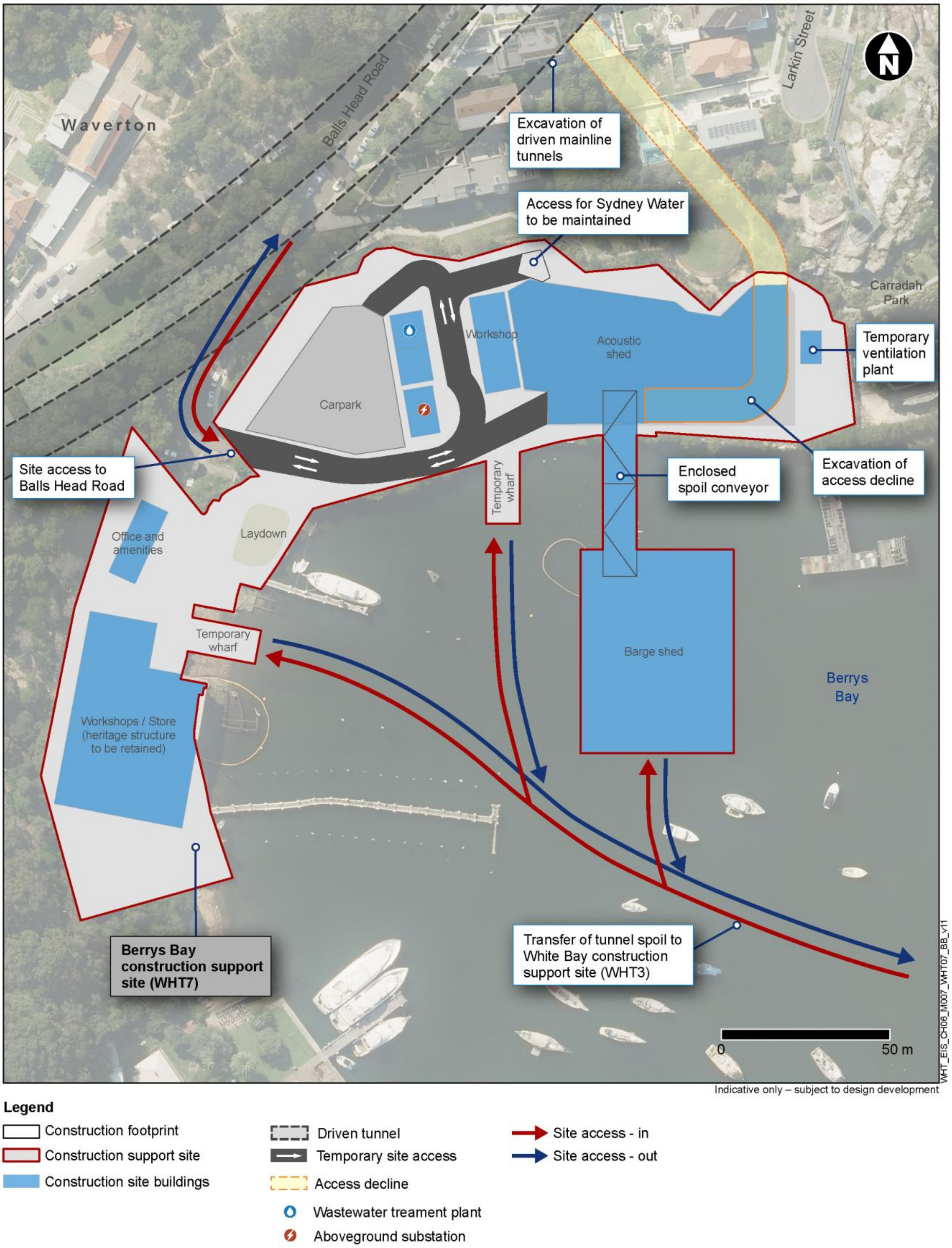


Figure 5-12 Indicative construction support site layout – WHT7 – Berrys Bay

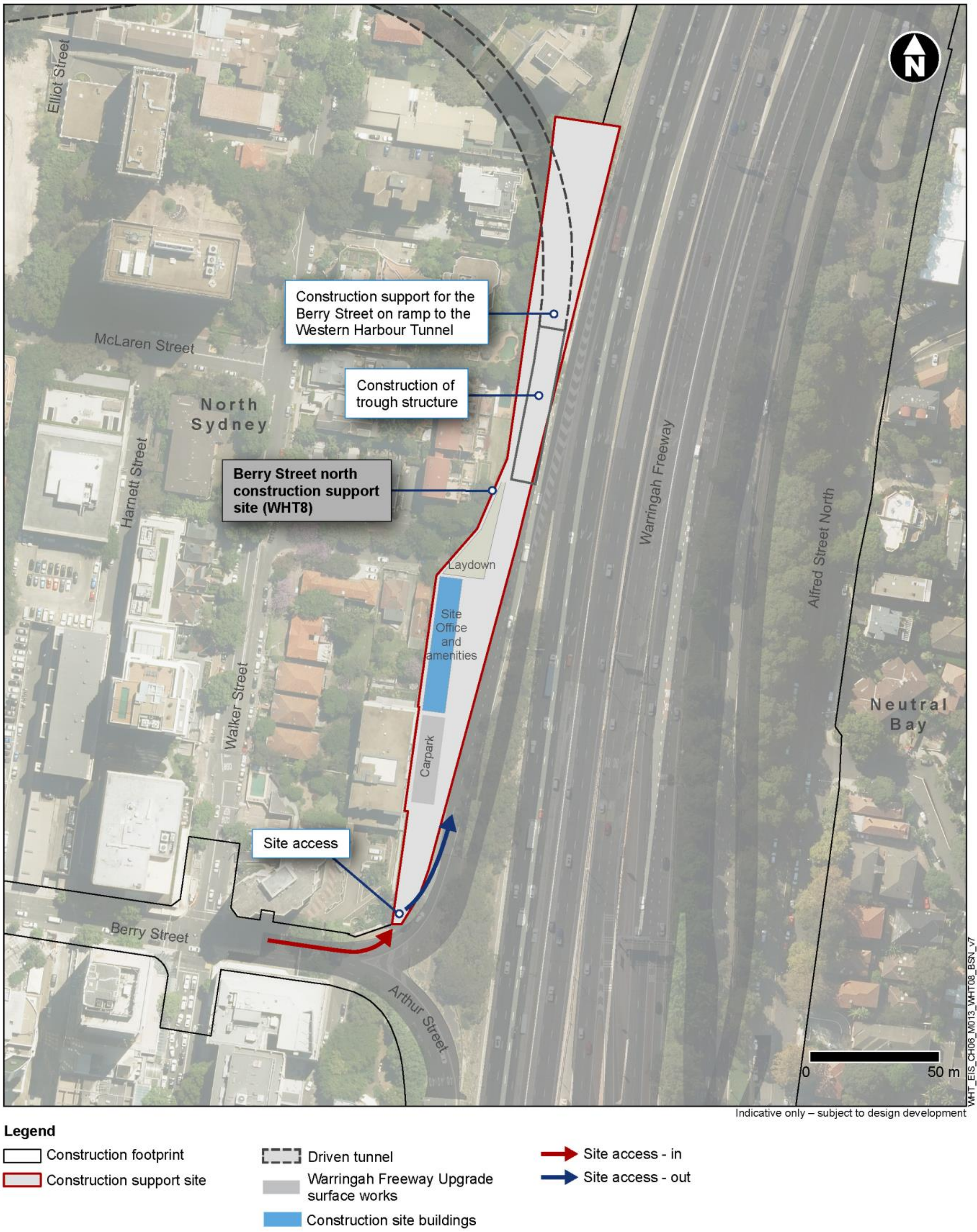


Figure 5-13 Indicative construction support site layout – WHT8 – Berry Street north

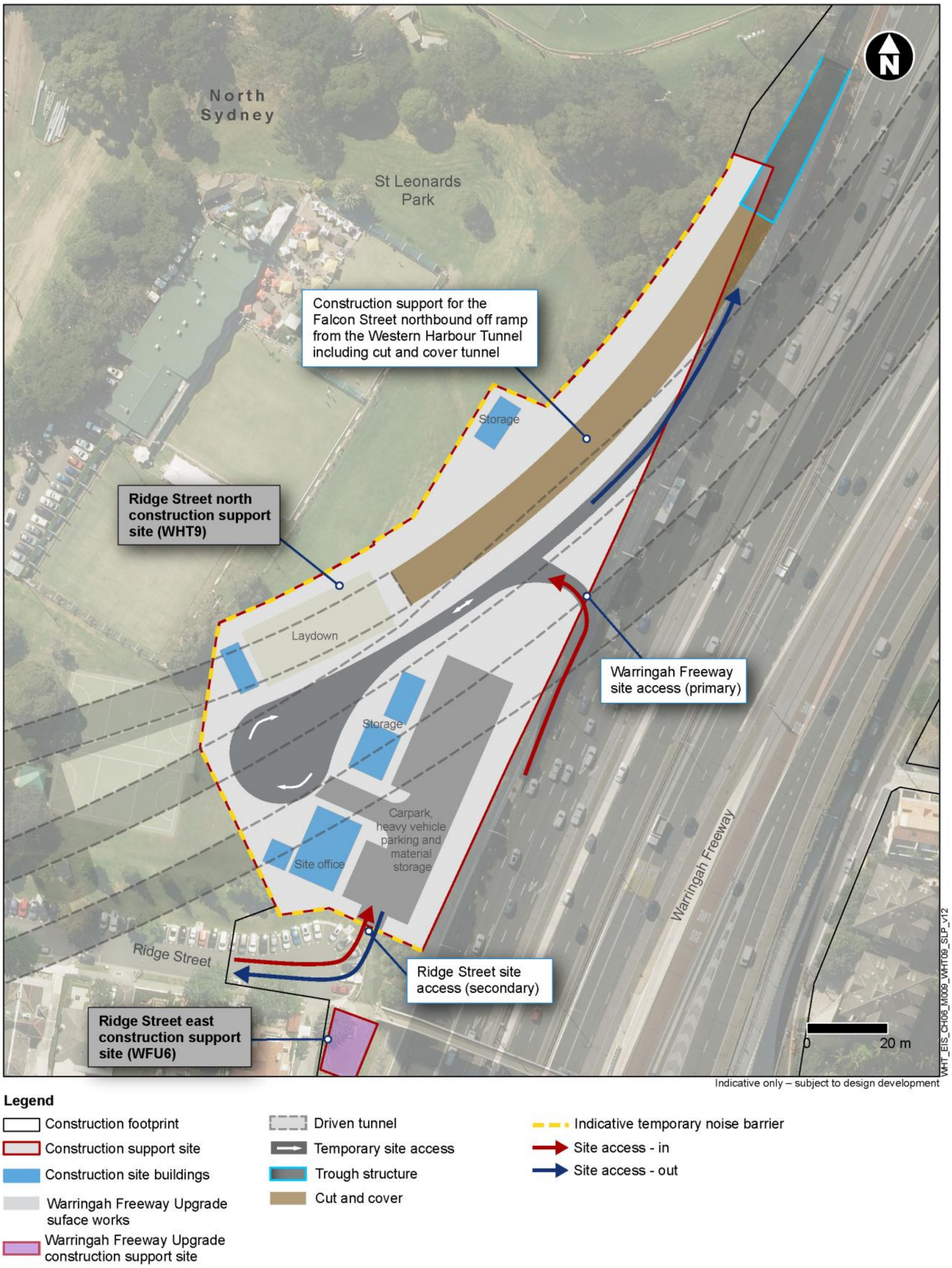


Figure 5-14 Indicative construction support site layout – WHT9 – Ridge Street north

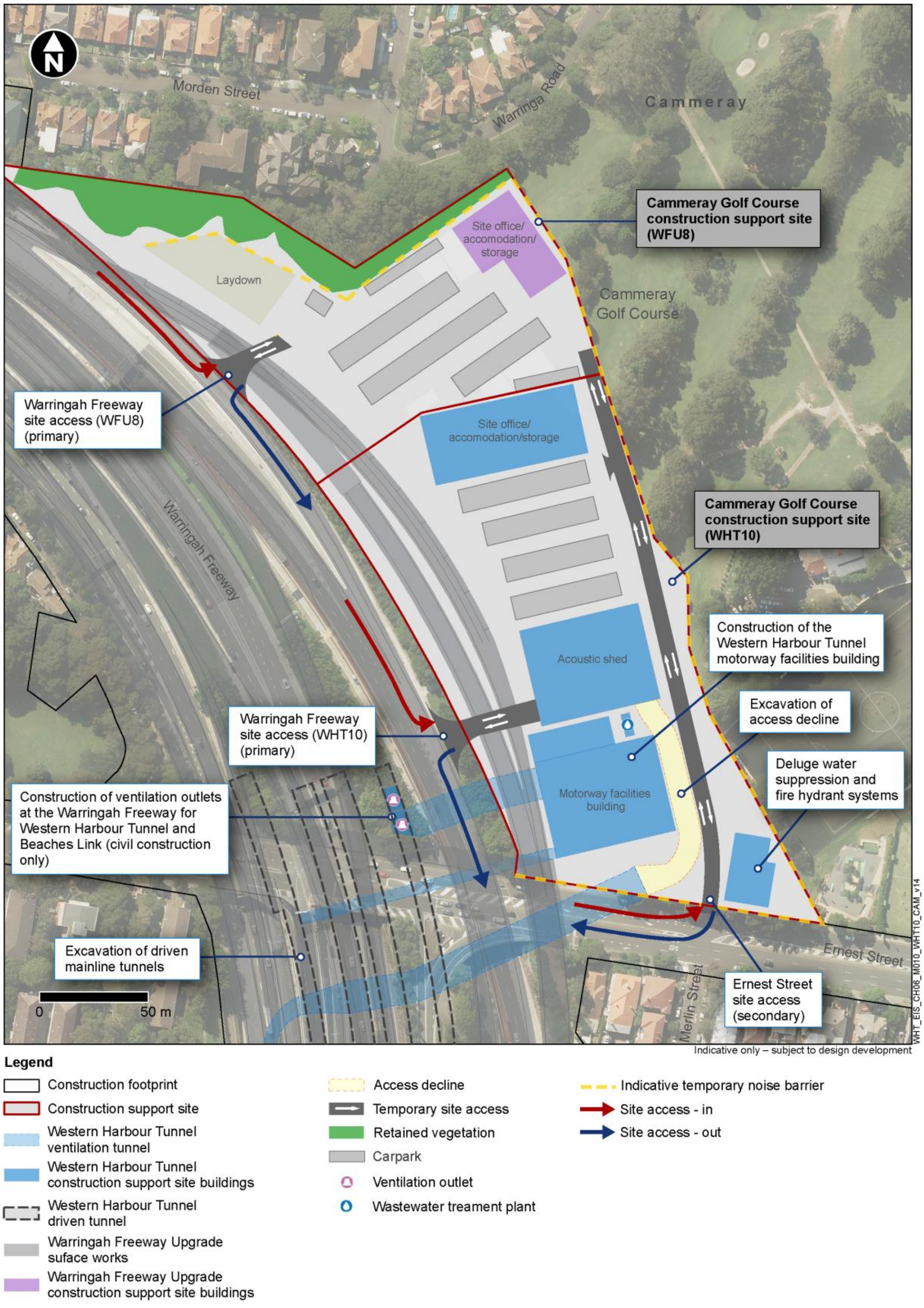


Figure 5-15 Indicative construction support site layout – WHT10 and WFU8 – Cammeray Golf Course

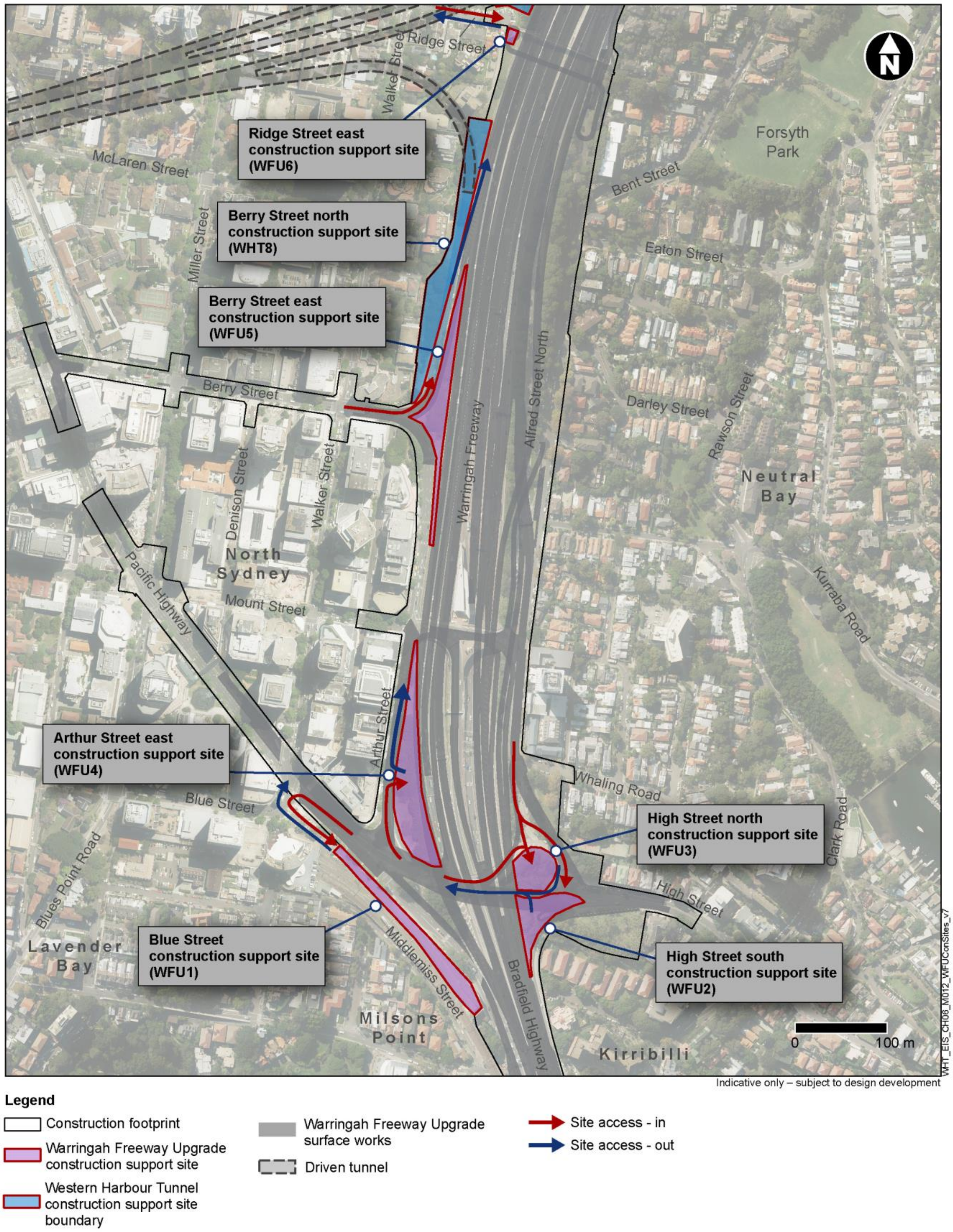


Figure 5-16 Construction support sites for Warringah Freeway Upgrade – WFU1 to WFU6

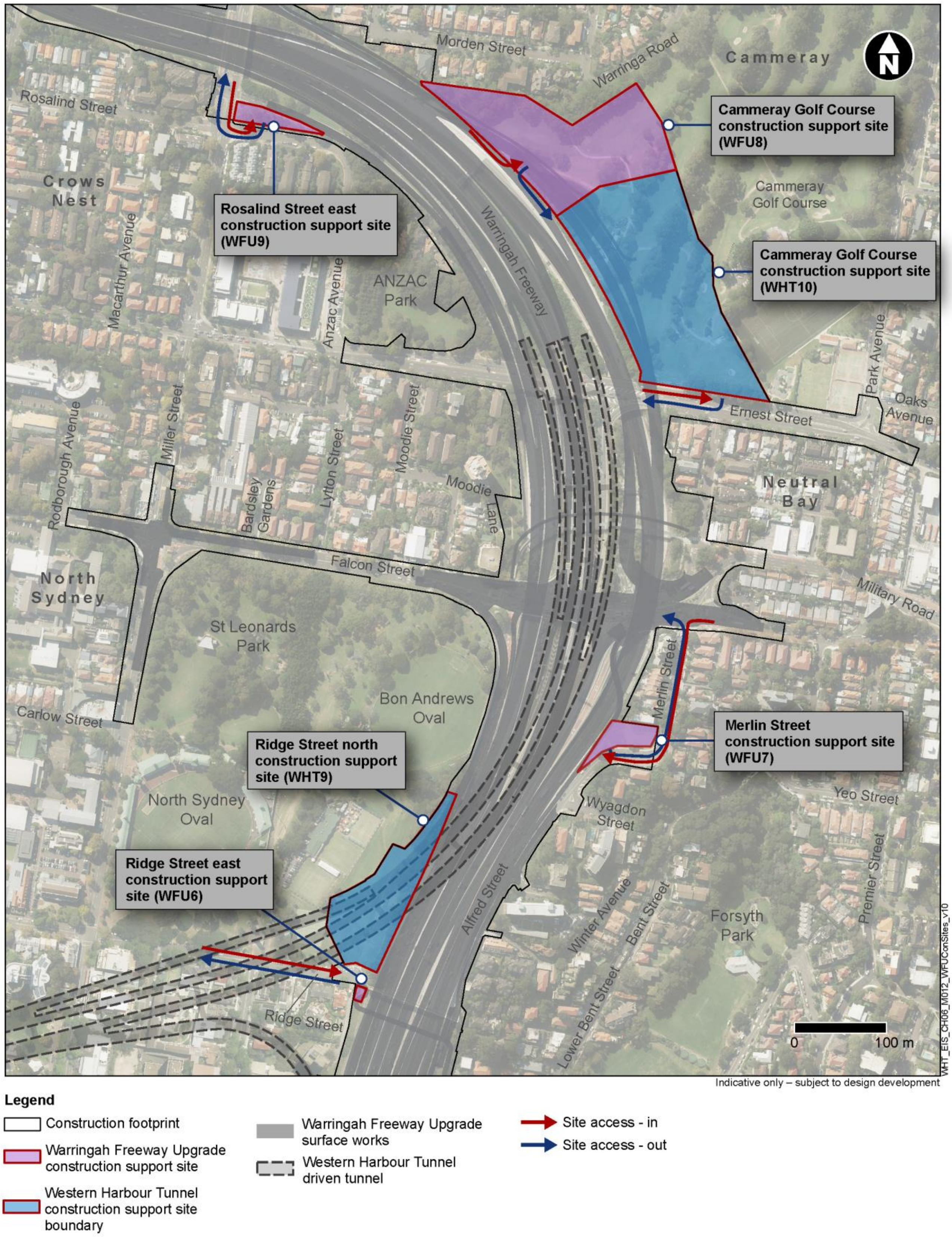


Figure 5-17 Construction support sites for Warringah Freeway Upgrade – WFU6 to WFU9

5.3.2 Construction support site access and traffic generation

The proposed access routes to and from each construction support site are summarised in Table 5-9 and Figure 5-18 to Figure 5-20. Access routes are proposed to be from major arterial roads rather than local roads where feasible. Daily peak light vehicle and heavy vehicle volumes associated with spoil and waste removal, material deliveries as well as arrival and departure of construction personnel are also summarised in Table 5-9.

Table 5-9 Proposed access routes and peak traffic generation for each construction support site – Warringah Freeway and surrounds

No.	Site	Proposed access routes	Peak vehicle movements per day		Morning peak vehicle movements (6am to 10am)		Evening peak vehicle movements (3pm to 7pm)	
			Light	Heavy	Light	Heavy	Light	Heavy
WHT7	Berrys Bay	Balls Head Road	210	55	101	11	69	12
WHT8	Berry Street north	Berry Street, Warringah Freeway	130	30	20	10	18	6
WHT9	Ridge Street north	Ridge Street, Warringah Freeway	165	200	64	51	67	51
WHT10	Cammeray Golf Course	Ernest Street, Warringah Freeway	480	485	198	128	212	130
WFU1	Blue Street	Blue Street	315	10	96	4	92	2
WFU2	High Street south	Pacific Highway, High Street	80	15	17	6	13	2
WFU3	High Street north	Pacific Highway, Alfred Street north	65	10	14	4	8	2
WFU4	Arthur Street east	Arthur Street	135	10	28	4	23	2
WFU5	Berry Street east	Berry Street, Warringah Freeway	30	30	9	4	5	2
WFU6	Ridge Street east	Ridge Street, Warringah Freeway	70	20	17	4	9	2
WFU7	Merlin Street	Merlin Street	150	0	40	0	35	0
WFU8	Cammeray Golf Course	Ernest Street, Warringah Freeway	865	40	238	12	250	7
WFU9	Rosalind Street east	Rosalind Street	205	15	46	4	47	2
-	ANZAC Park	Ernest Street	75	30	27	10	19	4

Figure 5-18 Indicative construction vehicle routes – WHT7 – Berrys Bay construction support site

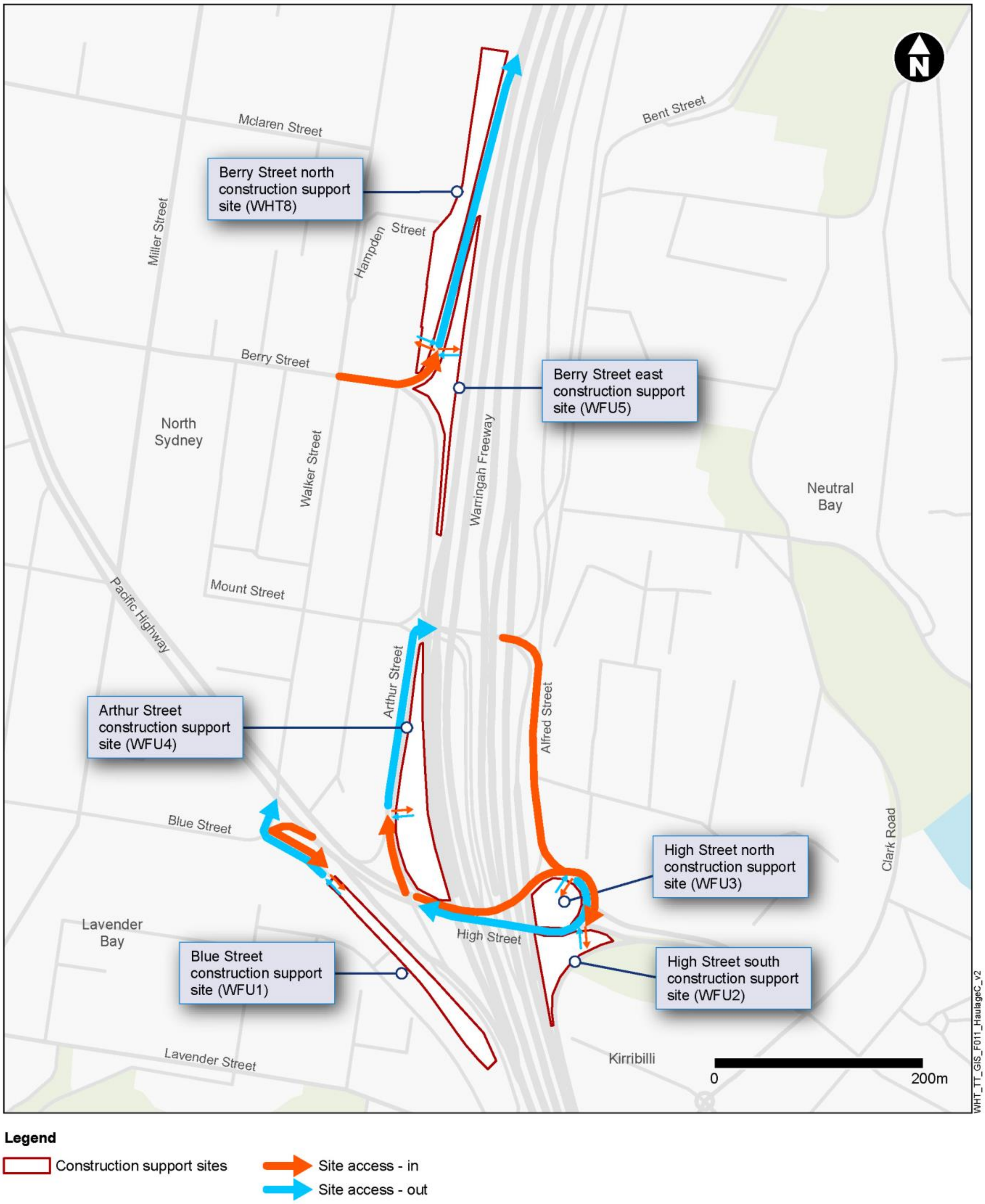


Figure 5-19 Indicative construction vehicle routes – WHT8 and WFU1 to WFU5

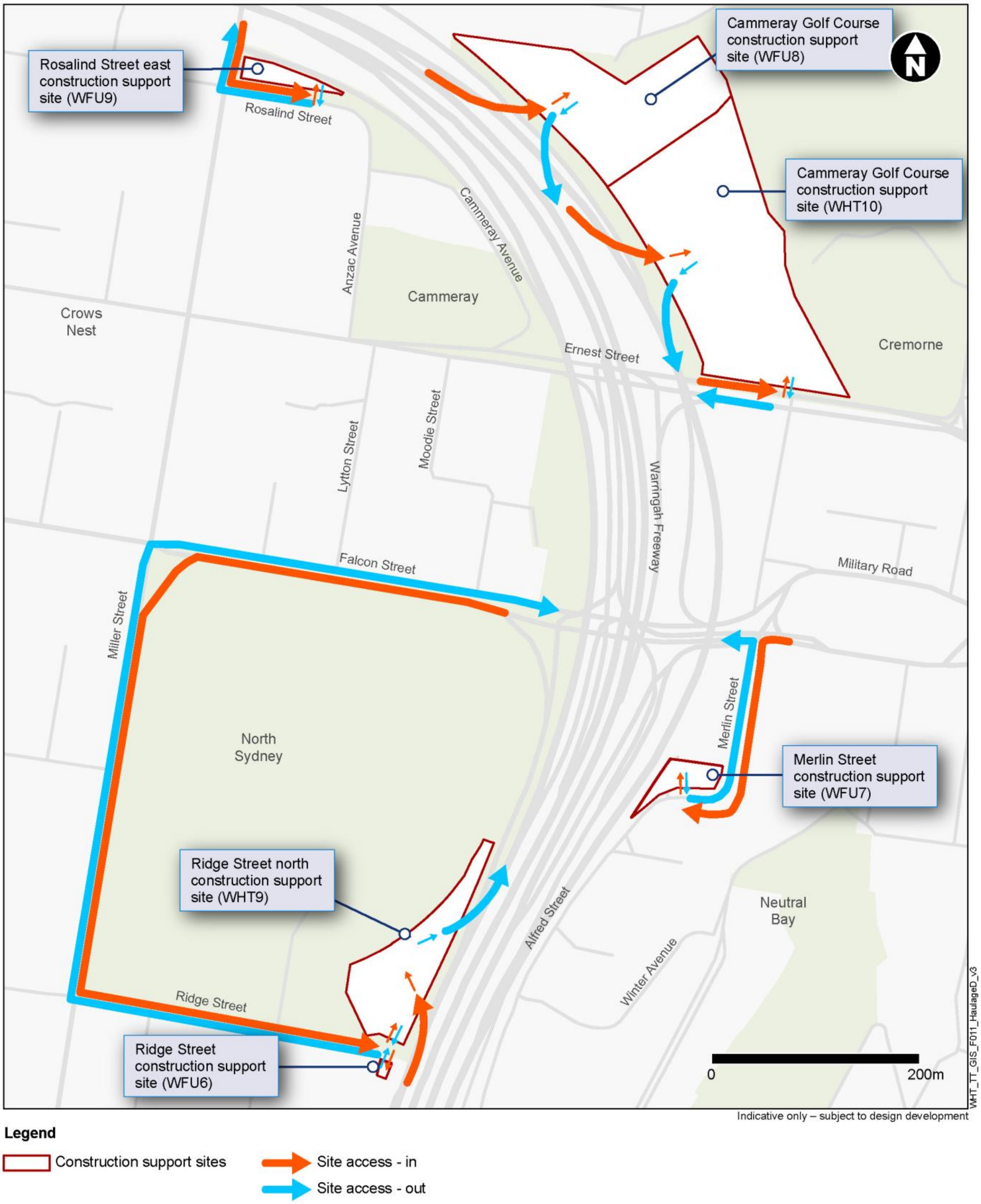


Figure 5-20 Indicative construction vehicle routes – WHT9 to WHT10 and WFU6 to WFU9

5.3.3 Timing of construction support site use

The indicative timing of the use of each construction support site is summarised in Table 5-10 and includes site establishment and site rehabilitation.

Table 5-10 Timing of construction support site use – Warringah Freeway and surrounds

No.	Site	Indicative timing of construction support site use						
		2020	2021	2022	2023	2024	2025	2026
WHT7	Berrys Bay							
WHT8	Berry Street north							
WHT9	Ridge Street north							
WHT10	Cammeray Golf Course							
WFU1 to WFU9	Warringah Freeway Upgrade sites							

5.3.4 Impact on traffic flows

Intersection performance

SIDRA intersection modelling has been carried out to determine the relative impacts of construction traffic at key access points to and from construction support sites when compared to conditions without construction of the project.

The intersection performance results for the road network under the ‘base’ (without construction vehicles) and ‘construction’ (with construction vehicles and proposed intersection modifications during construction) scenarios are summarised in Table 5-11 for the morning and evening peak hours, respectively. A worst case scenario has been assessed by assuming the Western Harbour Tunnel component construction works and Warringah Freeway Upgrade component construction works would be carried out at the same time.

Table 5-11 Modelled base and construction morning and evening peak hour intersection performance – Warringah Freeway and surrounds

Intersection/peak period	2022 base						2022 construction					
	Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	Level of Service	Degree of Saturation	Maximum queue length by directional approach (metres)		Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	Level of Service	Degree of Saturation	Maximum queue length by directional approach (metres)	
Miller Street/Falcon Street												
Morning peak	3710	50	D	0.94	Northbound	110	3750	53	D	0.94	Northbound	115
					Eastbound	240					Eastbound	265
					Southbound	230					Southbound	230
					Westbound	90					Westbound	90
Evening peak	3500	99	F	>1	Northbound	130	3530	>100	F	>1	Northbound	120
					Eastbound	440					Eastbound	>500
					Southbound	280					Southbound	280
					Westbound	215					Westbound	215
Warringah Freeway/Falcon Street interchange												
Morning peak	13,250	N/A[1]	F[1]	>1	Northbound	>500	13,310	N/A[1]	F[1]	>1	Northbound	>500
					Eastbound	55					Eastbound	50
					Southbound	65					Southbound	65
					Westbound	>500					Westbound	>500
Evening peak	13,760	N/A[1]	F[1]	>1	Northbound	>500	13,810	N/A[1]	F[1]	>1	Northbound	>500
					Eastbound	110					Eastbound	95
					Southbound	60					Southbound	60
					Westbound	340					Westbound	385
Warringah Freeway/Ernest Street interchange												

Intersection/peak period	2022 base						2022 construction					
	Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	Level of Service	Degree of Saturation	Maximum queue length by directional approach (metres)		Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	Level of Service	Degree of Saturation	Maximum queue length by directional approach (metres)	
Morning peak	6280	N/A[1]	C[1]	0.60	Northbound	-	6550	N/A[1]	C[1]	0.62	Northbound	-
					Eastbound	40					Eastbound	40
					Southbound	-					Southbound	-
					Westbound	155					Westbound	145
Evening peak	5820	N/A[1]	D[1]	0.57	Northbound	115	6110	N/A[1]	D[1]	0.60	Northbound	135
					Eastbound	135					Eastbound	140
					Southbound	-					Southbound	-
					Westbound	80					Westbound	85
Ernest Street/Merlin Street/WHT10 construction support site access												
Morning peak	2900	7	A	0.49	Northbound	20	3090	9	A	0.50	Northbound	20
					Eastbound	85					Eastbound	105
					Southbound	-					Southbound	40
					Westbound	105					Westbound	110
Evening peak	3180	9	A	0.77	Northbound	25	3370	11	A	0.83	Northbound	25
					Eastbound	250					Eastbound	295
					Southbound	-					Southbound	45
					Westbound	60					Westbound	60
Ernest Street/Miller Street												
Morning peak	3280	20	B	0.63	Northbound	110	3380	20	B	0.68	Northbound	110
					Eastbound	65					Eastbound	65

Intersection/peak period	2022 base						2022 construction					
	Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	Level of Service	Degree of Saturation	Maximum queue length by directional approach (metres)		Demand flow (vehicles per hour)	Average delay (seconds per vehicle)	Level of Service	Degree of Saturation	Maximum queue length by directional approach (metres)	
					Southbound	75					Southbound	105
					Westbound	105					Westbound	100
Evening peak	3530	31	C	0.76	Northbound	130	3530	31	C	0.76	Northbound	130
					Eastbound	145					Eastbound	145
					Southbound	150					Southbound	150
					Westbound	100					Westbound	100
Warringah Freeway/Miller Street interchange												
Morning peak	5200	N/A[1]	C[1]	0.82	Northbound	35	5330	N/A[1]	C[1]	0.88	Northbound	35
					Eastbound	-					Eastbound	-
					Southbound	90					Southbound	90
					Westbound	120					Westbound	175
Evening peak	5110	N/A[1]	D[1]	0.89	Northbound	55	5120	N/A[1]	D[1]	0.89	Northbound	55
					Eastbound	-					Eastbound	-
					Southbound	85					Southbound	85
					Westbound	170					Westbound	175

Note 1: Interchanges have been modelled as a network, where Level of Service is based on speed efficiency (SIDRA Level of Service criteria for networks) and not average vehicle delay

Pre-construction performance

Intersections that would operate at LoS D or worse without construction vehicles include:

- Miller Street/Falcon Street (morning and evening peak)
- Warringah Freeway/Falcon Street interchange (morning and evening peak)
- Warringah Freeway/Ernest Street interchange (evening peak)
- Warringah Freeway/Miller Street interchange (evening peak).

Miller Street/Falcon Street during the evening peak and the Warringah Freeway/Falcon Street interchange during both peaks would also operate with a degree of saturation greater than one, meaning they would be operating at capacity during these times.

Construction performance

With construction traffic included on the road network, all intersections and interchanges would operate at the same Level of Service as the base scenarios. The Ernest Street/Merlin Street intersection would be modified to include a north approach, providing access to the Cammeray Golf Course construction support site (WHT10 and WFU8). The modification of this intersection would minimally impact the performance of the intersection, with average delays to increase by up to two seconds per vehicle.

Midblock performance

In the North Sydney area, the capacity and operation of intersections is generally the constraining factor for network performance. Notwithstanding this, midblock performance has been assessed to determine the potential relative impacts of construction traffic on key routes.

The midblock performance results for the road network under the 'base' (without construction vehicles) and 'construction' (with construction vehicles and proposed intersection modifications during construction) scenarios are summarised in Table 5-12 for the morning and evening peak hours, respectively. A worst-case scenario has been assessed by assuming the Western Harbour Tunnel construction works and Warringah Freeway Upgrade construction works would be carried out at the same time.

Table 5-12 Base and construction morning and evening peak hour midblock performance – Warringah Freeway and surrounds

Location/ direction	Capacity (PCU)	Morning peak						Evening peak					
		2022 base			2022 construction			2022 base			2022 construction		
		Vol (PCU)	V/C	LoS	Vol (PCU)	V/C	LoS	Vol (PCU)	V/C	LoS	Vol (PCU)	V/C	LoS
Pacific Highway south of Walker Street													
Northbound	4900	2380	0.49	C	2440	0.50	C	1660	0.34	B	1690	0.35	B
Southbound[1]	2900 (AM) 1900 (PM)	490	0.17	A	510	0.18	A	660	0.35	B	670	0.35	B
Pacific Highway south of Bay Road													
Northbound	2900	850	0.29	B	880	0.30	B	1110	0.38	B	1130	0.39	B
Southbound	1900	1210	0.64	D	1220	0.65	D	1040	0.55	C	1050	0.55	C
Bay Road west of Pacific Highway													
Eastbound	900	260	0.29	B	300	0.33	B	280	0.31	B	300	0.33	B
Westbound	900	420	0.47	C	460	0.51	C	320	0.35	B	340	0.37	B

Location/ direction	Capacity (PCU)	Morning peak						Evening peak					
		2022 base			2022 construction			2022 base			2022 construction		
		Vol (PCU)	V/C	LoS	Vol (PCU)	V/C	LoS	Vol (PCU)	V/C	LoS	Vol (PCU)	V/C	LoS
Berry Street east of Walker Street													
Eastbound	3900	1790	0.46	C	1830	0.47	C	2530	0.65	D	2540	0.65	D
Falcon Street east of Miller Street													
Eastbound	1900	1380	0.72	D	1400	0.74	D	1580	0.83	E	1600	0.84	E
Westbound	2900	1180	0.41	B	1210	0.42	C	1190	0.41	B	1210	0.42	C
Ridge Street east of Miller Street													
Eastbound	900	360	0.40	B	390	0.43	C	150	0.17	A	170	0.19	A
Westbound	900	220	0.24	A	250	0.27	B	300	0.34	B	330	0.36	B
Miller Street north of Ernest Street													
Northbound[2]	900 (AM) 1900 (PM)	660	0.73	D	670	0.74	D	830	0.44	C	830	0.44	C
Southbound[3]	2900 (AM) 1900 (PM)	1190	0.41	C	1320	0.45	C	1260	0.66	D	1260	0.66	D
Ernest Street west of Merlin Street													
Eastbound	1900	790	0.41	C	900	0.47	C	2100	>1	F	2220	>1	F
Westbound	2900	2100	0.72	D	2210	0.76	D	1040	0.36	B	1160	0.40	B
Blue Street south of Pacific Highway													
Northbound	900	190	0.21	A	220	0.24	A	350	0.39	B	360	0.40	B
Southbound	900	250	0.28	B	280	0.31	B	420	0.47	C	430	0.48	C
Arthur Street north of Pacific Highway													
Northbound	1900	880	0.46	C	910	0.48	C	640	0.33	B	650	0.34	B
Alfred Street north of Mount Street													
Northbound	900	40	0.04	A	40	0.05	A	30	0.03	A	30	0.04	A
Southbound	2900	1470	0.51	C	1470	0.51	C	750	0.26	A	750	0.26	A
Falcon Street west of Merlin Street													
Eastbound	3900	2520	0.64	D	2520	0.64	D	3120	0.80	D	3120	0.80	D
Westbound	5900	3440	0.58	C	3440	0.58	C	2320	0.39	B	2330	0.39	B
Walker Street north of Pacific Highway													
Northbound	1900	920	0.48	C	930	0.49	C	700	0.37	B	700	0.37	B
Southbound	900	320	0.36	B	320	0.36	B	370	0.42	C	370	0.42	C

Note 1: Pacific Highway south of Walker Street in the southbound direction has a clearway in operation during the morning peak period only.

Note 2: Miller Street north of Ernest Street in the northbound direction has a clearway in operation during the evening peak period only.

Note 3: Miller Street north of Ernest Street in the southbound direction has a clearway in operation during the morning peak period only.

Pre-construction performance

Without construction traffic, traffic demand is forecast to exceed capacity:

- On Ernest Street west of Merlin Street in the eastbound direction (evening peak).

Construction performance

The addition of construction traffic would change the midblock Level of Service at the following locations:

- Falcon Street east of Miller Street in the westbound direction from LoS B to LoS C (morning and evening peak)
- Ridge Street east of Miller Street in the eastbound direction from LoS B to LoS C (morning peak)
- Ridge Street east of Miller Street in the westbound direction from LoS A to LoS B (morning peak).

At all midblock locations listed above, these sections of road would continue to operate with spare capacity and at an acceptable level during construction.

Local road impacts

Western Harbour Tunnel

Bay Road and Balls Head Road are local roads forming part of the construction vehicle route for the Berrys Bay construction support site (WHT7). Tunnel spoil haulage would be carried out via marine transport to reduce the number of heavy vehicle movements along the narrow Balls Head Road. About 210 light vehicle and 55 heavy vehicle movements per day would be generated at the Berrys Bay construction support site (WHT7). The low volume of vehicular construction traffic is not expected to substantially impact Bay Road or Balls Head Road. No loss of parking is anticipated on Bay Road or Balls Head Road.

Ridge Street is also a local road that would be used by construction vehicles accessing the Ridge Street north construction support site (WHT9) during early works and site establishment, with primary access to be provided directly from the Warringah Freeway. About 12 parking spaces would be removed on Ridge Street at its eastern end to provide suitable access during site establishment. There would be about 70 light vehicle and 20 heavy vehicle movements to and from the site per day. Relatively low traffic impacts due to these construction vehicles are anticipated given that Ridge Street would operate with spare capacity during construction as shown in Table 5-12 and the limited use of this access once the site is established. In addition, there are alternatives for parking elsewhere on local roads within North Sydney, which would mitigate the loss of parking at this location.

The Ernest Street/Merlin Street intersection, located east of Warringah Freeway, would be modified during construction with an additional north approach allowing site access to the Cammeray Golf Course construction support site (WHT10 and WFU8). This provides a secondary access point to the construction site, with primary access for heavy vehicles to be provided directly from the Warringah Freeway. Impacts on Merlin Street due to the intersection’s modification would be acceptable as shown in Table 5-11. Up to 10 parking spaces on Ernest Street would be removed to provide suitable access to the site. Clearways operate on Ernest Street during peak periods so any closure of the kerbside lane associated with the construction support site would only result in loss of parking outside of peak periods and would be mitigated by parking on nearby local roads such as Ernest Street (east of Merlin Street), Oaks Avenue and Park Avenue.

Warringah Freeway Upgrade

Similar to the Ridge Street north construction support site (WHT9), the Ridge Street east construction support site (WFU6) would require the removal of about 12 parking spaces on Ridge Street at its eastern end to provide suitable access. This site would generate about 70 light vehicle and 20 heavy vehicle movements per day so would not substantially impact the traffic performance of Ridge Street due to the low construction volumes anticipated.

The primary traffic impacts of the Cammeray Golf Course construction support site (WHT10 and WFU8) on Merlin Street would be:

- Upgrade of the Ernest Street/Merlin Street intersection to include a north approach
- Up to 865 light vehicle and 40 heavy vehicle movements per day from the Cammeray Golf Course construction support site (WHT10 and WFU8) through the Ernest Street/Merlin Street intersection.

The additional north approach and construction vehicles at the Ernest Street/Merlin Street intersection would minimally increase the average vehicle delay experienced at the intersection as assessed in Table 5-11.
In addition, Ernest Street provides a secondary access point to the Cammeray Golf Course construction support site (WHT10 and WFU8), with primary access for heavy vehicles to be provided directly from the Warringah Freeway. Therefore, the impact of the Cammeray Golf Course construction support site (WHT10 and WFU8) on Merlin Street would be negligible.

The primary traffic impacts of the Merlin Street construction support site on Merlin Street would be:

- 150 light vehicle movements per day on Merlin Street south of Falcon Street due to the Merlin Street construction support site
- Temporary removal of up to 10 parking spaces along Merlin Street in the vicinity of the Merlin Street construction support site.

The number of daily light vehicle movements on Merlin Street south of Falcon Street is low so performance impacts on Merlin Street are anticipated to be minor. The impact of any lost parking spaces would be relatively minor given that other local roads nearby would provide suitable alternatives to mitigate any loss of parking.

As discussed above for Western Harbour Tunnel, up to 10 parking spaces on Ernest Street would be removed to provide suitable access to the Cammeray Golf Course construction support site (WHT10 and WFU8). Clearways operate on Ernest Street during peak periods so any closure of the kerbside lane associated with the construction support site would only result in loss of parking outside of peak periods and would be mitigated by parking on nearby local roads such as Ernest Street (east of Merlin Street), Oaks Avenue and Park Avenue.

Up to 10 parking spaces would also be removed to provide suitable access to other construction support sites established for the Warringah Freeway Upgrade such as the Rosalind Street construction support site (WFU9). If parking spaces were lost, impacts would be relatively minor given that other local roads nearby would provide suitable alternatives to mitigate any loss of parking.

Construction works associated with the Ridge Street pedestrian bridge, Alfred Street North widening and Mount Street interchange would result in the permanent removal of the following parking spaces on Alfred Street North:

- 47 parking spaces between Wyagdon Street and Ridge Street
- 49 parking spaces between Ridge Street and Whaling Road, to be replaced with 23 new parking spaces following completion of works.

These are on-street metered parking spaces (up to nine hours) serving commuters working in North Sydney. Their removal would result in a net loss of on-street parking in North Sydney and Neutral Bay given that there are no nearby alternatives.

In addition, temporary long-term closure of sections of Alfred Street North would be required during construction. Access to properties along Alfred Street North would be maintained throughout construction via existing U-turn facilities or alternative routes on the local road network.

A number of other local roads would be traversed by construction vehicles due to the Warringah Freeway Upgrade. The majority of construction support sites would be used for occasional works, generating low construction traffic volumes and therefore traffic impacts on local roads such as Walker Street and Rosalind Street would be relatively low.

Access to all other construction support sites as part of the Warringah Freeway Upgrade would be provided from state and regional roads such as Pacific Highway, Blue Street, Ernest Street, Miller Street, Berry Street, Falcon Street, Arthur Street and High Street.

Construction workforce parking

Car parking areas would be provided at the following construction support sites:

- Berrys Bay (WHT7)
- Berry Street north (WHT8)
- Ridge Street north (WHT9)
- Cammeray Golf Course (WHT10/WFU8)
- Blue Street (WFU1)
- High Street south (WFU2)
- High Street north (WFU3)
- Arthur Street east (WFU4)
- Berry Street east (WFU5)
- Merlin Street (WFU7)
- Rosalind Street east (WFU9).

Where required, shuttle bus transfers between construction support sites would also be provided. Where on-site parking is not provided or where provision of on-site parking cannot accommodate the full construction workforce, the workforce would be required to park on the surrounding road network. Impacts on these roads would be detailed in the CTMP. To minimise the potential parking impacts on the road network, the construction workforce would be encouraged to use public transport where available, with key bus corridors including Pacific Highway, Warringah Freeway, Miller Street, Falcon Street and Military Road. In addition, the T1 North Shore and T9 Northern Lines are accessible from Milsons Point, North Sydney, Wollstonecraft and Waverton railway stations.

Impacts of temporary closure of the Warringah Freeway

Due to the requirement to close sections of the Warringah Freeway and the increased safety risks associated with working adjacent to live traffic, full closure of the Warringah Freeway carriageway would be beneficial for short periods, allowing for construction activities that would be carried out more efficiently and with less disruption to traffic (such as resheeting, installation of bridge spans and demolition of kerbs and medians).

The potential short-term closure of the Warringah Freeway would generally be carried out during nights with restricted access. To minimise the impacts of any closure, an extensive communication strategy would be implemented to notify the community and affected motorists of the closures and the recommended detour routes. Active traffic management would also be in place during the closure to guide motorists to appropriate detours and manage capacity where necessary to maintain traffic flows on key routes and limit the impacts of any closures.

Forecasts of traffic demands on roads that would experience a substantial increase in traffic are shown in Table 5-13. It is likely that the roads experiencing high detoured volumes would be around North Sydney, Neutral Bay, Rozelle and the Sydney CBD, with the most substantial impacts likely to be on Pacific Highway.

Generally, almost all roads that would be impacted by diverted traffic form part of the regional and state road network or are signposted as recommended routes to key destinations and would have sufficient capacity to accommodate additional traffic resulting from closure detours, even under a full closure scenario.

For those few roads where detour volumes could exceed capacity, demand through the Warringah Freeway corridor could be reduced through demand management, which would also minimise additional volumes on local and collector roads. Traffic and demand management would be consistent with management measures that are currently employed to mitigate the impacts of regular closures to the Warringah Freeway and Bradfield Highway/Cahill Expressway as part of scheduled maintenance works for the Sydney Harbour Bridge.
Further construction traffic planning would be carried out as part of the detailed CTMP to address potential impacts on local and collector roads as a result of signposted detour routes.

Table 5-13 Peak detoured volumes during closure of Warringah Freeway (PCU per hour)

Road and direction	Overall capacity	Volume with no closure	Full northbound and southbound closure	Full northbound closure	Outer northbound lane closure only	Full southbound closure	Outer southbound lane closure only
Pacific Highway northbound	1900	760	2280	2310	1160	880	900
Pacific Highway southbound	1900	260	670	270	270	690	520
Miller Street northbound	900	100	730	710	480	190	150
Miller Street southbound	1900	150	510	160	150	520	300
Mount Street southbound on ramp to Western Suburbs	900	210	700	210	230	710	300
Mount Street southbound on ramp to Eastern Suburbs	900	220	430	220	230	430	470
Arthur Street northbound from Pacific Highway	1900	180	590	300	190	540	290
Arthur Street southbound from Berry Street	2900	260	720	320	290	700	470
Falcon Street eastbound	1900	470	1030	800	680	590	580
Falcon Street westbound	1900	180	460	330	190	300	240
Walker Street northbound	900	90	460	470	320	50	60
Walker Street southbound	900	90	300	80	70	300	210
High Street southbound on ramp	900	230	580	250	240	590	490
Bent Street and Alfred Street southbound	900	30	280	50	40	280	200
Clark Road northbound	900	350	570	570	430	340	350
Clark Road southbound	900	230	450	220	230	430	370
Cahill Expressway northbound to Sydney Harbour Bridge	1400	460	1170	1190	1340	350	330
Cahill Expressway southbound from Sydney Harbour Bridge	1600	260	650	280	270	640	630
Victoria Road eastbound	2900	960	1350	930	950	1360	1190
Victoria Road westbound	2900	1790	2260	2250	1990	1890	1890

Warringah Freeway and surrounds construction impact summary

Assessment of the performance of key locations in the road network affected by construction activities indicates that the road network in the Warringah Freeway and surrounds study area would not materially change under construction conditions and that the impacts of construction on traffic operation would be manageable. The Miller Street/Falcon Street intersection and the Warringah Freeway/Falcon Street interchange would perform at capacity before and during construction activities. Midblock volumes on Falcon Street and Ernest Street would continue to result in a poor Level of Service with or without the project.

Access to most construction support sites would be provided from state and regional roads with some exceptions. Bay Road and Balls Head Road are local roads which would provide access to the Berrys Bay construction support site (WHT7). However, tunnel spoil haulage would be by marine transport. The low volume of vehicular construction traffic is not expected to substantially impact Bay Road and Balls Head Road. A number of other local roads would be used by construction vehicles. The majority of these construction support sites would generate low construction traffic volumes and therefore traffic impacts to local roads would be relatively low.

Around 73 long-stay parking spaces would be permanently removed on Alfred Street North between Wyagdon Street and Whaling Road during construction works associated with the Ridge Street pedestrian bridge, Alfred Street North widening and Mount Street interchange.

The potential closure of the Warringah Freeway during off-peak times would result in increases in traffic volumes on alternative routes. Traffic and demand management would be required to mitigate these impacts and would be consistent with management measures that are currently employed to mitigate the impacts of regular closures to the Warringah Freeway and Bradfield Highway as part of scheduled maintenance works for the Sydney Harbour Bridge and Sydney Harbour Tunnel.

5.4 Gore Hill Freeway and Artarmon

5.4.1 Construction support site locations

The assessment of construction impacts in the Gore Hill Freeway and Artarmon study area includes the Waltham Street construction support site (WHT11).

The indicative site layout is shown in Figure 5-21.

Figure 5-21 Indicative construction support site layout – WHT11 – Waltham Street

5.4.2 Construction support site access and traffic generation

The proposed route to and from the Waltham Street construction support site (WHT11) is summarised in Table 5-5 and Figure 5-11. Access routes are proposed to be from major arterial roads rather than local roads where reasonable and feasible. Daily peak light vehicle and heavy vehicle numbers associated with spoil and waste removal, material deliveries and arrival and departure of construction personnel are also summarised in Table 5-5.

Table 5-14 Proposed access routes and peak traffic generation for each construction support site – Gore Hill Freeway and Artarmon

No.	Site	Proposed access routes	Peak vehicle movements per day		Morning peak vehicle movements (6am to 10am)		Evening peak vehicle movements (3pm to 7pm)	
			Light	Heavy	Light	Heavy	Light	Heavy
WHT11	Waltham Street	Waltham Street	180	65	86	18	86	18

Figure 5-22 Indicative construction vehicle routes – WHT11

5.4.3 Timing of construction support site use

The indicative timing of the use the Waltham Street construction support site (WHT11) is summarised in Table 5-15 and includes site establishment and site rehabilitation.

Table 5-15 Timing of construction support site use – Gore Hill Freeway and Artarmon

No.	Site	Indicative timing of construction support site use																											
		2020				2021				2022				2023				2024				2025				2026			
WHT11	Waltham Street																■	■	■	■	■	■	■	■	■				

5.4.4 Impact on traffic flows

Intersection performance

SIDRA intersection modelling has not been carried out given that construction vehicle volumes generated at the Waltham Street construction support site (WHT11) are low and fall below the intersection modelling threshold assumed for the construction assessment as outlined in Section 3.5.

Midblock performance

The midblock performance results for the road network under the ‘base’ (without construction vehicles) and ‘construction’ (with construction vehicles and proposed intersection modifications during construction) scenarios are summarised in Table 5-16 for the morning and evening peak hours, respectively.

Table 5-16 Base and construction morning and evening peak hour midblock performance – Gore Hill Freeway and Artarmon

Location/direction	Capacity (PCU)	Morning peak						Evening peak					
		2022 base			2022 construction			2022 base			2022 construction		
		Vol (PCU)	V/C	LoS	Vol (PCU)	V/C	LoS	Vol (PCU)	V/C	LoS	Vol (PCU)	V/C	LoS
Reserve Road north of Dickson Avenue													
Northbound	1900	580	0.30	B	610	0.32	B	1150	0.61	D	1180	0.62	D
Southbound	1900	1280	0.68	D	1310	0.69	D	660	0.34	B	690	0.36	B
Dickson Avenue east of Reserve Road													
Eastbound	900	260	0.29	B	290	0.32	B	170	0.19	A	200	0.22	A
Westbound	900	140	0.15	A	160	0.18	A	230	0.25	A	260	0.29	B

Pre-construction performance

Without construction traffic, traffic demand is not forecast to exceed capacity on Reserve Road and Dickson Avenue.

Construction performance

The addition of construction traffic is forecast to change the midblock Level of Service at Dickson Avenue east of Reserve Road in the westbound direction from LoS A to LoS B during the evening peak; this road would continue to operate with spare capacity and at an acceptable Level of Service during construction.

Local road impacts

Reserve Road, Dickson Avenue and Waltham Street are local roads that form part of the construction vehicle route associated with the works to be carried out at the Waltham Street construction support site (WHT11). Relatively low impacts are anticipated given the low number of construction vehicles on these roads (180 light vehicle and 65 heavy vehicle movements per day).

Up to 10 parking spaces may be removed temporarily on Dickson Avenue or Waltham Street to provide suitable access to the Waltham Street construction support site (WHT11). If parking spaces are lost, impacts would be relatively minor given the low number of spaces removed and the availability of other local roads nearby to accommodate these lost parking spaces.

Construction workforce parking

A car parking area would be provided at the Waltham Street construction support site (WHT11).
Where required, shuttle bus transfers between construction support sites would also be provided. Where provision of on-site parking cannot accommodate the full construction workforce, the workforce would be required to park on the surrounding road network. Impacts on these roads would be detailed in the CTMP.
To minimise the potential parking impacts on the road network, the construction workforce would be encouraged to use public transport where available, with key bus corridors including Pacific Highway, Warringah Freeway, Gore Hill Freeway and Epping Road. In addition, the T1 North Shore and T9 Northern Lines are accessible from Artarmon and St Leonards railway stations to minimise the potential parking impacts on the road network.

Gore Hill Freeway and Artarmon construction impact summary

Assessment of the performance of key locations in the road network affected by construction activities indicates that the road network in the Gore Hill Freeway and Artarmon study area would perform marginally worse under construction. However, in all locations this would still fall within acceptable limits with no noticeable impact when compared to traffic conditions without the project.

5.5 Impacts on other groups

5.5.1 Public transport

An overview of impacts on the public transport network during construction of the project is shown in Figure 5-23.

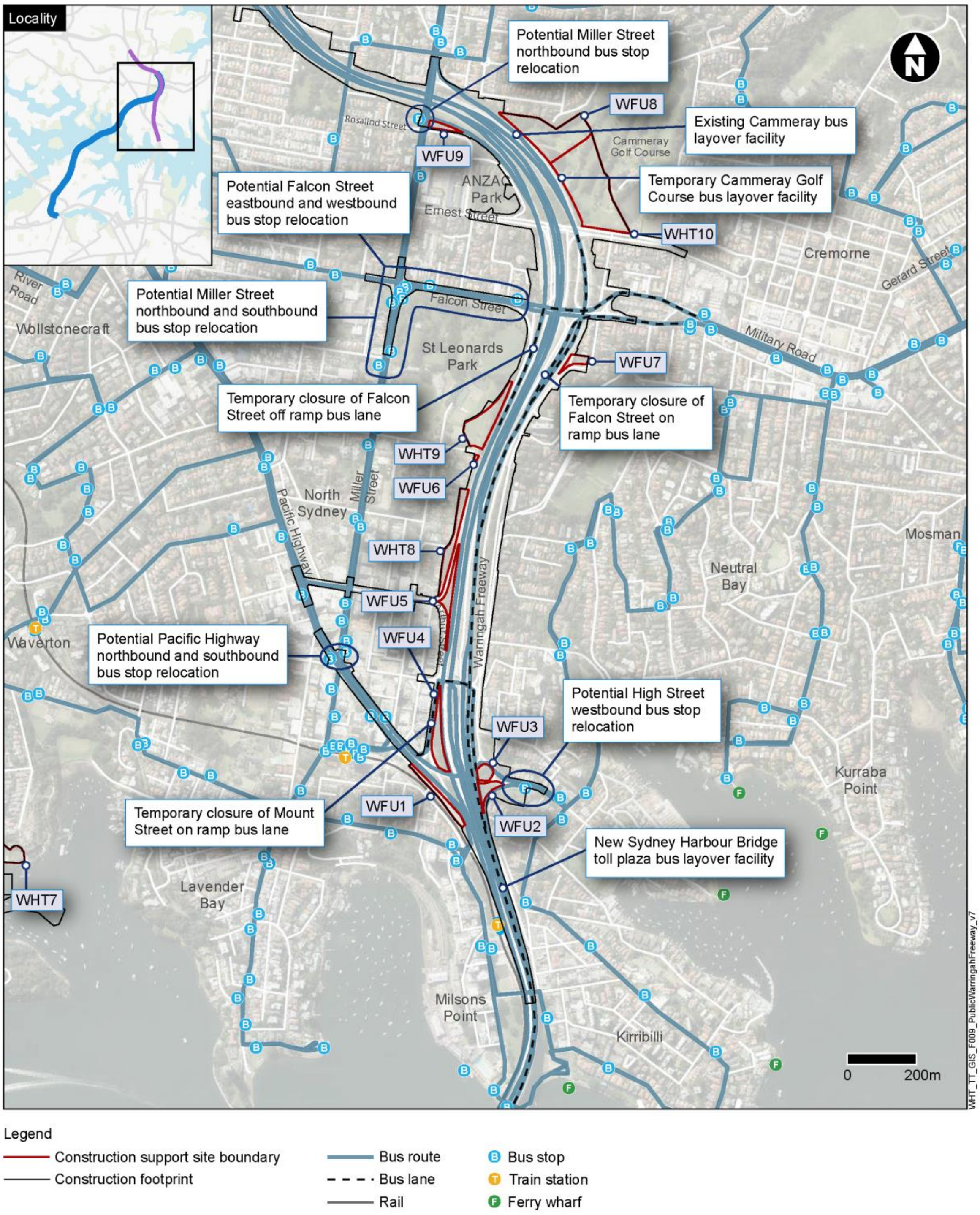


Figure 5-23 Public transport impacts during construction around North Sydney

Western Harbour Tunnel

Construction of the project would result in additional construction vehicles travelling on the road network around Rozelle, North Sydney and Artarmon, which would increase bus travel times given the congested nature of networks in these areas.

No direct impacts on heavy rail or light rail services are expected during construction of the Western Harbour Tunnel component. Impacts on ferry services are discussed in Section 5.5.3.

Warringah Freeway Upgrade

A number of construction support sites would be established to accommodate the Warringah Freeway Upgrade, with the Cammeray Golf Course serving as the primary construction support site (WFU8) and smaller satellite compounds scattered throughout the North Sydney precinct. These smaller compounds would be in operation for a short duration and their impact on bus services would be limited to a minor increase in travel times due to additional construction vehicles on the local road network, particularly along Miller Street, Falcon Street, Ernest Street, Berry Street and Pacific Highway.

Bus priority infrastructure and the capacity of layover facilities on the Warringah Freeway in the southbound direction would be maintained throughout all stages of the Warringah Freeway Upgrade. Potential strategies to be implemented include the use of temporary routes on approach to the Sydney Harbour Bridge, the utilisation of temporary bus layover facilities within Cammeray Golf Course, and a new layover facility within the existing Sydney Harbour Bridge Northern Toll Plaza area.

Potential modifications to existing bus lanes may be required for short periods during construction of the Warringah Freeway Upgrade and include:

- Temporary closure of the Mount Street on ramp bus lane
- Temporary closure of the Falcon Street on ramp bus lane
- Temporary closure of the Falcon Street off ramp bus lane.

During the short-term closures, buses would be required to use the adjacent general traffic lanes available. Impacts due to the temporary closure of the bus lanes would be relatively minor and managed during the short period that these bus lanes would not be in operation.

Adjustment to bus stops within the construction zone on High Street (serving bus route 263), Pacific Highway (serving bus route 200), Miller Street and Falcon Street (serving up to 20 unique bus routes) would be required. Bus services using these stops provide connectivity to the Sydney CBD, North Shore, Northern Beaches and the Hills District. Any adjustments to these bus stops would be determined as the project progresses, with advanced notification provided to affected bus customers of the changes to stopping sequences and location of bus stops. Disruption to bus customers would be minimised by relocating the bus stops to the closest practical alternative. In some instances, bus stop relocation could require some existing parking spaces to be removed. Given the potential small increase in travel distance to a relocated bus stop, impacts are anticipated to be acceptable and manageable.

Given the large amount of road surface works on the Warringah Freeway and North Sydney road network, extensive community and stakeholder consultation would be carried out in conjunction with Transport for NSW including the Sydney Coordination Office. This is likely to include a Community and Road User Campaign which would be implemented before the start of works to inform all road users including bus operators of the upcoming network changes and proposed detour routes. Likely detour routes and their impact on road users due to the Warringah Freeway closures are discussed in Section 5.3.4. Given the proposed overnight timing of these closures, relatively few bus services would be impacted by the closure.

Public transport construction impact summary

Overall, the assessment of the impact of Western Harbour Tunnel component construction activities on the land-based public transport network indicates acceptable performance, with minor adjustments to some bus stops in North Sydney and a minor increase in bus travel times for some customers.

The assessment of the impact of Warringah Freeway Upgrade component construction activities on the land-based public transport network also indicates acceptable performance, with a minor increase in bus travel times, and some short-term adjustments to bus priority infrastructure such as temporary closure of on/off ramp bus lanes and adjustments/relocation of bus stops.

5.5.2 Active transport

An overview of impacts on the active transport network during construction of the project is shown in Figure 5-24 to Figure 5-26.

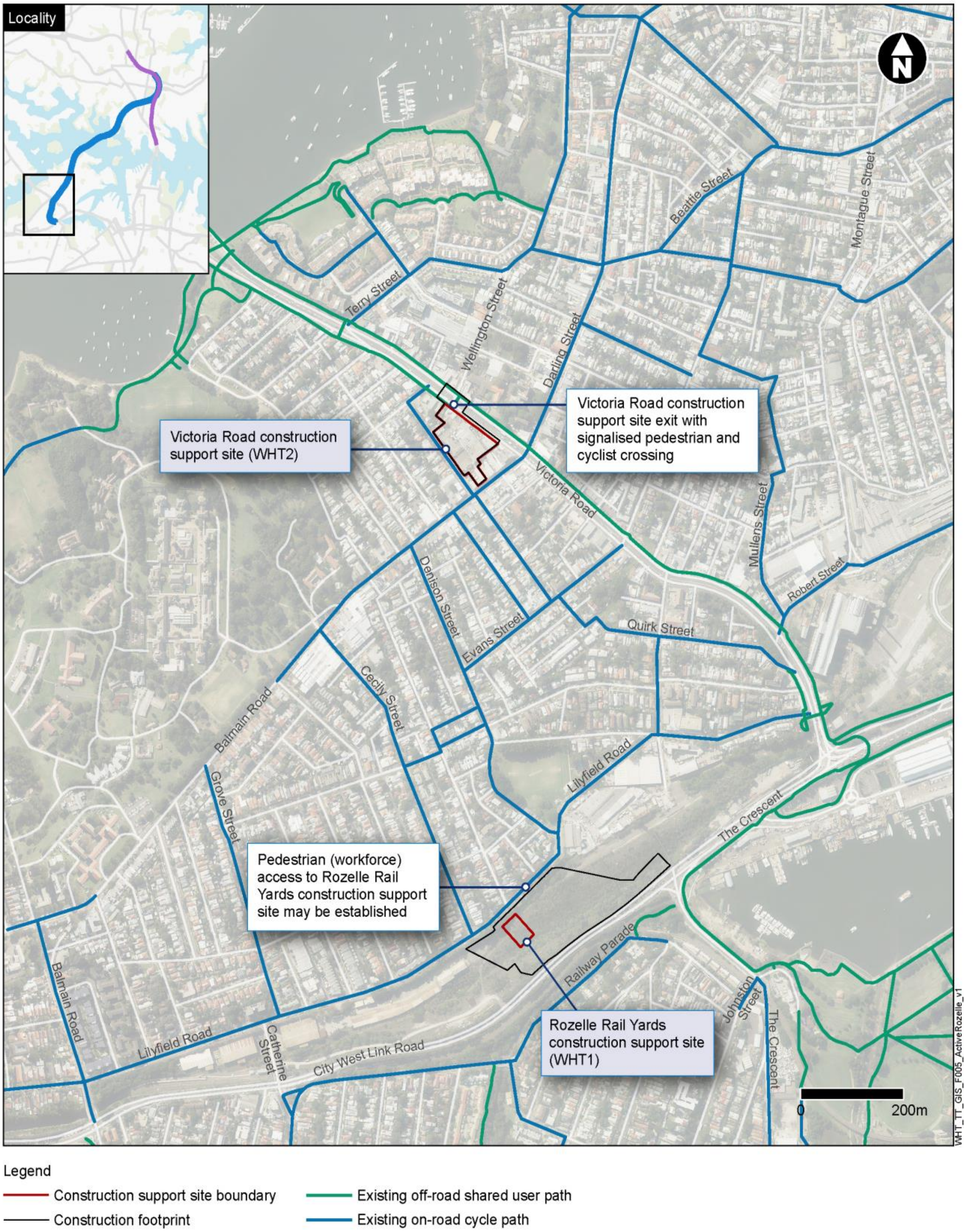


Figure 5-24 Active transport impacts during construction around Rozelle

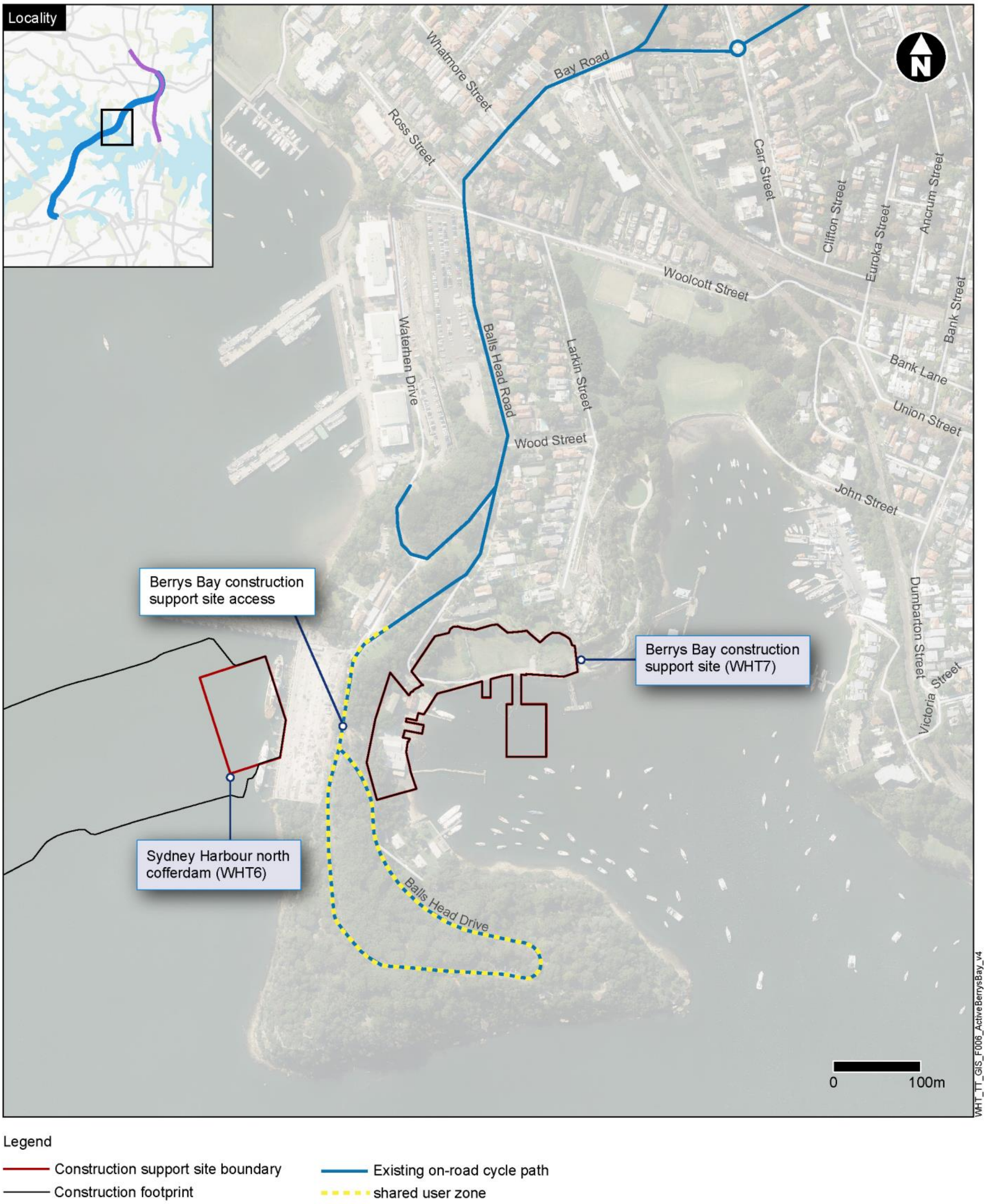


Figure 5-25 Active transport impacts during construction around Waverton

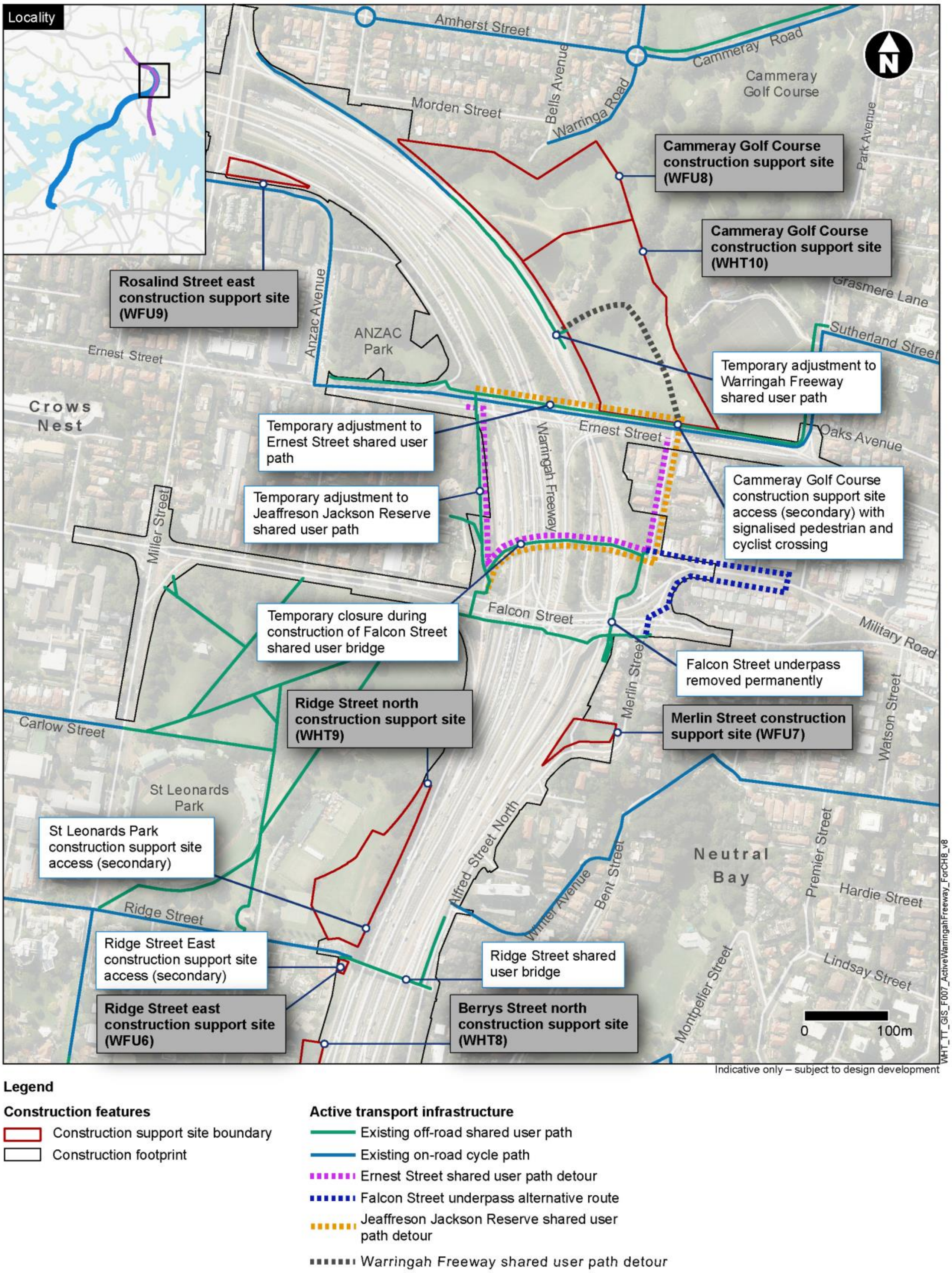


Figure 5-26 Active transport impacts during construction around North Sydney

Western Harbour Tunnel

Rozelle and surrounds

The shared user paths on Victoria Road within the vicinity of the Victoria Road construction support site (WHT2) would be maintained throughout construction. Construction vehicles entering and exiting site would give way to pedestrians and cyclists using the shared user path on the western side of Victoria Road. This would be facilitated through the modification of the traffic signals at the Victoria Road/Wellington Street intersection with a new south approach for construction vehicles, and controlled shared user crossings across the site exit.

Yurulbin Park in Birchgrove would be closed to accommodate the Yurulbin Point construction support site (WHT4). Birchgrove Park, located about 400 metres away, would provide an alternative for pedestrians and cyclists using Yurulbin Park for leisure and recreational activities.

Warringah Freeway and surrounds

Limited vehicular access to and from the Berrys Bay construction support site (WHT7) would be provided, with about 210 light vehicle and 55 heavy vehicle movements per day. The construction vehicle route to this site is via Balls Head Road, leading to Balls Head Reserve, which is used by runners and walkers and designated as a shared zone. Therefore, interactions between construction vehicles accessing the Berrys Bay construction support site (WHT7) and pedestrians would need to be managed. Given the low daily volume of construction traffic anticipated on Balls Head Road, the impact on the active transport network due to the Berrys Bay construction support site (WHT7) would be relatively low.

Primary access for heavy vehicles to the Cammeray Golf Course construction support site (WHT10 and WFU8) is proposed to and from the Warringah Freeway. A secondary access point would be established at the Ernest Street/Merlin Street intersection by adding a north approach for entering and exiting construction vehicles. There is currently a shared user path on the northern side of Ernest Street. Impacts on pedestrians and cyclists using this path would be minimised by directing heavy vehicles to access the site off Warringah Freeway where feasible and reasonable and controlling pedestrian and cyclist movements via a signalised crossing spanning the Ernest Street site entry/exit. In addition, the shared user path along Warringah Freeway near Cammeray Golf Course would be realigned to travel along the rear of the support site to the Ernest Street/Merlin Street intersection. Minor impacts to pedestrians and cyclists are anticipated given that existing connectivity would be maintained with a short additional travel distance of up to 100 metres.

Primary access to the Ridge Street north construction support site (WHT9) is proposed to and from the Warringah Freeway. However, during early works and site establishment, access may be required on the northern side of Ridge Street adjacent to the Ridge Street shared user bridge until the Warringah Freeway site access is operational. Given that there is no footpath on the northern side of Ridge Street, minimal impacts on pedestrians are anticipated. Ridge Street is designated as a high difficulty on-road cycle environment, and therefore construction vehicles may interact with cyclists accessing the Ridge Street shared user bridge. Construction vehicle movements to and from the construction support site at the Ridge Street access would be managed through active traffic management to reduce the potential for interactions between these vehicles and cyclists. Impacts on sports and recreational users at St Leonards Park would also be minimal and limited to a minor reduction in playing field area.

Warringah Freeway Upgrade

Cammeray Golf Course construction support site

The Cammeray Golf Course construction support site (WHT10 and WFU8) would be established for both the Western Harbour Tunnel and Warringah Freeway Upgrade components of the project. As discussed above, pedestrian and cyclist movements across the Ernest Street site access road would be controlled by signals at the Ernest Street/Merlin Street intersection. This would minimise interactions between pedestrians and cyclists and construction traffic. Also, the shared user path along Warringah Freeway near Cammeray Golf Course would be realigned to the rear of the support site to this intersection, with minor impacts anticipated as discussed above.

Ridge Street east construction support site

Similar to the Ridge Street north construction support site (WHT9) established for Western Harbour Tunnel, access to the Ridge Street east construction support site (WFU6) would be provided at the eastern end of Ridge Street adjacent to the Ridge Street shared user bridge. Pedestrians would access the western end of the bridge from the footpath on the southern side of Ridge Street, near the Ridge Street east construction support site (WFU6) access. Although this presents a conflict between pedestrians and heavy vehicles, construction volumes generated at the site would be low, with about 70 light vehicle and 20 heavy vehicle movements per day. Therefore, impacts are anticipated to be manageable with appropriate mitigation measures.
Construction traffic volumes at all other construction support sites established for the Warringah Freeway Upgrade are also low, with minimal impacts expected on the active transport network. In addition, the impact on sports and recreational users at ANZAC Park would also be minimal and limited to a minor reduction in playing field area.

Ernest Street bridge

During Stage 2 works of the Warringah Freeway Upgrade, a new shared user bridge would be constructed across Warringah Freeway at the location of the existing Ernest Street Bridge, where the existing shared user path would be removed. The new bridge would be constructed prior to the removal of the existing shared user path and would not result in any interruption to pedestrians and cyclists that currently use the existing Ernest Street shared user path. Temporary adjustments to the shared user path on the northern side of Ernest Street would be required to facilitate the movement of pedestrians and cyclists during the transition from the old shared user path to the new bridge.

Pedestrians and cyclists would be detoured via the Falcon Street shared user bridge, located about 140 metres south of Ernest Street. These users would be required to travel an additional 400 metres. Given the additional travel distance and potential requirement for pedestrians and cyclists to cross Ernest Street to access the Falcon Street shared user bridge, advance warning signs would be erected to notify these users of the temporary adjustment to the shared user path and the recommended detour route. Temporary adjustment to the shared user path is anticipated during part of Stage 2 works only, and therefore the impact on the active transport network would be moderate and manageable.

Falcon Street bridge

A new shared user bridge over the Warringah Freeway would be constructed to replace the existing shared user bridge at Falcon Street. The new bridge would be constructed prior to the demolition of the existing bridge and would not result in any interruption to pedestrians or cyclists that currently use the existing bridge. Temporary adjustments would also be required on the shared user path in Jeaffreson Jackson Reserve to accommodate the construction of a new Falcon Street shared user bridge. These adjustments would be relatively short in duration and would not coincide with the temporary adjustments required to the shared user path on Ernest Street. Results from the survey carried out at the shared user path indicated low volumes, with a maximum hourly volume of 45 pedestrians and six cyclists on the days surveyed. Pedestrians and cyclists would be detoured via Ernest Street and the existing Falcon Street shared user bridge, resulting in an additional travel distance of up to 400 metres. Impacts are anticipated to be moderate and manageable given the short-term duration of the shared user path adjustments and the low number of pedestrians and cyclists that currently use this path. Advance warning sings would be erected to notify users of the temporary adjustments to the Jeaffreson Jackson Reserve shared user path and the recommended detour route.

The cycleway underpass below the eastern side of the Falcon Street Bridge would be permanently removed during Stage 1 works of the Warringah Freeway Upgrade. As shown in Figure 4-23 to Figure 4-25, results from the survey carried out between 6am and 8pm on a weekday and weekend in 2017 indicate that the underpass is underutilised with fewer than 12 pedestrians and cyclists recorded using the facility during the weekday and weekend peak hours. Closure of the underpass would require pedestrians and cyclists to either travel up to an additional 380 metres via existing zebra and signalised pedestrian crossings spanning Falcon Street and

Military Road, or travel across Falcon Street Bridge, which would increase travel times. However, due to the low volumes of pedestrians and cyclists using the underpass, the impact would be minor.

Active transport construction impact summary

The assessment of the impact of Western Harbour Tunnel construction activities on the active transport network indicates that impacts would be minor and manageable with existing connectivity maintained. A detour route would be provided due to adjustments to the shared user path along Warringah Freeway near Cammeray Golf Course.

Assessment of the impact of Warringah Freeway Upgrade construction activities on the active transport network also indicates that impacts would be relatively minor and manageable. Detour routes would be required due to adjustments to the shared user path on the northern side of Ernest Street and the shared user path in Jeaffreson Jackson Reserve. In addition, the currently underutilised Falcon Street underpass would be removed permanently, with existing alternative routes available for pedestrians and cyclists to access the Falcon Street shared user bridge. The potential additional travel distances are believed to be moderate and manageable and would not require any further management measures.

5.5.3 Maritime movements and activities

This section presents a summary of the maritime impacts during construction. Further detail is provided in the Navigation Impact Assessment completed by Royal HaskoningDHV (refer to Appendix A).

The assessment of construction impacts on maritime activities relates to the following construction support sites:

- WHT3 – White Bay (shown in Figure 5-9)
- WHT4 – Yurulbin Point (shown in Figure 5-10)
- WHT5 – Sydney Harbour south cofferdam (shown in Figure 5-27)
- WHT6 – Sydney Harbour north cofferdam (shown in Figure 5-27)
- WHT7 – Berrys Bay (shown in Figure 5-12).

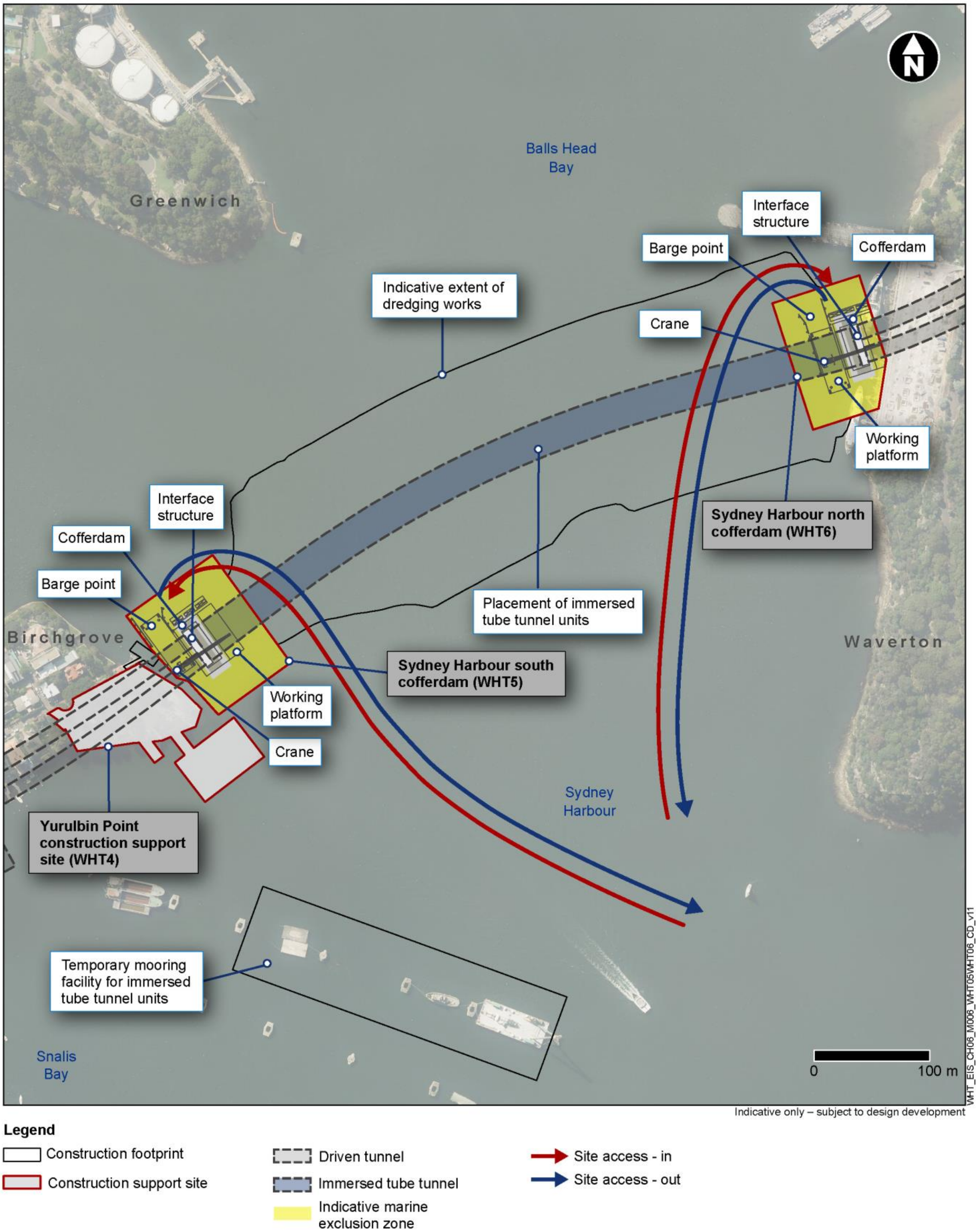


Figure 5-27 Indicative construction support site layout – WHT5 – Sydney Harbour south cofferdam, WHT6 – Sydney Harbour north cofferdam

The indicative type and number of marine transport and construction vessels likely to be used during construction is summarised in Table 5-17, and the main routes these vessels would travel across Sydney Harbour during construction are shown in Figure 5-28.

Table 5-17 Marine peak traffic generation for each construction support site

No.	Site	Vessel type, function and peak vessel movements per day		
		Small boat (workforce)	Barge (spoil)	Barge (deliveries)
WHT3	White Bay	22	14	34
WHT4	Yurulbin Point	8	4	12
WHT5	Sydney Harbour south cofferdam	8	2[1]	16
WHT6	Sydney Harbour north cofferdam			
WHT7	Berrys Bay	6	6	6
-	Dredge/immersed tube tunnel area	-	4[1]	-

Note 1: Includes barge movement/s transporting suitable dredged material to the designated offshore disposal site (two barge movements for cofferdam spoil and four barge movements for dredge spoil)

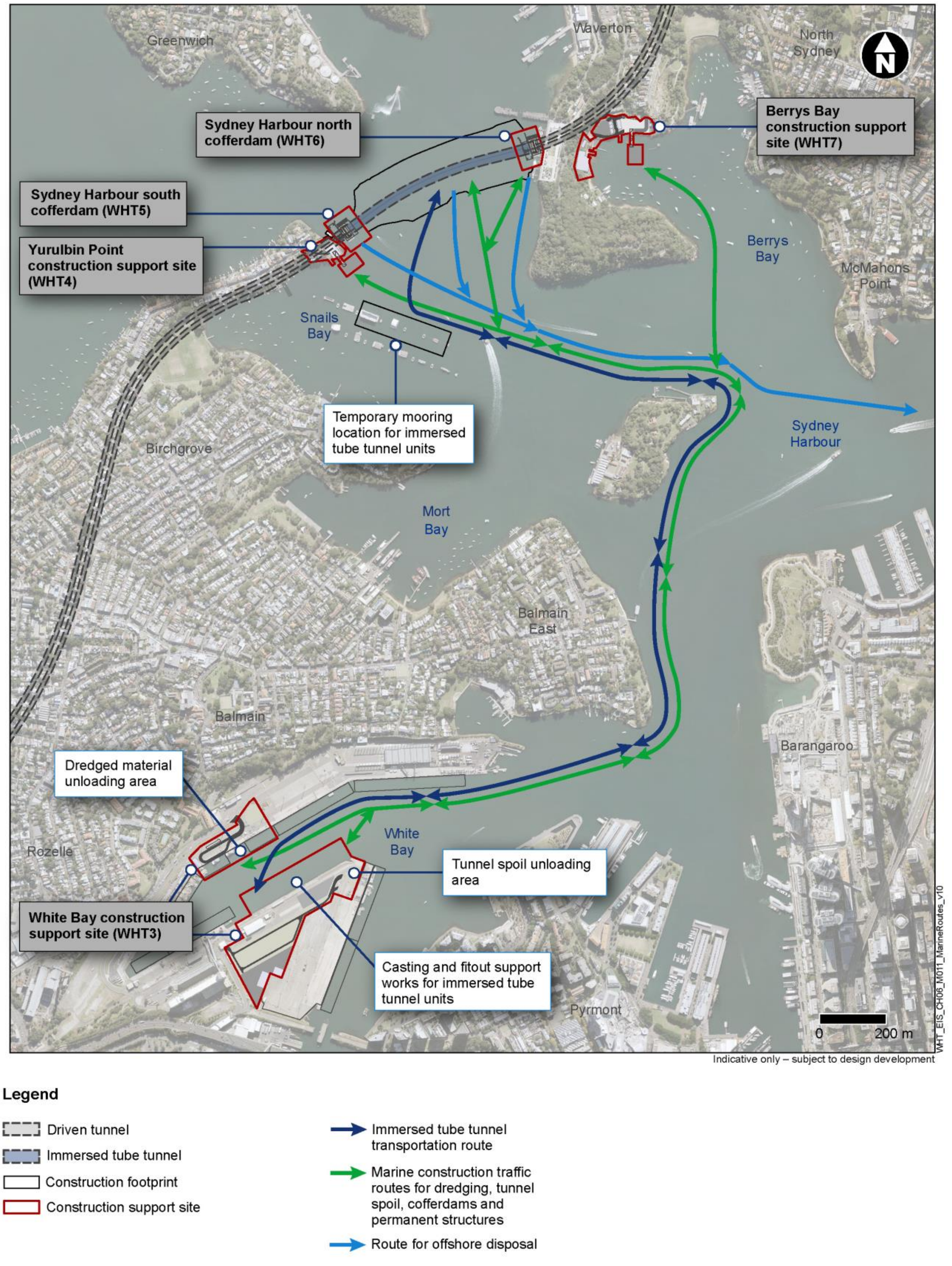


Figure 5-28 Marine transport and construction vessel routes in Sydney Harbour

The indicative timing of the use of the sites is summarised in Table 5-18 and includes site establishment and site rehabilitation.

Table 5-18 Timing of construction support site use with potential for impact on maritime activities

No.	Site	Indicative timing of construction support site use						
		2020	2021	2022	2023	2024	2025	2026
WHT3	White Bay							
WHT4	Yurulbin Point							
WHT5	Sydney Harbour south cofferdam							
WHT6	Sydney Harbour north cofferdam							
WHT7	Berrys Bay							

Impacts on maritime services are anticipated due to:

- Temporary closure of Birchgrove Ferry Wharf
- Provision of temporary moorings at Snails Bay
- Establishment and operation of the Yurulbin Point (WHT4) and Berrys Bay (WHT7) construction support sites
- Installation of Sydney Harbour south cofferdam (WHT5) and Sydney Harbour north cofferdam (WHT6)
- Dredging activities in preparation for the installation of immersed tube tunnels
- Up to seven partial closures of Sydney Harbour between Birchgrove and Berrys Bay for a period of up to 48 hours
- Barge movements to and from the project construction support sites
- Boat movements for transporting the construction workforce.

Wharf closure

Temporary closure of Birchgrove Ferry Wharf and partial closure of the Harbour between Birchgrove and Berrys Bay would impact ferry services, specifically the F3 Parramatta River route and the F8 Cockatoo Island route, as well as the Lane Cove to City Captain Cook Cruises service. Opportunities to relocate the Birchgrove Ferry Wharf would be investigated during construction planning. The location of the potential relocated wharf would be determined in consultation with Transport for NSW and Sydney Ferries. Captain Cook Cruises would also be advised of the proposed changes to the wharf's location.

Potential impacts would include altered ferry and cruise routes and an increase in travel time due to speed restrictions within the vicinity of construction plan and equipment. The increase in transit time is anticipated to be minor (less than five minutes longer compared to normal operation). In addition, ferry customers have alternatives available such as the Balmain Ferry Wharf, which serves the same ferry routes, as well as bus route 441, accessible from Grove Street and providing connections to Sydney CBD and other bus services operating along Victoria Road. Customers would be notified of any anticipated changes to the ferry network to allow them to plan their journey well ahead of time. Appropriate signage would also be provided at ferry wharves informing customers of changes.

Harbour closures

Scheduling of the partial Harbour closures would be carried out in consultation with Port Authority NSW, Roads and Maritime, Transport for NSW and other relevant stakeholders. Appropriate notice would be provided to Port Authority NSW of the closures required for the project.

Navigational restrictions would temporarily prohibit larger vessels such as oil tankers from crossing the Harbour between Birchgrove and Waverton. Operators of these vessels would be consulted and notified of the planned closures to ensure that these vessels avoid the area and complete their journey before or after any closure periods. Small vessels including ferries would be able to travel through Birchgrove and Waverton during partial closure of the Harbour, with speed restrictions imposed and movements to be carried out under escort as appropriate.

Consultation would be carried out to notify recreational users of the scheduled closures and exclusion zones. All proposed changes to navigational channels within Sydney Harbour during construction of the project would be detailed in a Marine Works Management Plan and Marine Traffic Management Plan, which would be approved by the Harbour Master before the start of works.

Exclusion zones

Exclusion zones would be set up around the cofferdams at Birchgrove (Sydney Harbour south (WHT5)) and Berrys Bay (Sydney Harbour north (WHT6)), thereby reducing navigation width. The exclusion zones would be marked by lit yellow buoys as specified by the Harbour Master to clearly demarcate these zones and facilitate the safe passage of all vessels travelling within the vicinity of the cofferdams.

Dredging of the navigation channel would also result in restrictions to navigational movements. Impacts on vessels using Gore Cove would be minimised by ensuring that dredgers do not impede the channel during scheduled inbound and outbound trips. The establishment of exclusion zones would reduce the operating width of the Harbour at the construction location. These impacts would be largely mitigated by the proposed Marine Traffic Management Plan discussed in Section 9.

Relocation of swing moorings

Temporary moorings would be located at Snails Bay (see Figure 5-29), with space provided for a minimum of four construction elements. These moorings are owned by Roads and Maritime, with details of their location and use to be outlined in the Marine Works Management Plan. Given that moorings are already in use at Snails Bay, relatively minor impacts on maritime activities are likely and would be limited to the additional construction vessel movements within Snails Bay.

Moorings within the vicinity of the Berrys Bay construction support site (WHT7) would require temporary relocation. If required, arrangements would be determined in consultation with the vessel owners. Impacts on any relocated moorings are expected to be relatively minor.

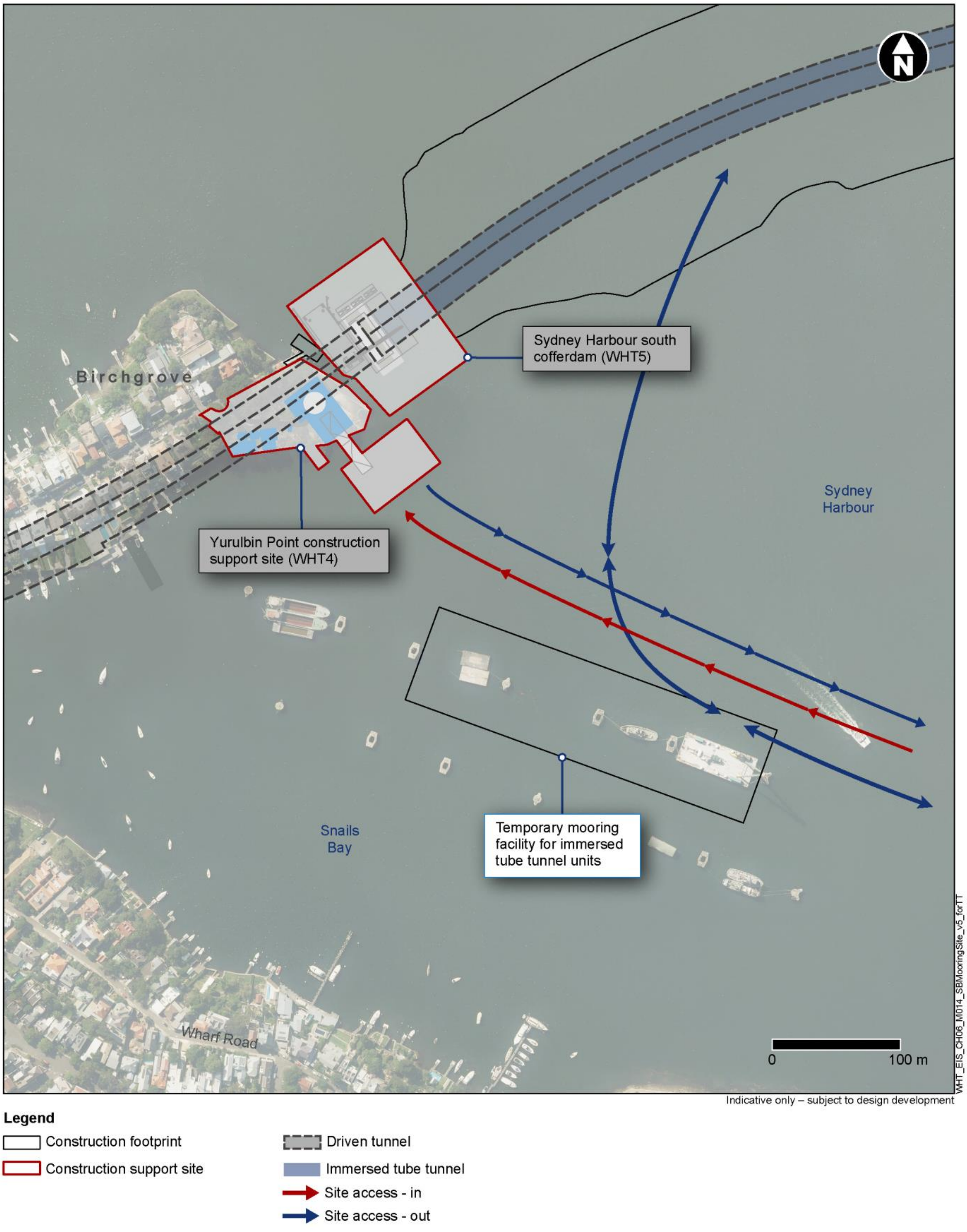


Figure 5-29 Location of moorings at Snails Bay

Barge and boat movements

The peak period for marine traffic would be during construction of transition structures, when there would be up to 100 barge movements between White Bay and the cofferdams per day. However, the duration of these works would be relatively short (about two days).

Prolonged periods of relatively high marine construction activity would occur over a 12-month period, generating daily vessel movements consisting of:

- 50 barge movements
- 32 small boat movements for transporting employees
- Tug boat movements
- Two stationary barges at cofferdams that would move periodically
- One dredger
- One immersed tube tunnel segment.

Details of the construction activities associated with these vessel movements and the marine traffic routes are provided in Appendix A.

Construction vessel movements would be managed under a Marine Traffic Management Plan, which would outline the general operational plan for the movement and management of marine vessels in and around the construction support sites.

Construction vessel movements would not interfere with port operations or the navigation of seagoing ships and ferries within Sydney Harbour, unless prior approval has been obtained from the Harbour Master. In addition, vessels of 30 metres length overall (LOA) and above travelling east of Dobroyd Head are required to participate in Port Authority NSW's Vessel Traffic Service, which provides continuous monitoring of marine vessels within Sydney Harbour.

Community groups including paddle craft, fishing, sailing, scout and guide clubs may be affected by the proposed construction activities. Sailing clubs would need to alter their courses to minimise conflict with construction vessel movements and would be consulted before the start of construction works. Marine Rescue would not be directly impacted by the construction activities. Transiting past the Western Harbour Crossing at high speed would need to be restricted during construction. However, these speed restrictions would not apply to Marine Rescue in an emergency situation in accordance with the Marine Safety Regulation 2016.

The majority of barge movements would be accommodated at the White Bay construction support site (WHT3). Given that cruise liners, cargo ships and bulk carriers berth at the White Bay and Glebe Island precinct, operators of these vessels would be informed of the scheduled works and use of White Bay as a construction support site for the project. The construction contractor would manage barge movements to ensure that the impacts on inbound and outbound marine traffic are minimised. Details of all construction vessel movements would be included in the Marine Traffic Management Plan.

Events held in Sydney Harbour such as paddling events in February and yacht races including the Sydney to Hobart in December generally occur in the Outer Sydney Harbour. Marine construction traffic in the Outer Sydney Harbour would be avoided if feasible and managed by the construction contractor. A key issue for navigation would be during events such as the New Year's Eve fireworks display. Navigation restrictions have historically applied, which limit navigation to the edge of the waterway. All large construction equipment such as dredgers and barges would be removed from the works area and relocated to White Bay construction support site (WHT3) or other suitable locations.

Impacts on all other Harbour users such as commercial fishing vessels, water taxis, charter companies and government organisations would be limited to a minor increase in travel time resulting from imposed speed restrictions during construction.

Appendix A provides additional detail regarding impacts on the maritime network during construction.

Maritime construction impact summary

The assessment of the impact of construction activities on the maritime network in the Outer Sydney Harbour indicates relatively minor impacts due to infrequent marine construction vessel movements and wide navigation waterway widths.

The impact on navigation in the Inner Sydney Harbour would also be relatively minor. Although a relatively high number of construction vessel movements are expected, the Inner Sydney Harbour would be maintained as a working harbour, with vessels larger than the marine construction vessels currently transiting through the Harbour. Waterway users would need to remain vigilant at all times and abide by any navigational restrictions imposed as part of the Marine Traffic Management Plan.

Birchgrove Ferry Wharf would be temporarily closed and potentially relocated. There would be a temporary requirement to partially close the Harbour between Birchgrove and Berrys Bay. This would impact ferry services, specifically the F3 Parramatta River route and the F8 Cockatoo Island route, as well as the Lane Cove to City Captain Cook Cruises service. Opportunities to relocate the Birchgrove Ferry Wharf would be investigated during construction planning. The location of the potential wharf relocation would be determined in consultation with Transport for NSW and Sydney Ferries. Captain Cook Cruises would also be advised of the proposed changes to the wharf's location. The increase in transit time is anticipated to be minor (less than five minutes compared to normal operation).

Navigational restrictions would temporarily prohibit larger vessels such as oil tankers crossing the Harbour between Birchgrove and Berrys Bay. Operators of these vessels would be consulted and notified of the planned closures to ensure that these vessels avoid the area and complete their journey before or after any closure periods. Small vessels including ferries would be able to travel through Birchgrove and Berrys Bay during partial closure of the Harbour, with speed restrictions imposed and movements to be carried out under escort as appropriate. Consultation would be carried out to notify recreational users of the scheduled closures and exclusion zones.

Moorings within the vicinity of the Berrys Bay construction support site (WHT7) would require temporary relocation. If required, arrangements would be determined in consultation with the vessel owners. Impacts on any relocated moorings are expected to be relatively minor.

5.5.4 Special events

The majority of construction works for the Western Harbour Tunnel would have minimal impacts on special events, as the proposed construction zones and construction traffic routes are not located close to venues that regularly schedule events that require traffic or public transport event plans. Potential exceptions to this may include:

- North Sydney Oval: events at North Sydney Oval typically do not require active traffic management or changes in network operation to accommodate visitors. Construction routes travelling along Miller Street would have no substantial impact on events at North Sydney Oval. However, the availability of car parking, particularly at Ridge Street would be temporarily reduced during the construction period
- Balls Head Reserve: Balls Head Road is typically closed to traffic during New Year's Eve. This would restrict access for light vehicles to the Berrys Bay construction support site (WHT7). Construction activity would generally be scheduled to avoid any conflict with special events such as New Year's Eve celebrations, as the regular road closures associated with New Year's Eve celebrations would prevent access to the construction in any event
- Yurulbin Park: A popular vantage point for New Year's Eve celebrations on Sydney Harbour is Yurulbin Park. After 3pm on New Year's Eve, access to Birchgrove peninsula from Victoria Road is restricted to residents, buses, taxis and authorised vehicles. The closure of the park during construction would require members of the public to seek alternative vantage points, potentially increasing pressure at other locations.

Barge movements generated at the Yurulbin Point construction support site (WHT4) would be scheduled to avoid conflict with New Year's Eve celebrations

- ANZAC Park: Temporary occupation (about six months) of land within ANZAC Park would be required to support construction activities. Consideration of community events such as the ANZAC Day Dawn Service at the memorial statue during the planning of major construction activities would be important to minimise potential construction impacts.

Construction activities in the road corridor, particularly on the Warringah Freeway, would require a Road Occupancy Licence (ROL) to close the road for any period. The granting of a ROL would generally be subject to network operation restrictions, which would preclude road closures during high activity holidays such as New Year's Eve or during arrival and departure periods for major events such as sports grand finals or during major road closures in the Sydney CBD.

Impacts on special events in Sydney Harbour are discussed in Section 5.5.3.

Overall, construction would generally have minimal impacts on special events, since the majority of construction support sites are not located in the vicinity of any major special event venues. Those construction support sites that are located in the vicinity of special event venues at Berrys Bay near Balls Head Reserve would not be accessible due to regular closures associated with New Year's Eve celebrations, so would not be accessible or in operation during these periods.

5.6 Cumulative construction impacts

5.6.1 Cumulative construction impacts – Beaches Link and Gore Hill Freeway Connection project

As outlined in Section 3.5, peak construction of the project and the Beaches Link and Gore Hill Freeway Connection project is expected to occur in 2024, should the project and the Beaches Link and Gore Hill Freeway Connection project be constructed concurrently.

The Cammeray Golf Course construction support site (WHT10 and WFU8) would be used for both projects and therefore the cumulative impact at this compound has been assessed. However, in the event that Western Harbour Tunnel and Beaches Link are both constructed, works at the Cammeray Golf Course construction support site (WHT10 and WFU8) would be programmed to avoid any overlap between the two projects.

Vissim construction modelling

As discussed in Section 3.5.2, to assess worst-case cumulative construction impacts, network simulation modelling was carried out in Vissim of the Warringah Freeway and surrounds study area, to quantify the performance of the road network with and without construction traffic during concurrent construction of the project and the Beaches Link and Gore Hill Freeway Connection.

Network performance

Table 5-19 and Table 5-20 demonstrate forecast network performance in 2024 both without and with cumulative construction activities occurring.

Table 5-19 Modelled morning peak network performance with concurrent construction program – Warringah Freeway and surrounds

Network measure	2024 base	2024 cumulative construction
Network statistics for all vehicles		
Total traffic demand (veh)	105,000	106,200
Total VKT through network	346,800	344,500
Total vehicle travel time through the network (hours)	10,100	10,500

Network measure	2024 base	2024 cumulative construction
Total number of stops	597,700	664,200
Average vehicle statistics		
Average vehicle trip length through the network (km)	3.5	3.6
Average vehicle trip time through the network (hours)	0:06:11	0:06:29
Average number of stops per trip	6.1	6.9
Average trip speed (km/hr)	34.3	32.9
Unreleased traffic		
Total unreleased trips	7200	9190
% of demand unreleased	7%	9%

Table 5-20 Modelled evening peak network performance with concurrent construction program – Warringah Freeway and surrounds

Network measure	2024 base	2024 cumulative construction
Network statistics for all vehicles		
Total traffic demand (veh)	104,800	106,000
Total VKT through network	344,800	345,500
Total vehicle travel time through the network (hours)	10,200	10,600
Total number of stops	661,700	754,800
Average vehicle statistics		
Average vehicle trip length through the network (km)	3.4	3.4
Average vehicle trip time through the network (hours)	0:06:01	0:06:15
Average number of stops per trip	6.5	7.4
Average trip speed (km/hr)	34.0	32.6
Unreleased traffic		
Total unreleased trips	3470	4200
% of demand unreleased	3%	4%

The results indicate that when compared to forecast 2024 peak period base conditions, cumulative construction activities in the Warringah Freeway and surrounds study area has the potential to:

- Increase traffic demand by around one per cent
- Create less than one additional stop per trip
- Reduce average trip speeds by around four per cent.

These overall network impacts are considered minor and manageable.

General traffic travel times

Table 5-21 and Table 5-22 demonstrate forecast corridor travel times for general traffic in 2024 both without and with cumulative construction activities occurring.

Table 5-21 Modelled morning peak hour general traffic travel times with concurrent construction program – Warringah Freeway and surrounds

Route	Direction	2024 base (hours)	2024 cumulative construction (hours)
Sydney Harbour Bridge to Warringah Freeway/Falcon Street interchange	Northbound	0:04:42	0:04:39
	Southbound	0:04:02	0:04:01
Sydney Harbour Tunnel to Warringah Freeway/Falcon Street interchange	Northbound	0:03:51	0:03:57
	Southbound	0:04:06	0:04:03
Sydney Harbour Bridge to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:06:13	0:06:13
	Southbound	0:08:48	0:10:53
Sydney Harbour Tunnel to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:22	0:05:28
	Southbound	0:08:50	0:11:21
Berry Street to Amherst Street via Miller Street	Northbound	0:04:10	0:04:05
	Southbound	0:07:48	0:09:22

Table 5-22 Modelled evening peak hour general traffic travel times with concurrent construction program – Warringah Freeway and surrounds

Route	Direction	2024 base (hours)	2024 cumulative construction (hours)
Sydney Harbour Bridge to Warringah Freeway/Falcon Street interchange	Northbound	0:03:43	0:03:45
	Southbound	0:04:16	0:05:32
Sydney Harbour Tunnel to Warringah Freeway/Falcon Street interchange	Northbound	0:03:36	0:03:42
	Southbound	0:14:27	0:15:05
Sydney Harbour Bridge to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:31	0:05:59
	Southbound	0:16:15	0:16:13
Sydney Harbour Tunnel to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:19	0:06:01
	Southbound	0:19:51	0:20:20
Berry Street to Amherst Street via Miller Street	Northbound	0:04:34	0:05:36
	Southbound	0:13:45	0:10:39

The results indicate that when compared to forecast 2024 peak period base conditions, cumulative construction activities in the Warringah Freeway and surrounds study area has the potential to:

- Impact corridor travel times by less than one minute for the majority of routes
- Increase travel times by between one and three minutes for the following routes:
  - Warringah Freeway: Gore Hill Freeway to Sydney Harbour Bridge (morning peak)
  - Warringah Freeway: Gore Hill Freeway to Sydney Harbour Tunnel (morning peak)
  - Warringah Freeway: Falcon Street to Sydney Harbour Bridge (evening peak)
  - Miller Street: Amherst Street to Berry Street (morning peak)
  - Miller Street: Berry Street to Amherst Street (evening peak).

Bus travel times

Table 5-23 and Table 5-24 demonstrate forecast corridor travel times for buses in 2024 both without and with cumulative construction activities occurring.

Table 5-23 Modelled morning peak hour bus travel times with concurrent construction program – Warringah Freeway and surrounds

Route	Direction	2024 base (hours)	2024 cumulative construction (hours)
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:13:01	0:11:25
	Southbound	0:14:56	0:16:08
Sydney Harbour Bridge to Bay Street (Via North Sydney Station and Pacific Highway)	Northbound	0:07:20	0:06:17
	Southbound	0:12:44	0:12:16
Sydney Harbour Bridge to Ben Boyd Road	Northbound	0:06:51	0:07:02
	Southbound	0:07:12	0:06:57
Sydney Harbour Bridge to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:06:49	0:06:38
	Southbound	0:17:54	0:26:18

Table 5-24 Modelled evening peak hour bus travel times with concurrent construction program – Warringah Freeway and surrounds

Route	Direction	2024 base (hours)	2024 cumulative construction (hours)
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:12:04	0:13:03
	Southbound	0:18:07	0:16:14
Sydney Harbour Bridge to Bay Street (Via North Sydney Station and Pacific Highway)	Northbound	0:07:13	0:07:23
	Southbound	0:09:30	0:09:53
Sydney Harbour Bridge to Ben Boyd Road	Northbound	0:08:39	0:10:31
	Southbound	0:05:40	0:05:33
Sydney Harbour Bridge to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:06:13	0:06:22
	Southbound	0:18:44	0:17:21

The results indicate that when compared to forecast 2024 peak period base conditions, cumulative construction activities in the Warringah Freeway and surrounds study area has the potential to:

- Impact corridor travel times by less than one minute for the majority of routes
- Increase travel times by between one and three minutes for the following routes:
  - Southbound via Miller Street to the Sydney Harbour Bridge (morning peak)
  - Northbound via the Warringah Freeway and Military Road to Ben Boyd Road (evening peak).

The most substantial potential impact is to southbound travel times via the Warringah Freeway. For Warringah Freeway routes, increased traffic demand including potential additional traffic movements across the southbound bus lane south of Falcon Street could increase congestion, impacting bus travel times. This issue could be mitigated by considered and tailored construction traffic planning based on actual traffic conditions and confirmed cumulative activities at the time of construction.

Intersection performance

The intersection performance results for the road network with and without construction traffic are provided in Table 5-25 and Table 5-26 for the morning and evening peak hours, respectively.

Table 5-25 Modelled morning peak hour intersection performance with concurrent construction program – Warringah Freeway and surrounds

Intersection	2024 base		2024 cumulative construction	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
Willoughby Road/Gore Hill Freeway interchange	66	E	>100	F
Brook Street/Warringah Freeway on ramp	>100	F	>100	F
Brook Street/Warringah Freeway off ramp	58	E	95	F
Brook Street/Merrenburn Avenue	>100	F	>100	F
Amherst Street/West Street	6	A	<5	A
Amherst Street/Miller Street	21	B	22	B
Miller Street/Warringah Freeway on ramp	<5	A	7	A
Miller Street/Warringah Freeway off ramp	13	A	34	C
Miller Street/Ernest Street	58	E	67	E
Miller Street/Falcon Street	56	D	58	E
Ernest Street/Warringah Freeway on ramp	41	C	31	C
Ernest Street/Warringah Freeway off ramp (off ramp in PM, on ramp in AM)	41	C	31	C
Falcon Street/Warringah Freeway ramps	73	F	57	E
Watson Street/Military Road	38	C	38	C
Military Road/Ben Boyd Road	33	C	35	C
Falcon Street/Merlin Street	57	E	55	D
Berry Street/Walker Street	35	C	35	C
Berry Street/Miller Street	68	E	59	E
Mount Street/Arthur Street	73	F	76	F
Mount Street/Walker Street	42	D	37	C
Pacific Highway/High Street/Arthur Street	52	D	42	D
Pacific Highway/Walker Street/Blue Street	55	D	50	D
Pacific Highway/Miller Street/Mount Street	93	F	74	F
Pacific Highway/Berry Street	51	D	48	D
Pacific Highway/Bay Road	68	E	74	F
Miller Street/McLaren Street	24	B	23	B
Miller Street/Ridge Street	11	A	11	A
Miller Street/Carlow Street	12	A	12	A
High Street/Clark Road	60	E	31	C
High Street/Alfred Street	13	A	17	B

Intersection	2024 base		2024 cumulative construction	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
Mount Street/Alfred Street	17	B	17	B
Ernest Street/Ben Boyd Road	33	C	52	D
Pedestrian crossing at Military Road	5	A	<5	A

Table 5-26 Modelled evening peak hour intersection performance with concurrent construction program – Warringah Freeway and surrounds

Intersection	2024 base		2024 cumulative construction	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
Willoughby Road/Gore Hill Freeway interchange	41	C	47	D
Brook Street/Warringah Freeway on ramp	29	C	27	B
Brook Street/Warringah Freeway off ramp	31	C	29	C
Brook Street/Merrenburn Avenue	24	B	24	B
Amherst Street/West Street	6	A	28	B
Amherst Street/Miller Street	26	B	31	C
Miller Street/Warringah Freeway on ramp	5	A	7	A
Miller Street/Warringah Freeway off ramp	14	B	18	B
Miller Street/Ernest Street	62	E	58	E
Miller Street/Falcon Street	83	F	86	F
Ernest Street/Warringah Freeway on ramp	12	A	13	A
Ernest Street/Warringah Freeway off ramp (off ramp in PM, on ramp in AM)	15	B	16	B
Falcon Street/Warringah Freeway ramps	62	E	61	E
Watson Street/Military Road	30	C	37	C
Military Road/Ben Boyd Road	39	C	48	D
Falcon Street/Merlin Street	98	F	87	F
Berry Street/Walker Street	57	E	39	C
Berry Street/Miller Street	45	D	42	D
Mount Street/Arthur Street	61	E	78	F
Mount Street/Walker Street	61	E	23	B
Pacific Highway/High Street/Arthur Street	46	D	53	D
Pacific Highway/Walker Street/Blue Street	54	D	45	D
Pacific Highway/Miller Street/Mount Street	46	D	44	D
Pacific Highway/Berry Street	19	B	30	C
Pacific Highway/Bay Road	15	B	19	B
Miller Street/McLaren Street	44	D	26	B
Miller Street/Ridge Street	86	F	45	D
Miller Street/Carlow Street	42	C	24	B

Intersection	2024 base		2024 cumulative construction	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
High Street/Clark Road	49	D	34	C
High Street/Alfred Street	>100	F	24	B
Mount Street/Alfred Street	10	A	12	A
Ernest Street/Ben Boyd Road	14	A	15	B
Pedestrian crossing at Military Road	9	A	11	A

With construction traffic, intersections that operate with a poorer Level of Service compared to without construction traffic include:

- Willoughby Road/Gore Hill Freeway interchange (morning and evening peak)
- Brook Street/Warringah Freeway off ramp (morning peak)
- Amherst Street/West Street (evening peak)
- Amherst Street/Miller Street (evening peak)
- Miller Street/Warringah Freeway off ramp (morning peak)
- Miller Street/Falcon Street (morning peak)
- Military Road/Ben Boyd Road (evening peak)
- Mount Street/Arthur Street (evening peak)
- Pacific Highway/Berry Street (evening peak)
- Pacific Highway/Bay Road (morning peak)
- High Street/Alfred Street (morning peak)
- Ernest Street/Ben Boyd Road (morning and evening peak).

During the morning peak, intersections that would experience a substantial increase in average vehicle delay (ie around 30–40 seconds) during construction include Willoughby Road/Gore Hill Freeway interchange and Brook Street/Warringah Freeway ramps. This is due to the introduction of construction traffic that would use these roads to access the Flat Rock Drive and Cammeray Golf Course construction support sites (WHT10 and WFU8), incrementally increasing demand and consequent delays.

A minor increase in average vehicle delay during construction would occur at intersections within North Sydney during the evening peak.

Other impacts

Cumulative construction impacts on the local road network, public transport, active transport and maritime activities within the project's footprint would be similar to those which would be expected under the 'project only' scenario discussed in Sections 5.2.4, 5.3.4, 5.4.4 and 0.

Potential cumulative construction program construction impact summary

Assessment of the performance of key locations in the road network affected by construction activities indicates that the road network under the concurrent Western Harbour Tunnel and Beaches Link construction programs would impact corridor travel times by up to three minutes and reduce overall average travel speeds by about four per cent. Potential impacts to bus travel times are more substantial for southbound buses that use the Warringah Freeway due to increased traffic demand and increased traffic movements across the southbound bus lane south of Falcon Street, causing congestion.

Impacts to the Warringah Freeway and surrounds study area could be mitigated by considered and tailored construction traffic planning based on actual traffic conditions and confirmed cumulative activities at the time of construction.

5.6.2 Cumulative construction impact – other projects

As outlined in Section 3.5, peak tunnelling for the project is expected to occur in 2022. This would potentially overlap with the construction program of two other projects in the Sydney Metropolitan area that would fall within the construction footprint of the project: M4-M5 Link and Sydney Metro City & Southwest. In the Rozelle and surrounds study area, the Rozelle Rail Yards (WHT1), Victoria Road (WHT2) and White Bay (WHT3) construction support sites could be operational at the same time as construction for M4-M5 Link and Sydney Metro City & Southwest. Although use of the Rozelle Rail Yards construction support site (WHT1) commences in 2023 and therefore outside the 2022 assessment year, construction traffic volumes at this site have been included in the assessment to present a worst-case cumulative construction scenario.

M4-M5 Link construction support sites and their associated construction vehicle routes that fall within the Rozelle and surrounds study area assessed for this project include:

- Rozelle – light vehicles access the site from Lilyfield Road and heavy vehicles access the site from City West Link
- The Crescent – light vehicles and heavy vehicles access the site from The Crescent
- Victoria Road – light vehicles and heavy vehicles access the site from Victoria Road
- Iron Cove Link – light vehicles and heavy vehicles access the site from Victoria Road.

Sydney Metro City & Southwest construction support sites and their associated construction vehicle routes that fall within the Rozelle and surrounds study area assessed for this project include:

- Barangaroo – light vehicles and heavy vehicles access the site from Hickson Road via the Western Distributor
- Pitt Street – light vehicles and heavy vehicles access the site from Pitt Street, Castlereagh Street and Bathurst Street via the Western Distributor.

Peak hour volumes generated for each of these sites have been added to the traffic modelling assumptions in addition to the construction vehicles generated due to the project. Results of these assessments are presented in the following sections.

Vissim construction modelling

As detailed in Section 3.5.2, to assess worst-case cumulative construction impacts, network simulation modelling was carried out in Vissim for the Rozelle and surrounds study area, to quantify the performance of the road network with and without construction traffic due to combined construction traffic from the project in conjunction with M4-M5 Link and Sydney Metro City & Southwest.

Network performance

Table 5-27 and Table 5-28 demonstrate forecast network performance in 2022 both without and with cumulative construction activities occurring.

The results indicate that when compared to forecast 2022 peak period base conditions, cumulative construction activities in the Rozelle and surrounds area has the potential to:

- Increase traffic demand by up to three per cent
- Create up to three additional stops per trip
- Reduce average trip speeds by between five per cent (morning peak) and 14 per cent (evening peak).

The overall network impacts are considered relatively minor and manageable.

Table 5-27 Modelled morning peak network performance with cumulative construction – Rozelle and surrounds

Network measure	2022 base	2022 cumulative construction
Network statistics for all vehicles		
Total traffic demand (veh)	45,100	46,000
Total VKT through network	114,700	112,200
Total vehicle travel time through the network (hours)	6800	6970
Total number of stops	550,200	550,900
Average vehicle statistics		
Average vehicle trip length through the network (km)	2.7	2.8
Average vehicle trip time through the network (hours)	0:09:47	0:10:30
Average number of stops per trip	13.2	13.8
Average trip speed (km/hr)	16.9	16.1
Unreleased traffic		
Total unreleased trips	4140	7210
% of demand unreleased	8%	13%

Table 5-28 Modelled evening peak network performance with cumulative construction – Rozelle and surrounds

Network measure	2022 base	2022 cumulative construction
Network statistics for all vehicles		
Total traffic demand (veh)	45,200	46,500
Total VKT through network	119,600	113,200
Total vehicle travel time through the network (hours)	5660	6210
Total number of stops	289,500	365,300
Average vehicle statistics		
Average vehicle trip length through the network (km)	2.7	2.9
Average vehicle trip time through the network (hours)	0:07:47	0:09:26
Average number of stops per trip	6.6	9.2
Average trip speed (km/hr)	21.1	18.2
Unreleased traffic		
Total unreleased trips	3940	7370
% of demand unreleased	8%	14%

General traffic travel times

Table 5-29 and Table 5-30 demonstrate forecast corridor travel times for general traffic in 2022 both without and with cumulative construction activities occurring.

Table 5-29 Modelled morning peak hour general traffic travel times with cumulative construction – Rozelle and surrounds

Route	Direction	2022 base (hours)	2022 cumulative construction (hours)
City West Link and Western Distributor (Balmain Road to Druitt Street ramp)	Eastbound	0:14:36	0:12:44
	Westbound	0:10:29	0:15:50

Route	Direction	2022 base (hours)	2022 cumulative construction (hours)
Victoria Road (Evans Street to ANZAC Bridge)	Northbound	0:11:00	0:14:24
	Southbound	0:03:19	0:03:13

Table 5-30 Modelled evening peak hour general traffic travel times with cumulative construction – Rozelle and surrounds

Route	Direction	2022 base (hours)	2022 cumulative construction (hours)
City West Link and Western Distributor (Balmain Road to Druitt Street ramp)	Eastbound	0:05:34	0:06:53
	Westbound	0:11:23	0:13:21
Victoria Road (Evans Street to ANZAC Bridge)	Northbound	0:04:54	0:05:50
	Southbound	0:04:07	0:03:56

The results indicate that when compared to forecast 2022 peak period base conditions, cumulative construction activities in the Rozelle and surrounds area have the potential to:

- Impact travel times on City West Link westbound by up to five minutes (morning peak)
- Impact travel times on Victoria Road northbound by up to 3.5 minutes (morning peak)
- Impact travel times in the evening peak by up to two minutes on both City West Link and Victoria Road.

Bus travel times

Table 5-31 and Table 5-32 demonstrate forecast corridor travel times for buses in 2022 both without and with cumulative construction activities occurring.

Table 5-31 Modelled morning peak hour bus travel times during cumulative construction – Rozelle and surrounds

Route	Direction	2022 base (hours)	2022 cumulative construction (hours)
Victoria Road (Evans Street to ANZAC Bridge)	Northbound	0:08:30	0:11:05
	Southbound	0:02:20	0:02:31

Table 5-32 Modelled evening peak hour bus travel times during cumulative construction – Rozelle and surrounds

Route	Direction	2022 base (hours)	2022 cumulative construction (hours)
Victoria Road (Evans Street to ANZAC Bridge)	Northbound	0:09:15	0:10:48
	Southbound	0:04:11	0:03:54

The results indicate that when compared to forecast 2022 peak period base conditions, cumulative construction activities in the Rozelle and surrounds area has the potential to impact northbound bus travel times on ANZAC Bridge-Victoria Road by up to 2.5 minutes.

Intersection performance

The intersection performance results for the road network with and without construction traffic are provided in Table 5-33 and Table 5-34 for the morning and evening peak hours, respectively.

Table 5-33 Modelled morning peak hour intersection performance with cumulative construction – Rozelle and surrounds

Intersection	2022 base		2022 cumulative construction	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
Victoria Road/Darling Street	87	F	85	F
Victoria Road/Evans Street	61	E	57	E
Victoria Road/Gordon Street	37	C	36	C
Victoria Road/Robert Street	68	E	68	F
Victoria Road/The Crescent	56	D	57	E
The Crescent/James Craig Road	30	C	25	B
The Crescent/City West Link	>100	F	78	F
The Crescent/Johnston Street	>100	F	>100	F
City West Link/Catherine Street	69	E	59	E
City West Link/Balmain Road	>100	F	>100	F

Table 5-34 Modelled evening peak hour intersection performance with cumulative construction – Rozelle and surrounds

Intersection	2022 base		2022 cumulative construction	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
Victoria Road/Darling Street	85	F	85	F
Victoria Road/Evans Street	70	E	72	F
Victoria Road/Gordon Street	69	E	75	F
Victoria Road/Robert Street	>100	F	>100	F
Victoria Road/The Crescent	98	F	>100	F
The Crescent/James Craig Road	28	B	37	C
The Crescent/City West Link	62	E	96	F
The Crescent/Johnston Street	82	F	>100	F
City West Link/Catherine Street	17	B	30	C
City West Link/Balmain Road	70	E	>100	F

Modelling of the cumulative construction scenario on roads through the Rozelle and surrounds study area indicate that the increased traffic volumes resulting from construction traffic generation, particularly from spoil haulage trucks would result in a general decrease in intersection performance along Victoria Road and City West Link – as reflected in the network and corridor performance statistics. This is primarily due to the increased space required by spoil haulage trucks at key capacity constrained intersections, including:

- Victoria Road and The Crescent
- The Crescent and City West Link
- The Crescent and Johnson Street
- City West Link and Balmain Road.

Cumulative Traffic Working Group

A cumulative traffic working group was established in July 2018 to investigate the potential cumulative traffic impacts associated with the concurrent traffic generating activities in the Glebe Island and White Bay area due to construction of the of Rozelle Interchange, Western Harbour Tunnel and Sydney Metro West, along with an expansion of existing operations at Glebe Island by the Port Authority of NSW. The working group includes the following stakeholders:

- Transport for NSW
- Urban Growth (now Infrastructure NSW)
- Sydney Coordination Office
- Roads and Maritime (Sydney Division)
- Roads and Maritime (Rozelle Interchange project)
- Roads and Maritime (Western Harbour Tunnel)
- Sydney Metro West project
- Port Authority of NSW.

The cumulative traffic working group carried out traffic modelling to predict the potential impact of these projects and operations on the traffic network in and around the Rozelle precinct and developed a range of mitigation measures to be implemented, including:

- Implementation and incentivising bus services to transport suitable project personnel to and from site
- Avoiding tunnelling shift changeovers occurring between 7am and 9am and 4pm and 6pm Monday to Friday, to reduce peak period traffic impacts
- Offshore disposal of tunnel spoil, which is primarily crushed sandstone, when generated at harbourside construction support sites to reduce heavy haulage.

The project would adopt the first two of the aforementioned mitigation measures. An application for offshore disposal of suitable dredged material has been submitted to the Commonwealth Department of the Environment and Energy to implement offshore disposal where appropriate.

Cumulative construction impact summary

Assessment of the performance of key locations in the road network affected by cumulative construction activities from the project along with construction activities from other projects including M4-M5 Link and Sydney Metro City & Southwest, indicates that the road network in Rozelle and surrounds study area would perform worse under the cumulative construction scenario. This may include an increase in general traffic travel time on City West Link and Victoria Road by up to five minutes, and increased delays at intersections along these roads as reflected in the travel time increases. However, the cumulative project impacts in the Rozelle and surrounds study area are shown to be moderate and manageable; the potential issues could be mitigated by considered and tailored cumulative construction traffic planning based on actual traffic conditions and confirmed cumulative activities at the time of construction.

6. Future road network performance without the project

6.1 Overview

This section provides a summary of the road network operation under 2027 and 2037 forecast traffic demand without the project (the ‘Do minimum’ scenario). This reflects the operation of the network under the assumptions that the Western Harbour Tunnel and Warringah Freeway Upgrade project does not occur and represents a business-as-usual ‘Do minimum’ including all approved projects such as the Rozelle Interchange and associated M4-M5 Link works as part of WestConnex. Assessment of the future road network performance without the project is based on the following performance measures:

- Network performance based on vehicle hours of travel (VHT) vehicle kilometres of travel (VKT) and average network speed
- Intersection performance based on intersection Level of Service
- General traffic and bus travel times for key corridors.

6.2 Metropolitan road network performance

6.2.1 Strategic corridors

A summary of the forecast growth at key locations for the 2027 and 2037 forecast years is provided in Table 6-1 to Table 6-3.

Table 6-1 Modelled ‘Do minimum’ morning peak hour traffic demands at key locations (SMPM)

Road	Location	Direction	2016 (veh)	2027 (veh)	2037 (veh)
Sydney Harbour Bridge	Bradfield Highway	Northbound	4850	5500	6000
		Southbound	5500	6050	6600
		Combined	*10,350*	*11,550*	*12,600*
Sydney Harbour Bridge	Cahill Expressway	Southbound	2600	2900	3200
Sydney Harbour Tunnel	Sydney Harbour	Northbound	3950	4200	4450
		Southbound	3700	4100	4350
		Combined	*7650*	*8300*	*8800*
Gladesville Bridge	Parramatta River	Northbound	3050	3800	4150
		Southbound	3650	4050	4300
		Combined	*6700*	*7850*	*8450*
Sydney Harbour screenline		**Northbound**	**11,850**	**13,500**	**14,600**
		Southbound	**15,450**	**17,100**	**18,450**
		Combined	***27,300***	***30,600***	***33,050***
ANZAC Bridge	Pyrmont	Eastbound	5100	6250	6600
		Westbound	3000	3850	3900
		Combined	*8100*	*10,100*	*10,500*
Western Distributor	Sydney CBD	Northbound	2550	3050	3300
		Southbound	2800	3100	3350
		Combined	*5350*	*6150*	*6650*

Table 6-2 Modelled 'Do minimum' evening peak hour traffic demands at key locations (SMPM)

Road	Location	Direction	2016 (veh)	2027 (veh)	2037 (veh)
Sydney Harbour Bridge	Bradfield Highway	Northbound	6150	6650	7200
		Southbound	3150	3450	3750
		Combined	*9300*	*10,100*	*10,950*
Sydney Harbour Bridge	Cahill Expressway	Southbound	2500	2650	2850
Sydney Harbour Tunnel	Sydney Harbour	Northbound	3850	3900	4100
		Southbound	2850	3400	3800
		Combined	*6700*	*7300*	*7900*
Gladesville Bridge	Parramatta River	Northbound	3750	4050	4250
		Southbound	2900	3250	3550
		Combined	*6650*	*7300*	*7800*
Sydney Harbour screenline		**Northbound**	**13,750**	**14,600**	**15,550**
		Southbound	**11,400**	**12,750**	**13,950**
		Combined	***25,150***	***27,350***	***29,500***
ANZAC Bridge	Pyrmont	Eastbound	4200	5300	5450
		Westbound	4250	5850	6200
		Combined	*8450*	*11,150*	*11,650*
Western Distributor	Sydney CBD	Northbound	3200	3750	4000
		Southbound	1850	2150	2300
		Combined	*5050*	*5900*	*6300*

Table 6-3 Modelled 'Do minimum' daily traffic demands at key locations (SMPM)

Road	Location	Direction	2016 (veh)	2027 (veh)	2037 (veh)
Sydney Harbour Bridge	Bradfield Highway	Northbound	90,500	101,500	110,000
		Southbound	52,500	58,000	62,500
		Combined	*143,000*	*159,500*	*172,500*
Sydney Harbour Bridge	Cahill Expressway	Southbound	39,000	44,000	48,000
Sydney Harbour Tunnel	Sydney Harbour	Northbound	55,000	56,000	60,500
		Southbound	48,500	55,000	60,000
		Combined	*103,500*	*111,000*	*120,500*
Gladesville Bridge	Parramatta River	Northbound	51,000	62,000	65,500
		Southbound	43,000	51,000	53,500
		Combined	*94,000*	*113,000*	*119,000*
Sydney Harbour Screenline		**Northbound**	**196,500**	**219,500**	**236,000**
		Southbound	**183,000**	**208,000**	**224,000**
		Combined	***379,500***	***427,500***	***460,000***
ANZAC Bridge	Pyrmont	Eastbound	75,500	91,500	95,500
		Westbound	63,000	84,500	89,500
		Combined	*138,500*	*176,000*	*185,000*
Western Distributor	Sydney CBD	Northbound	52,500	60,000	64,000
		Southbound	42,000	49,000	53,500
		Combined	*94,500*	*109,000*	*117,500*

Analysis of the forecast traffic demands across Sydney Harbour shows a substantial growth in peak period cross Harbour trips of up to 21 per cent by 2037, with daily trips also forecast to increase by 21 per cent within the same period. Proportional growth in daily trips would be highest for the Gladesville Bridge and Victoria Road corridor, particularly northbound.

A summary of forecast travel times during peak periods for key routes across Sydney Harbour in the vicinity of the project is provided in Figure 6-1 and Figure 6-2.

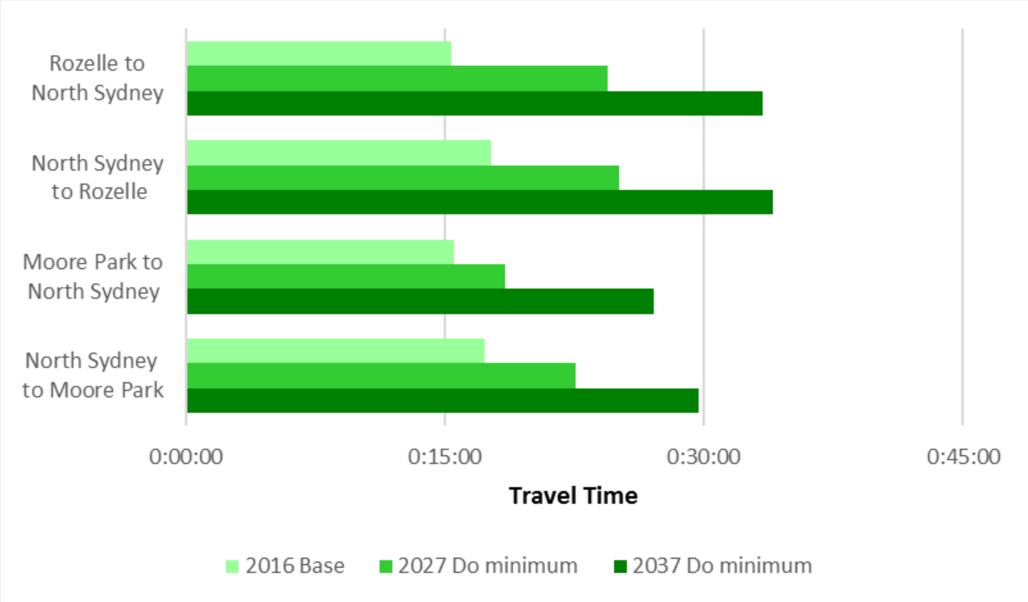


Figure 6-1 Modelled 'Do minimum' morning peak hour travel times along key corridors (SMPM)

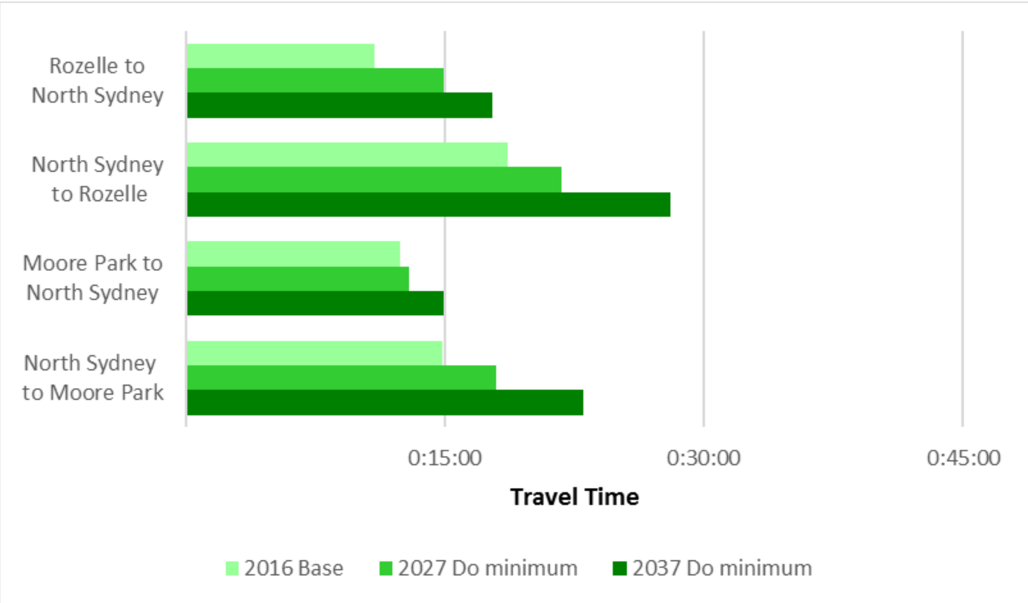


Figure 6-2 Modelled 'Do minimum' evening peak hour travel times along key corridors (SMPM)

Analysis of the modelled forecast travel times along key routes in the vicinity of the Western Harbour Tunnel shows that a substantial increase in travel times would occur by 2037.

Morning peak travel times would increase more than evening peak travel times; this is a reflection of the unique conditions for morning peak travel southbound across Sydney Harbour. In addition to morning peak travel generally being more concentrated in time, southbound travel in the morning peak along the Warringah Freeway involves multiple lanes converging and merging, whereas northbound traffic generally involves fewer merges and is limited by upstream constraints, particularly on the Western Distributor and ANZAC Bridge.

These trends in forecast travel times indicate that travel patterns would remain consistent with existing conditions, albeit with substantial increases in overall demand. This would result in the most pronounced increases in travel time along arterial roads, where there is less available capacity, high volumes of opposing traffic and interactions with other road users including public transport and pedestrians. Harbour crossing traffic during peak periods in particular would see a large increase in travel time relative to the current travel times on these routes, indicating that without additional capacity accessibility to either side of Sydney Harbour will become substantially restricted in the future.

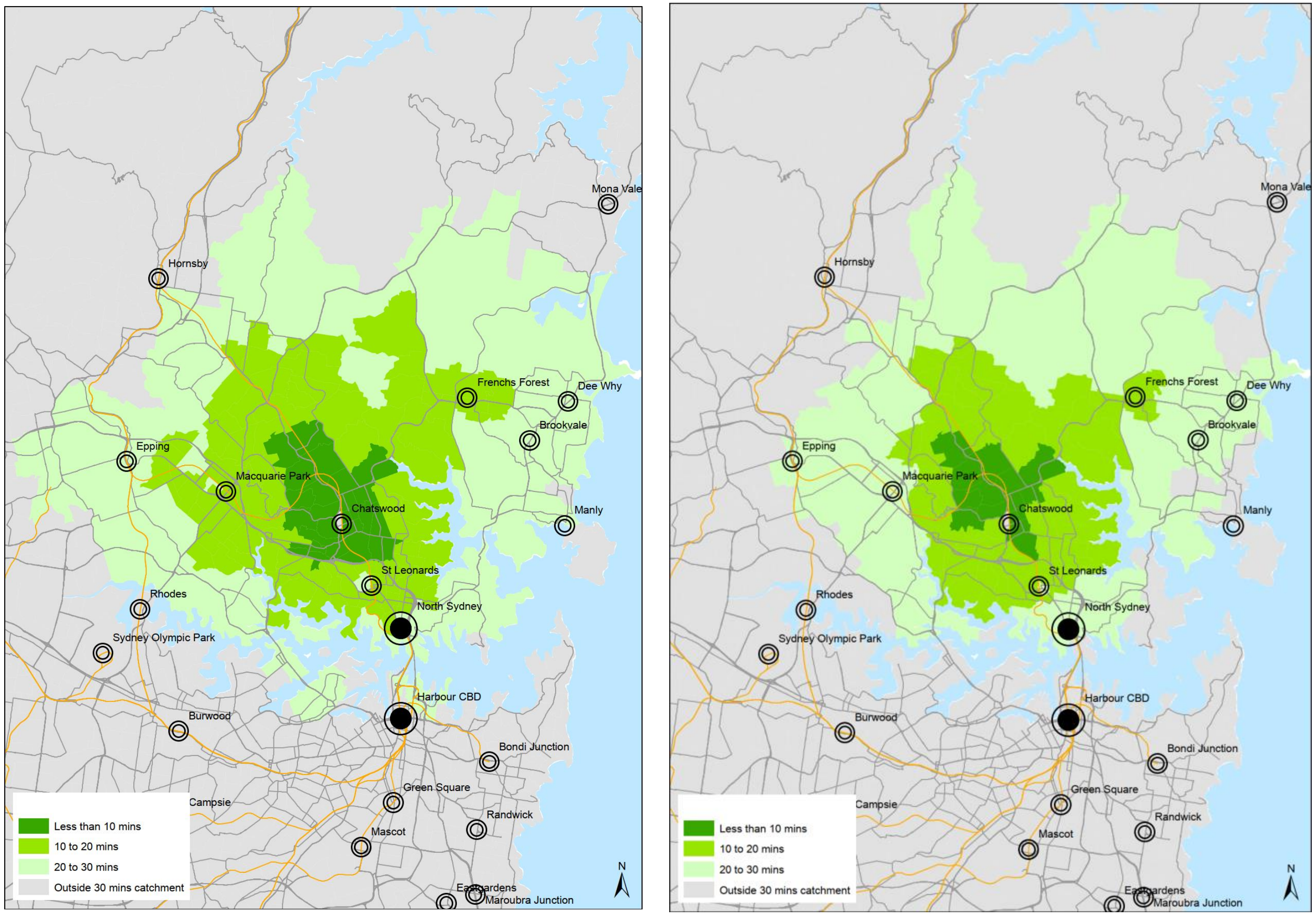
6.2.2 30-minute city catchments

Plots of the forecast 30-minute catchments by road for strategic centres in the vicinity of the project are provided in Figure 6-3 to Figure 6-5.

Analysis of the 30-minute catchments under the 2037 ‘Do minimum’ scenarios shows:

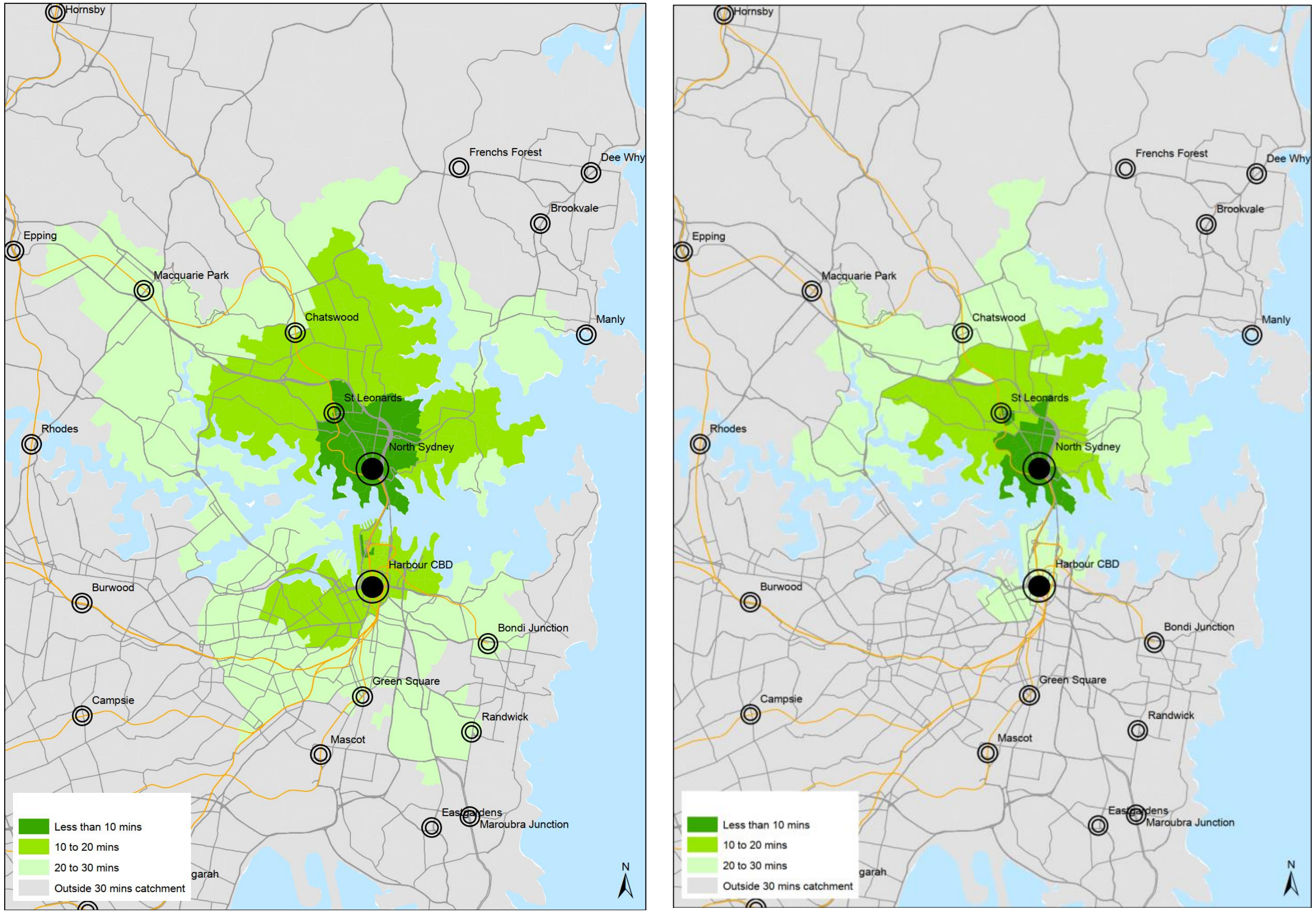
- Access to nearby strategic centres from Chatswood would reduce, with Manly and Sydney CBD no longer accessible from Chatswood within 30 minutes by road
- Access to nearby strategic centres from North Sydney would remain similar; however, other centres such as Macquarie Park, Green Square and Randwick would no longer be accessible by road within 30 minutes
- A trip from north of Sydney Harbour to the Sydney CBD would not be possible within 30 minutes.

Overall, by 2037, demand growth on the road network within the study area would increase to the degree that the associated increases in road vehicle travel time would make many nearby strategic centres no longer accessible within a 30-minute trip. This growth in traffic volumes would also result in higher travel times for public transport and reduce the size of equivalent public transport catchments.



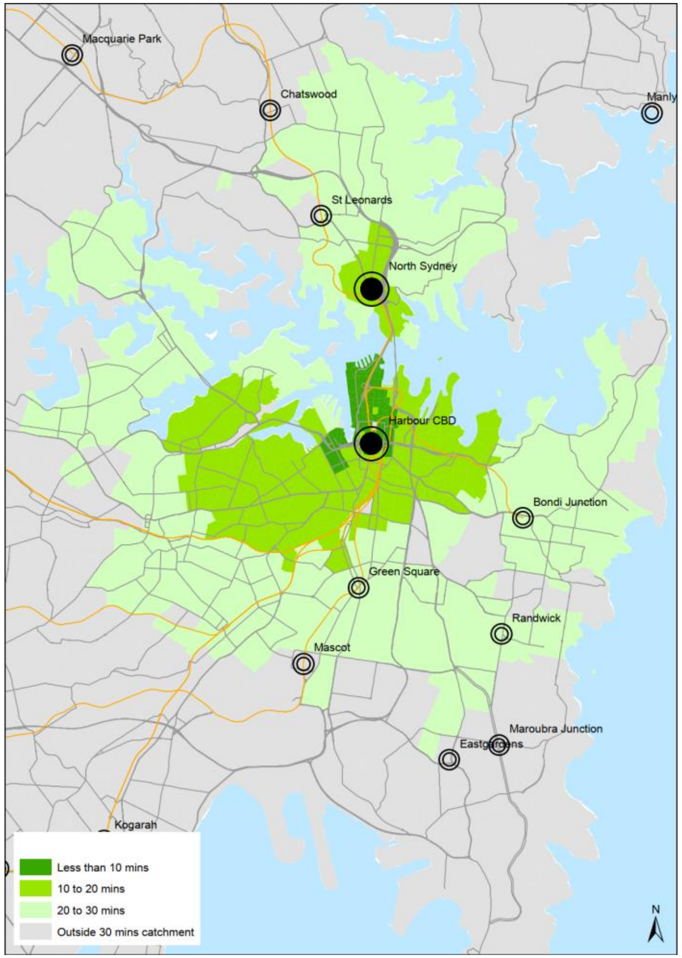
2016 **2037 'Do minimum'**

Figure 6-3 Modelled 2037 'Do minimum' morning peak 30-minute catchment by road from Chatswood (SMPM)

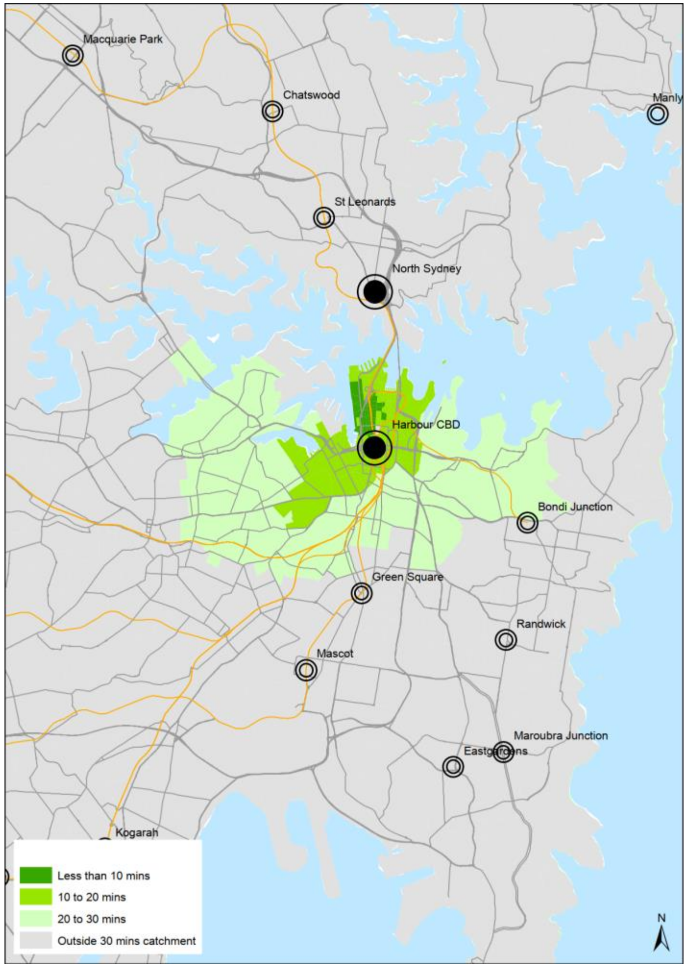


2016 **2037 'Do minimum'**

Figure 6-4 Modelled 2037 'Do minimum' morning peak 30-minute catchment by road from North Sydney (SMPM)



2016



2037 'Do minimum'

Figure 6-5 Modelled 2037 'Do minimum' morning peak 30-minute catchment by road from Sydney CBD (SMPM)

6.2.3 Heavy vehicles and freight

Forecast heavy vehicle demands across Sydney Harbour are presented in Table 6-4 to Table 6-6.

Table 6-4 Modelled Do minimum morning peak hour heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	2016 (veh)	2027 (veh)	2037 (veh)
Sydney Harbour Bridge	Bradfield Highway	Northbound	200	210	240
		Southbound	160	190	200
		Combined	*360*	*400*	*440*
Sydney Harbour Bridge	Cahill Expressway	Southbound	20	20	20
Sydney Harbour Tunnel	Sydney Harbour	Northbound	150	170	190
		Southbound	170	180	210
		Combined	*320*	*350*	*400*
Gladesville Bridge	Parramatta River	Northbound	140	180	230
		Southbound	230	250	300
		Combined	*370*	*430*	*530*
Sydney Harbour screenline		**Northbound**	**490**	**560**	**660**
		Southbound	**580**	**640**	**730**
		Combined	***1070***	***1200***	***1390***
ANZAC Bridge	Pyrmont	Eastbound	190	320	370
		Westbound	170	250	260
		Combined	*360*	*570*	*630*
Western Distributor	Sydney CBD	Northbound	150	180	200
		Southbound	130	170	170
		Combined	*280*	*350*	*370*

Table 6-5 Modelled 'Do minimum' evening peak hour heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	2016 (veh)	2027 (veh)	2037 (veh)
Sydney Harbour Bridge	Bradfield Highway	Northbound	280	320	360
		Southbound	130	140	140
		Combined	*410*	*460*	*500*
Sydney Harbour Bridge	Cahill Expressway	Southbound	10	10	10
Sydney Harbour Tunnel	Sydney Harbour	Northbound	130	150	170
		Southbound	130	150	170
		Combined	*260*	*300*	*340*
Gladesville Bridge	Parramatta River	Northbound	110	90	110
		Southbound	120	200	270
		Combined	*230*	*290*	*380*
Sydney Harbour screenline		**Northbound**	**520**	**560**	**640**
		Southbound	**390**	**500**	**590**
		Combined	***910***	***1060***	***1230***
ANZAC Bridge	Pyrmont	Eastbound	140	220	250
		Westbound	130	220	240
		Combined	*270*	*440*	*490*
Western Distributor	Sydney CBD	Northbound	190	250	280
		Southbound	110	120	130
		Combined	*300*	*370*	*410*

Table 6-6 Modelled 'Do minimum' daily heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	2016 (veh)	2027 (veh)	2037 (veh)
Sydney Harbour Bridge	Bradfield Highway	Northbound	4600	5300	5900
		Southbound	2100	2500	2700
		Combined	*6700*	*7800*	*8600*
Sydney Harbour Bridge	Cahill Expressway	Southbound	600	800	900
Sydney Harbour Tunnel	Sydney Harbour	Northbound	2400	2500	2900
		Southbound	2300	2400	2800
		Combined	*4700*	*4900*	*5700*
Gladesville Bridge	Parramatta River	Northbound	2000	1900	2300
		Southbound	2200	2700	3500
		Combined	*4200*	*4600*	*5800*
Sydney Harbour screenline		**Northbound**	**9000**	**9700**	**11,100**
		Southbound	**7200**	**8400**	**9900**
		Combined	***16,200***	***18,100***	***21,000***
ANZAC Bridge	Pyrmont	Eastbound	3200	4900	5600
		Westbound	3000	4900	5300
		Combined	*6200*	*9800*	*10,900*
Western Distributor	Sydney CBD	Northbound	3400	4300	4800
		Southbound	2300	3000	3200
		Combined	*5700*	*7300*	*8000*

Forecast heavy vehicle demands across Sydney Harbour show that heavy vehicle demands would increase by up to 35 per cent during peak periods and 30 per cent over the day by 2037.

The modelled travel times across Sydney Harbour indicate substantial increases in travel time during peak periods, with comparable traffic growth during peak periods and across the day.

While shorter distance freight movements generally avoid travelling during the commuter peak, longer distance freight trips are more likely to be required to travel during the peak period. Increased traffic volumes and travel times on both motorway and arterial corridors would result in lower productivity for freight vehicles and an overall reduction in the efficiency of the road-based freight network.

The forecast increase in freight movements over the next 20 years within Greater Sydney would also increase potential safety risks of freight vehicles travelling on already congested arterial roads and motorways as these vehicles interact with commuters, public transport and pedestrians, demonstrating the need to provide more motorway-standard connections to separate freight movements from other travel taking place on surface roads.

6.2.4 Strategic model road network performance

A summary of the forecast daily VKT and VHT of the Sydney region and the Western Harbour Tunnel and Beaches Link operational road traffic model area is provided in Table 6-7. In the Sydney region, daily VKT is forecast to increase by 44 per cent and daily VHT is forecast to more than double by 2037. In the Western Harbour Tunnel and Beaches Link operational road traffic model area, daily VKT is forecast to increase by 23 per cent and daily VHT is forecast to increase by 40 per cent by 2037. The forecast increases in daily VKT and VHT under the ‘Do minimum’ scenario indicates declining productivity on the road network.

Table 6-7 Modelled ‘Do minimum’ daily VKT and VHT (SMPM)

Network measure	Road	2016	2027	2037
Sydney region				
Daily VKT	Motorway	22,594,000	27,135,000	31,810,000
	Other	71,656,000	87,592,000	103,604,000
	Total	94,250,000	114,727,000	135,414,000
Daily VHT	Motorway	388,000	513,000	758,000
	Other	2,363,000	3,248,000	5,174,000
	Total	2,751,000	3,761,000	5,931,000
Western Harbour Tunnel and Beaches Link study area				
Daily VKT	Motorway	4,821,000	6,377,000	6,891,000
	Other	14,300,000	15,315,000	16,654,000
	Total	19,121,000	21,693,000	23,545,000
Daily VHT	Motorway	106,000	149,000	187,000
	Other	579,000	656,000	774,000
	Total	685,000	805,000	961,000

6.3 Rozelle and surrounds

6.3.1 Network performance

A summary of future network performance statistics for the Rozelle area under the ‘Do minimum’ scenario is provided in Table 6-8 and Table 6-9. Analysis of the network performance without the project indicates:

- Peak period traffic demand through the Rozelle area would increase by up to 40 per cent by 2037. While some growth is expected on the existing arterial corridors including Victoria Road and City West Link, these roads are currently operating at capacity. The majority of traffic growth through the Rozelle area is facilitated by the proposed WestConnex M4-M5 Link and the associated Rozelle Interchange, which would allow substantially more traffic to travel to and through the area via motorway tunnel
- During the morning peak, average future travel speeds through the network would remain similar to existing travel speeds; however, the total number of trips that would be able to travel through the network at this speed would be substantially greater
- During the evening peak, average travel speeds through the Rozelle area would substantially increase in the future by up to 42 per cent, along with a substantial increase in the total number of trips through the network. These increased average speeds are due to improved downstream capacity and substantially increased speeds provided by the M4-M5 Link.

Network performance measures for the Rozelle area indicate broadly similar network speeds in the morning peak and a substantial improvement in network speeds through the area in the evening peak. This is largely a result of the transfer of traffic growth to the M4-M5 Link. Surface roads including the ANZAC Bridge, Victoria Road and City West Link would continue to operate at capacity with comparable travel speeds to today, resulting in forecast demand being increasingly unable to travel as desired during peak periods. This is reflected in the increasing number of unreleased trips at the end of the modelled period.

Table 6-8 Modelled ‘Do minimum’ morning peak network performance – Rozelle and surrounds

Network measure	2016	2027	2037
Network statistics for all vehicles			
Total traffic demand (veh)	41,900	53,200	58,400
Total VKT through network	115,800	146,200	150,600
Total vehicle travel time through the network (hours)	5660	7630	8190
Total number of stops	406,500	543,700	600,900
Average vehicle statistics			
Average vehicle trip length through the network (km)	2.7	3.0	3.2
Average vehicle trip time through the network (hours)	0:07:49	0:09:24	0:10:23
Average number of stops per trip	9.4	11.2	12.7
Average trip speed (km/hr)	20.5	19.2	18.4
Unreleased traffic			
Total unreleased trips	2020	8150	12,310
% of demand unreleased	4%	13%	17%

Table 6-9 Modelled 'Do minimum' evening peak network performance – Rozelle and surrounds

Network measure	2016	2027	2037
Network statistics for all vehicles			
Total traffic demand (veh)	43,200	55,400	60,500
Total VKT through network	123,000	168,800	173,400
Total vehicle travel time through the network (hours)	4880	4480	4990
Total number of stops	214,600	142,700	167,600
Average vehicle statistics			
Average vehicle trip length through the network (km)	2.7	3.1	3.3
Average vehicle trip time through the network (hours)	0:06:26	0:04:59	0:05:37
Average number of stops per trip	4.7	2.6	3.1
Average trip speed (km/hr)	25.2	37.6	34.7
Unreleased traffic			
Total unreleased trips	1190	8450	13,550
% of demand unreleased	2%	13%	18%

6.3.2 General traffic travel times

Modelled future general traffic travel times for key routes through the Rozelle and surrounds study area under the 'Do minimum' scenario are presented in Table 6-10 and Table 6-11. Analysis of modelled travel times for the 'Do minimum' scenario shows:

- Travel times along City West Link and Western Distributor would generally increase in the eastbound direction and decrease in the westbound direction. In the eastbound direction, the additional traffic volume associated with the M4-M5 Link travelling to ANZAC Bridge and Western Distributor would result in increased localised delays. In the westbound direction, the Rozelle Interchange associated with the M4-M5 Link project would substantially reduce traffic volumes along City West Link, providing a bypass route and reducing delays at intersections along this corridor
- Northbound travel times along Victoria Road would reduce or remain similar to existing travel times. Southbound travel times would also decrease due to the reduction in traffic volumes on Victoria Road south of Iron Cove Bridge, where traffic would use the Iron Cove Link on ramp to travel directly to Rozelle Interchange.

Table 6-10 Modelled 'Do minimum' morning peak hour general traffic travel times – Rozelle and surrounds

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
City West Link and Western Distributor (Balmain Road to Druitt Street ramp)	Eastbound	0:13:37	0:21:59	0:21:33
	Westbound	0:06:26	0:04:59	0:05:29
Victoria Road (Evans Street to ANZAC Bridge)	Northbound	0:01:53	0:02:15	0:02:18
	Southbound	0:08:55	0:05:38	0:05:58

Table 6-11 Modelled 'Do Minimum' evening peak hour general traffic travel times – Rozelle and surrounds

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
City West Link and Western Distributor (Balmain Road to Druitt Street ramp)	Eastbound	0:04:59	0:05:14	0:05:01
	Westbound	0:10:26	0:06:04	0:06:57
Victoria Road (Evans Street to ANZAC Bridge)	Northbound	0:04:26	0:02:57	0:03:02
	Southbound	0:03:58	0:02:00	0:02:07

6.3.3 Bus travel times

Modelled future bus travel times for key routes through the Rozelle and surrounds study area under the 'Do minimum' scenario are presented in Table 6-12 and Table 6-13. Analysis of modelled bus travel times under the 'Do minimum' scenario indicates that during the morning peak, outbound bus travel times would not substantially change, while inbound bus travel times would improve. Reduced morning peak bus travel times would result from a reduction in traffic turning left from Victoria Road to ANZAC Bridge, where the existing bus lane ends.

During the evening peak, bus travel times would improve in both directions, primarily as a result of the reduction in traffic through the intersection of Victoria Road and City West Link created through the operation of the Rozelle Interchange. Reduced volumes on Victoria Road between City West Link and Iron Cove Bridge would also reduce travel times for buses, particularly in the outbound direction where there is currently no northbound bus lane.

Table 6-12 Modelled 'Do minimum' morning peak hour bus travel times – Rozelle and surrounds

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Victoria Road (Evans Street to ANZAC Bridge)	Northbound	0:03:31	0:01:50	0:03:47
	Southbound	0:04:58	0:06:00	0:04:27

Table 6-13 Modelled 'Do minimum' evening peak hour bus travel times – Rozelle and surrounds

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Victoria Road (Evans Street to ANZAC Bridge)	Northbound	0:08:46	0:02:43	0:04:18
	Southbound	0:04:26	0:01:57	0:02:31

6.3.4 Intersection performance

Modelled future performance for key intersections in the Rozelle and surrounds study area under the 'Do minimum' scenario are presented in Table 6-14 and Table 6-15. Modelled intersection performance indicates that the following intersections would perform at Level of Service F by 2037, indicating over-capacity conditions:

- Victoria Road and Darling Street
- Victoria Road and Robert Street
- The Crescent and Johnston Street
- City West Link and Balmain Road.

Overall intersection performance shows that there would generally be a substantial improvement in the performance of the majority of intersections immediately after the construction of the Rozelle Interchange as part of the M4-M5 Link project, with the exception of The Crescent/Johnston Street which would continue to operate at or above its existing capacity during the morning peak period. Delays on The Crescent would result in queues that would block traffic travelling north on The Crescent and Johnston Street.

The improvement in intersection performance at these locations would result from the substantial reduction in traffic demand on Victoria Road, City West Link and The Crescent due to the M4-M5 Link and the proposed new Rozelle Interchange, which allows traffic from the M4-M5 Link to avoid travelling on surface roads and through the already congested intersections on surface arterials.

Table 6-14 Modelled 'Do minimum' morning peak hour intersection performance – Rozelle and surrounds

Intersection	2016		2027		2037	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
Victoria Road/Darling Street	85	F	>100	F	>100	F
Victoria Road/Evans Street	43	D	33	C	35	C
Victoria Road/Gordon Street	21	B	27	B	27	B
Victoria Road/Robert Street	49	D	23	B	27	B
Victoria Road/The Crescent	27	B	28	B	55	D
The Crescent/James Craig Road	10	A	29	C	36	C
The Crescent/City West Link	21	B	43	D	47	D
The Crescent/Johnston Street	42	C	>100	F	>100	F
City West Link/Catherine Street	38	C	30	C	34	C
City West Link/Balmain Road	72	F	55	D	79	F
City West Link/M5 ramps	-	-	38	C	51	D

Table 6-15 Modelled 'Do minimum' evening peak hour intersection performance – Rozelle and surrounds

Intersection	2016		2027		2037	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
Victoria Road/Darling Street	75	F	57	E	62	E
Victoria Road/Evans Street	48	D	19	B	58	E
Victoria Road/Gordon Street	63	E	16	B	49	D
Victoria Road/Robert Street	>100	F	28	B	87	F
Victoria Road/The Crescent	88	F	19	B	37	C
The Crescent/James Craig Road	25	B	13	A	28	B
The Crescent/City West Link	55	D	22	B	22	B
The Crescent/Johnston Street	89	F	56	D	56	D
City West Link/Catherine Street	15	B	33	C	24	B
City West Link/Balmain Road	51	D	41	C	46	D
City West Link/M5 ramps	-	-	20	B	20	B

6.4 Warringah Freeway and surrounds

6.4.1 Network performance

A summary of network performance statistics for the Warringah Freeway and surrounds study area is provided in Table 6-16 and Table 6-17. Analysis of the modelled network statistics shows:

- Peak period travel demand through the Warringah Freeway and surrounds study area would increase by up to 17 per cent by 2037
- Average travel speeds through the Warringah Freeway and surrounds study area during peak periods would substantially decrease in the future by up to 27 per cent
- The number of stops during peak periods would substantially increase in the future, indicating that traffic conditions in the modelled area would become increasingly congested, with queues extending from the Sydney Harbour Bridge and Sydney Harbour Tunnel as far back as Brook Street and Willoughby Road
- Forecast demand would be increasingly unable to travel as desired during peak periods, as illustrated by unreleased trips in the modelling.

Network statistics for the Warringah Freeway and surrounds study area show that forecast traffic conditions are expected to degrade into the future as traffic demands both on the Warringah Freeway and within North Sydney CBD increase over time. As the total distance travelled through the network increases only marginally, reductions in speed and increases in travel time would generally be a consequence of increased congestion and delays, particularly on the Warringah Freeway in the peak direction into the Sydney CBD in the morning peak and out of the Sydney CBD in the evening peak.

The majority of delays through the North Sydney area are a result of increased travel demand through the Berry Street and Miller Street corridors. These corridors provide access to North Sydney CBD itself, but also provide access to the adjacent motorway corridor, both northbound and southbound. These corridors intersect at a busy intersection with high pedestrian volumes that conflict with turning movements for general traffic as well as the right turn movement for buses from Berry Street to Miller Street. The opening of Victoria Cross metro station as part of the Sydney Metro City & Southwest project will substantially increase pedestrian volumes at this location, which would further increase delays to road traffic.

Table 6-16 Modelled ‘Do minimum’ morning peak network performance – Warringah Freeway and surrounds

Network measure	2016	2027	2037
Network statistics for all vehicles			
Total traffic demand (veh)	96,700	104,500	112,400
Total VKT through network	339,900	340,400	350,700
Total vehicle travel time through the network (hours)	9070	9000	10,160
Total number of stops	580,000	616,200	746,100
Average vehicle statistics			
Average vehicle trip length through the network (km)	3.6	3.5	3.5
Average vehicle trip time through the network (hours)	0:05:45	0:05:32	0:06:01
Average number of stops per trip	6.1	6.3	7.4
Average trip speed (km/hr)	37.5	37.8	34.5
Unreleased traffic			
Total unreleased trips	2090	6890	11,270
% of demand unreleased	2%	7%	10%

Table 6-17 Modelled 'Do minimum' evening peak network performance – Warringah Freeway and surrounds

Network measure	2016	2027	2037
Network statistics for all vehicles			
Total traffic demand (veh)	101,200	109,500	118,100
Total VKT through network	331,800	344,900	349,000
Total vehicle travel time through the network (hours)	8550	9880	12,370
Total number of stops	357,700	621,100	980,300
Average vehicle statistics			
Average vehicle trip length through the network (km)	3.3	3.3	3.2
Average vehicle trip time through the network (hours)	0:05:05	0:05:37	0:06:51
Average number of stops per trip	3.6	5.9	9.1
Average trip speed (km/hr)	38.8	34.9	28.2
Unreleased traffic			
Total unreleased trips	370	3900	9800
% of demand unreleased	<1%	4%	8%

6.4.2 General traffic travel times

Modelled future general traffic travel times for key routes through the Warringah Freeway and surrounds study area under the 'Do minimum' scenario are presented in Table 5-17 and Table 5-18. Analysis of modelled travel times for the 'Do minimum' scenario shows:

- Travel times along Warringah Freeway from both Gore Hill Freeway and Falcon Street would generally increase in the future, due to increased traffic volumes and the associated merging and weaving delays that this additional traffic would generate
- Travel times through North Sydney CBD would generally increase in the future, also due to increased development and traffic demand travelling within the CBD, although the broader capacity constraints of the surrounding road network would limit the amount of additional traffic that would travel into North Sydney from other areas.

Overall, the forecast growth in traffic through North Sydney under the 'Do minimum' scenario would increase travel times both along Warringah Freeway and through North Sydney CBD.

Table 6-18 Modelled 'Do minimum' morning peak hour general traffic travel times – Warringah Freeway and surrounds

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Sydney Harbour Bridge to Warringah Freeway/Falcon Street interchange	Northbound	0:04:47	0:04:40	0:04:51
	Southbound	0:10:31	0:04:03	0:04:02
Sydney Harbour Tunnel to Warringah Freeway/Falcon Street interchange	Northbound	0:03:37	0:03:55	0:04:08
	Southbound	0:04:26	0:04:03	0:04:02
Sydney Harbour Bridge to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:06:35	0:06:13	0:06:16
	Southbound	0:16:45	0:13:35	0:15:22
Sydney Harbour Tunnel to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:23	0:05:26	0:05:30
	Southbound	0:06:28	0:11:39	0:12:37
Berry Street to Amherst Street via Miller Street	Northbound	0:04:03	0:03:42	0:03:53
	Southbound	0:04:40	0:04:25	0:05:43

Table 6-19 Modelled 'Do minimum' evening peak hour general traffic travel times – Warringah Freeway and surrounds

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Sydney Harbour Bridge to Warringah Freeway/Falcon Street interchange	Northbound	0:03:54	0:04:02	0:07:51
	Southbound	0:06:51	0:06:09	0:05:02
Sydney Harbour Tunnel to Warringah Freeway/Falcon Street interchange	Northbound	0:03:52	0:03:57	0:07:36
	Southbound	0:10:26	0:14:54	0:14:59
Sydney Harbour Bridge to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:40	0:05:35	0:06:45
	Southbound	0:11:40	0:13:56	0:17:31
Sydney Harbour Tunnel to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:38	0:05:28	0:06:46
	Southbound	0:14:23	0:25:21	0:30:09
Berry Street to Amherst Street via Miller Street	Northbound	0:06:44	0:03:52	0:03:50
	Southbound	0:04:48	0:05:01	0:08:39

6.4.3 Bus travel times

The modelled bus travel times for key routes through the Warringah Freeway and surrounds study area under the 'Do minimum' scenario are presented in Table 6-20 and Table 6-21. Analysis of the modelled bus travel times under the 'Do minimum' scenario shows that southbound bus travel times through North Sydney CBD, either via Pacific Highway or Miller Street, would increase in the future.

This increase in bus travel time through North Sydney would result from increased traffic volumes and conflicts along Miller Street, Berry Street and Pacific Highway, which would increase delays at the following critical intersections for buses that travel through North Sydney CBD:

- Pacific Highway and Berry Street
- Miller Street and Berry Street
- Miller Street and Pacific Highway.

For buses travelling into Sydney CBD, increased queues from the additional traffic travelling through the Cahill Expressway via Sydney Harbour Bridge would result in queuing across the bus lane south of Falcon Street and south of High Street. This would substantially increase travel times to the Sydney CBD from Gore Hill Freeway and North Sydney, as these queues are likely to block access for buses travelling along this lane.

Bus travel times along Warringah Freeway would also increase, particularly southbound from Gore Hill Freeway, which would be impacted by increased queues that would extend from the Cahill Expressway as a result of traffic growth on this corridor. Buses travelling southbound along the Warringah Freeway from Falcon Street and Military Road would also be impacted by this queue.

Table 6-20 Modelled 'Do minimum' morning peak hour bus travel times – Warringah Freeway and surrounds

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:13:02	0:09:55	0:09:30
	Southbound	0:11:21	0:11:31	0:13:26
Sydney Harbour Bridge to Bay Street (Via North Sydney Station and Pacific Highway)	Northbound	0:09:29	0:06:05	0:06:29
	Southbound	0:07:28	0:11:35	0:13:31
Sydney Harbour Bridge to Ben Boyd Road	Northbound	0:06:39	0:06:28	0:06:43
	Southbound	0:06:14	0:06:28	0:06:33
Sydney Harbour Bridge to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:07:10	0:06:43	0:06:42
	Southbound	0:07:09	0:25:33	0:28:17

Table 6-21 Modelled 'Do minimum' evening peak hour bus travel times – Warringah Freeway and surrounds

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:13:08	0:11:03	0:13:34
	Southbound	0:11:51	0:13:14	0:19:09
Sydney Harbour Bridge to Bay Street (Via North Sydney Station and Pacific Highway)	Northbound	0:06:41	0:07:13	0:09:52
	Southbound	0:07:29	0:09:17	0:13:59
Sydney Harbour Bridge to Ben Boyd Road	Northbound	0:06:45	0:08:27	0:08:36
	Southbound	0:05:34	0:05:52	0:06:51
Sydney Harbour Bridge to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:06:13	0:06:12	0:06:33
	Southbound	0:06:36	0:15:53	0:20:57

6.4.4 Intersection performance

Modelled future performance for key intersections in the Warringah Freeway and surrounds study area under the 'Do minimum' scenario are presented in Table 6-22 and Table 6-23. Modelled intersection performance indicates that a large proportion of intersections would perform at capacity at LoS F during peak periods by 2037:

- Willoughby Road and Gore Hill Freeway
- Brook Street and Warringah Freeway
- Brook Street and Merrenburn Avenue
- Falcon Street and Warringah Freeway
- Falcon Street and Merlin Street
- Berry Street and Walker Street
- Berry Street and Miller Street
- Mount Street and Arthur Street
- Mount Street and Walker Street
- Pacific Highway and Walker Street/Blue Street
- Pacific Highway and Bay Road
- Miller Street and McLaren Street
- Miller Street and Ridge Street
- High Street and Clark Road
- High Street and Alfred Street
- Ernest Street and Ben Boyd Road.

Unsatisfactory performance of some intersections under the future 'Do minimum' scenario generally results from increased demand in combination with the following broader network constraints:

- Southbound traffic volumes to the Cahill Expressway: There is only a single southbound lane for general traffic on the Sydney Harbour Bridge to the Cahill Expressway, and this lane currently operates at capacity during peak periods. Any additional traffic demand for this lane would result in increased southbound queues, which would extend north along the Warringah Freeway causing delays at upstream interchanges including Willoughby Road and Brook Street. This queue would have limited impact on the Miller Street interchange due to the length of the Miller Street on ramp, which is sufficient to prevent this queue extending past the on ramp and affecting traffic on Miller Street

- Increased traffic volumes through North Sydney CBD: the key intersections of Miller Street/Berry Street and Pacific Highway/Berry Street currently operate close to capacity due to high traffic volumes during peak periods. Combined with high pedestrian volumes, which reduce the capacity for left and right turn movements along Berry Street and Miller Street, and the high volume of buses that turn left from Pacific Highway into Berry Street then right from Berry Street into Miller Street, intersections along these important road corridors would perform substantially worse in the morning peak as demand within North Sydney CBD increases. In later years, queues would extend further, leading to poor operation of adjacent intersections along parallel routes such as Walker Street
- Falcon Street Interchange: during the evening peak, the large volume of traffic travelling northbound on the Warringah Freeway and exiting at Falcon Street to turn right conflicts with traffic travelling along Falcon Street. Increased volumes for these conflicting movements would result in longer delays at this interchange, with the potential risk of increased queueing onto the Warringah Freeway northbound.

Table 6-22 Modelled 'Do minimum' morning peak hour intersection performance – Warringah Freeway and surrounds

Intersection	2016		2027		2037	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
Willoughby Road/Gore Hill Freeway interchange	11	A	>100	F	>100	F
Brook Street/Warringah Freeway on ramp	31	C	>100	F	>100	F
Brook Street/Warringah Freeway off ramp	30	C	61	E	67	E
Brook Street/Merrenburn Avenue	31	C	>100	F	>100	F
Amherst Street/West Street	6	A	5	A	5	A
Amherst Street/Miller Street	19	B	21	B	20	B
Miller Street/Warringah Freeway on ramp	<5	A	7	A	6	A
Miller Street/Warringah Freeway off ramp	13	A	12	A	13	A
Miller Street/Ernest Street	34	C	25	B	32	C
Miller Street/Falcon Street	35	C	35	C	38	C
Ernest Street/Warringah Freeway on ramp	<5	A	5	A	5	A
Ernest Street/Warringah Freeway off ramp (off ramp in PM, on ramp in AM)	<5	A	5	A	5	A
Falcon Street/Warringah Freeway ramps	38	C	29	C	15	B
Watson Street/Military Road	16	B	18	B	26	B
Military Road/Ben Boyd Road	13	A	15	B	23	B
Falcon Street/Merlin Street	17	B	24	B	32	C
Berry Street/Walker Street	32	C	29	C	39	C
Berry Street/Miller Street	30	C	55	D	69	E
Mount Street/Arthur Street	84	F	46	D	59	E
Mount Street/Walker Street	43	D	36	C	48	D
Pacific Highway/High Street/Arthur Street	53	D	19	B	38	C
Pacific Highway/Walker Street/Blue Street	53	D	36	C	65	E
Pacific Highway/Miller Street/Mount Street	52	D	38	C	41	C
Pacific Highway/Berry Street	9	A	56	E	52	D
Pacific Highway/Bay Road	21	B	55	D	77	F
Miller Street/McLaren Street	24	B	23	B	72	F
Miller Street/Ridge Street	39	C	38	C	53	D
Miller Street/Carlow Street	14	B	13	A	13	A
High Street/Clark Road	>100	F	18	B	55	D
High Street/Alfred Street	60	E	13	A	62	E
Mount Street/Alfred Street	24	B	<5	A	<5	A
Ernest Street/Ben Boyd Road	11	A	12	A	12	A
Pedestrian crossing at Military Road	<5	A	6	A	5	A

Table 6-23 Modelled 'Do minimum' evening peak hour intersection performance – Warringah Freeway and surrounds

Intersection	2016		2027		2037	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
Willoughby Road/Gore Hill Freeway interchange	20	B	38	C	76	F
Brook Street/Warringah Freeway on ramp	16	B	14	B	17	B
Brook Street/Warringah Freeway off ramp	22	B	22	B	20	B
Brook Street/Merrenburn Avenue	12	A	11	A	13	A
Amherst Street/West Street	10	A	9	A	14	A
Amherst Street/Miller Street	15	B	29	C	31	C
Miller Street/Warringah Freeway on ramp	6	A	6	A	6	A
Miller Street/Warringah Freeway off ramp	13	A	15	B	15	B
Miller Street/Ernest Street	31	C	41	C	43	D
Miller Street/Falcon Street	69	E	44	D	49	D
Ernest Street/Warringah Freeway on ramp	15	B	15	B	15	B
Ernest Street/Warringah Freeway off ramp (off ramp in PM, on ramp in AM)	18	B	17	B	17	B
Falcon Street/Warringah Freeway ramps	46	D	72	F	>100	F
Watson Street/Military Road	29	C	46	D	59	E
Military Road/Ben Boyd Road	20	B	54	D	70	E
Falcon Street/Merlin Street	38	C	>100	F	>100	F
Berry Street/Walker Street	50	D	44	D	73	F
Berry Street/Miller Street	27	B	46	D	70	F
Mount Street/Arthur Street	32	C	49	D	92	F
Mount Street/Walker Street	31	C	32	C	75	F
Pacific Highway/High Street/Arthur Street	19	B	46	D	61	E
Pacific Highway/Walker Street/Blue Street	48	D	40	D	80	F
Pacific Highway/Miller Street/Mount Street	41	C	41	C	58	E
Pacific Highway/Berry Street	11	A	23	B	56	E
Pacific Highway/Bay Road	14	B	15	B	41	C
Miller Street/McLaren Street	17	B	21	B	55	D
Miller Street/Ridge Street	26	B	40	C	91	F
Miller Street/Carlow Street	29	C	8	A	19	B
High Street/Clark Road	36	C	61	E	97	F
High Street/Alfred Street	18	B	>100	F	>100	F
Mount Street/Alfred Street	11	A	12	A	10	A
Ernest Street/Ben Boyd Road	16	B	44	D	94	F
Pedestrian crossing at Military Road	20	B	27	B	34	C

6.5 Gore Hill Freeway and Artarmon

6.5.1 Network performance

A summary of future network performance statistics for the Gore Hill Freeway and Artarmon area under the 'Do minimum' scenario is provided in Table 6-24 and Table 6-25. Analysis of the network performance without the project indicates:

- Peak period traffic demand through the Gore Hill Freeway and Artarmon area would increase by up to 16 per cent by 2037
- Average travel speeds through the Gore Hill Freeway and Artarmon area during peak periods would substantially decrease in the future by up to 22 per cent
- The number of stops during peak periods would substantially increase in the future, indicating that traffic conditions through the corridor would become increasingly unstable.

Network performance measures for the Gore Hill Freeway and Artarmon area indicate a substantial degradation in traffic performance, consistent with a substantial increase in traffic demand without additional infrastructure to provide additional network capacity that would facilitate traffic growth.

Table 6-24 Modelled 'Do minimum' morning peak network performance – Gore Hill Freeway and Artarmon

Network measure	2016	2027	2037
Network statistics for all vehicles			
Total traffic demand (veh)	29,700	31,100	34,100
Total VKT through network	79,500	79,800	87,900
Total vehicle travel time through the network (hours)	1620	1710	2280
Total number of stops	35,800	43,100	113,700
Average vehicle statistics			
Average vehicle trip length through the network (km)	2.5	2.4	2.4
Average vehicle trip time through the network (hours)	0:03:05	0:03:08	0:03:48
Average number of stops per trip	1.1	1.3	3.2
Average trip speed (km/hr)	49.0	46.8	38.5
Unreleased traffic			
Total unreleased trips	<10	<10	530
% of demand unreleased	<1%	<1%	1%

Table 6-25 Modelled 'Do minimum' evening peak network performance – Gore Hill Freeway and Artarmon

Network measure	2016	2027	2037
Network statistics for all vehicles			
Total traffic demand (veh)	29,700	31,100	34,400
Total VKT through network	77,600	79,400	85,800
Total vehicle travel time through the network (hours)	1510	1800	2010
Total number of stops	33,400	48,000	62,400
Average vehicle statistics			
Average vehicle trip length through the network (km)	2.5	2.4	2.4
Average vehicle trip time through the network (hours)	0:02:53	0:03:17	0:03:23
Average number of stops per trip	1.1	1.5	1.8
Average trip speed (km/hr)	51.4	44.0	42.6
Unreleased traffic			
Total unreleased trips	<10	260	820
% of demand unreleased	<1%	1%	2%

6.5.2 General traffic travel times

Modelled future general traffic travel times for key routes through the Gore Hill Freeway and Artarmon study area under the 'Do minimum' scenario are presented in Table 6-26 and Table 6-27. Analysis of modelled travel times for the 'Do minimum' scenario shows that the majority of forecast travel times would remain similar by 2037, with the exception of the Gore Hill Freeway westbound in the evening peak. This is generally reflective of this section of the Gore Hill Freeway and the surrounding roads being primarily governed by the capacity at two key intersections:

- Longueville Road and Epping Road
- Pacific Highway and Longueville Road.

Given that these intersections are already operating at capacity, and their proximity to one another, increased demand at these intersections would also increase existing delays and queuing, and potentially impact operation of the Gore Hill Freeway.

Table 6-26 Modelled 'Do minimum' morning peak hour general traffic travel times – Gore Hill Freeway and Artarmon

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Longueville Road to Gore Hill Freeway	Eastbound	0:01:30	0:01:28	0:01:24
	Westbound	0:01:24	0:01:24	0:01:28
Lane Cove Tunnel to Gore Hill Freeway via transit lanes	Eastbound	0:01:24	0:01:24	0:01:18
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:18	0:01:18	0:01:24
	Westbound	0:01:17	0:01:17	0:02:16

Table 6-27 Modelled 'Do minimum' evening peak hour general traffic travel times – Gore Hill Freeway and Artarmon

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Longueville Road to Gore Hill Freeway	Eastbound	0:01:22	0:01:26	0:01:25
	Westbound	0:01:20	0:01:23	0:01:23
Lane Cove Tunnel to Gore Hill Freeway via transit lanes	Eastbound	0:01:20	0:01:20	0:01:20
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:21	0:01:22	0:01:23
	Westbound	0:01:12	0:01:12	0:01:12

6.5.3 Bus travel times

Modelled future bus travel times for key routes through the Gore Hill Freeway and Artarmon study area under the 'Do minimum' scenario are presented in Table 6-28 and Table 6-29. Modelled bus travel times indicate that travel times for buses along the Gore Hill Freeway through Artarmon would not change substantially into the future.

Table 6-28 Modelled 'Do minimum' morning peak hour bus travel times – Gore Hill Freeway and Artarmon

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:16	0:01:26	0:01:26
	Westbound	0:01:21	0:01:18	0:01:26

Table 6-29 Modelled 'Do minimum' evening peak hour bus travel times – Gore Hill Freeway and Artarmon

Route	Direction	2016 (hours)	2027 (hours)	2037 (hours)
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:15	0:01:22	0:01:22
	Westbound	0:01:24	0:01:13	0:01:13

6.5.4 Intersection performance

Modelled future performance for key intersections in the Gore Hill Freeway and Artarmon study area under the 'Do minimum' scenario are presented in Table 6-30 and Table 6-31. Modelled intersection performance indicates that the following intersections would perform at or above capacity at LoS E or F:

- Epping Road, Longueville Road and Parklands Avenue
- Reserve Road and Gore Hill Freeway interchange
- Reserve Road and Dickson Road
- Reserve Road and Barton Road.

The degradation of performance at the intersection of Epping Road and Longueville Road is consistent with existing delays at this intersection, exacerbated by increased traffic demands through the intersection in future years. Similarly, the Reserve Road interchange, while operating acceptably under existing traffic volumes, would not have sufficient capacity for future growth and delays that would develop at this interchange. These delays would also impact the intersection of Reserve Road and Dickson Road, and Reserve Road and Barton Road, resulting in unsatisfactory performance by 2027.

Table 6-30 Modelled 'Do minimum' morning peak hour intersection performance – Gore Hill Freeway and Artarmon

Intersection	2016		2027		2037	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
Epping Road/Longueville Road/Parklands Avenue	48	D	52	D	83	F
Longueville Road/Pacific Highway	42	C	40	C	54	D
Pacific Highway/Howarth Road/Norton Lane	7	A	20	B	28	B
Pacific Highway/Gore Hill Freeway interchange	23	B	29	B	41	C
Reserve Road/Gore Hill Freeway interchange	47	D	61	E	47	D
Reserve Road/Dickson Road	14	A	14	A	19	B
Reserve Road/Barton Road	11	A	69	E	>100	F

Table 6-31 Modelled 'Do minimum' evening peak hour intersection performance – Gore Hill Freeway and Artarmon

Intersection	2016		2027		2037	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
Epping Road/Longueville Road/Parklands Avenue	63	E	80	F	87	F
Longueville Road/Pacific Highway	36	C	42	C	49	D
Pacific Highway/Howarth Road/Norton Lane	7	A	13	A	13	A
Pacific Highway/Gore Hill Freeway interchange	23	B	29	C	23	B
Reserve Road/Gore Hill Freeway interchange	29	C	55	D	57	E
Reserve Road/Dickson Road	19	B	73	F	85	F
Reserve Road/Barton Road	6	A	>100	F	>100	F

7. Future transport network performance with project only

7.1 Overview

This section provides a summary of the road network performance in 2027 and 2037 with the project (the 'Do something' scenario). This assessment has been based on a comparison against the 'Do minimum' scenario (refer to section6) for the following performance measures:

- Strategic road network performance based on vehicle hours of travel (VHT), vehicle kilometres of travel (VKT) and average network speed
- Intersection performance based on intersection Level of Service
- General traffic and bus travel times for key corridors.

Strategic traffic modelling of the project indicates that the project would deliver substantial benefits to traffic travelling on the strategic road network, with trips between strategic centres saving up to 15 minutes when crossing Sydney Harbour during peak periods. These travel time savings would also substantially increase accessibility for these centres, increasing the catchment of residents who can travel to and from their place of work within the '30-minute city' window that is critical to maintaining the vision of a productive city promoted by the Greater Sydney Commission.

Increasing the size of this 30-minute city catchment would not be limited to private vehicles; public transport customers would also benefit substantially from the project. Existing services would save up to 20 minutes of travel time crossing Sydney Harbour as a result of improved bus priority and reduced traffic conflicts on Warringah Freeway, while the project itself could facilitate the operation of express buses that would provide direct access between major centres on the Lower North Shore and Inner West.

The substantial additional travel that would be facilitated by the project would also increase traffic demands at either end of the project, where it would integrate with the existing transportation network. There would be some residual delay surrounding these interface precincts. However, the additional delay associated with these precincts would be offset by the large travel time benefits provided by the project at the broader network level. These integration works have been developed to minimise the impact of additional travel facilitated by the project and ensure that the competing needs of customers (including private vehicles, public transport passengers, cyclists and pedestrians) have been incorporated into a balanced, equitable outcome.

7.2 Metropolitan road network performance

7.2.1 Strategic corridors

A summary of the forecast growth at key locations for the 2027 and 2037 forecast years is provided in Table 7-1 through to Table 7-3.

Table 7-1 Modelled 'Do something' morning peak hour traffic demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Sydney Harbour Bridge	Bradfield Highway	Northbound	5500	5500	6000	5800
		Southbound	6050	5600	6600	5950
		Combined	*11,550*	*11,100*	*12,600*	*11,750*
Sydney Harbour Bridge	Cahill Expressway	Southbound	2900	2650	3200	2850
Sydney Harbour Tunnel	Sydney Harbour	Northbound	4200	2900	4450	3300
		Southbound	4100	3950	4350	4200
		Combined	*8300*	*6850*	*8800*	*7500*
Gladesville Bridge	Parramatta River	Northbound	3800	3750	4150	3950
		Southbound	4050	3800	4300	4050
		Combined	*7850*	*7550*	*8450*	*8000*
Western Harbour Tunnel	Birchgrove	Northbound	N/A	*2650*	N/A	*3700*
		Southbound	N/A	*2650*	N/A	*3500*
		Combined	*N/A*	*5300*	*N/A*	*7200*
Sydney Harbour screenline		**Northbound**	**13,500**	**14,800**	**14,600**	**16,750**
		Southbound	**17,100**	**18,650**	**18,450**	**20,550**
		Combined	***30,600***	***33,450***	***33,050***	***37,300***
ANZAC Bridge	Pyrmont	Eastbound	6250	5950	6600	6500
		Westbound	3850	3300	3900	3300
		Combined	*10,100*	*9250*	*10,500*	*9800*
Western Distributor	Sydney CBD	Northbound	3050	2200	3300	2300
		Southbound	3100	2400	3350	2400
		Combined	*6150*	*4600*	*6650*	*4700*

Note: Comparing the 'Do something' scenario with the 'Do minimum' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Table 7-2 Modelled 'Do something' evening peak hour traffic demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Sydney Harbour Bridge	Bradfield Highway	Northbound	6650	5450	7200	6250
		Southbound	3450	3500	3750	3700
		Combined	*10,100*	*8950*	*10,950*	*9950*
Sydney Harbour Bridge	Cahill Expressway	Southbound	2650	2500	2850	2600
Sydney Harbour Tunnel	Sydney Harbour	Northbound	3900	3050	4100	3200
		Southbound	3400	2900	3800	3300
		Combined	*7300*	*5950*	*7900*	*6500*
Gladesville Bridge	Parramatta River	Northbound	4050	4200	4250	4250
		Southbound	3250	3000	3550	3350
		Combined	*7300*	*7200*	*7800*	*7600*
Western Harbour Tunnel	Birchgrove	Northbound	N/A	2500	N/A	3050
		Southbound	N/A	1950	N/A	2650
		Combined	*N/A*	4450	*N/A*	5700
Sydney Harbour screenline		**Northbound**	**14,600**	**15,200**	**15,550**	**16,750**
		Southbound	**12,750**	**13,850**	**13,950**	**15,600**
		Combined	***27,350***	***29,050***	***29,500***	***32,350***
ANZAC Bridge	Pyrmont	Eastbound	5300	4600	5450	4800
		Westbound	5850	5650	6200	5850
		Combined	*11,150*	*10,250*	*11,650*	*10,650*
Western Distributor	Sydney CBD	Northbound	3750	2100	4000	2300
		Southbound	2150	1950	2300	2000
		Combined	*5900*	*4050*	*6300*	*4300*

Note: Comparing the 'Do something' scenario with the 'Do minimum' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Table 7-3 Modelled 'Do something' daily traffic demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Sydney Harbour Bridge	Bradfield Highway	Northbound	101,500	77,500	110,000	86,500
		Southbound	58,000	54,000	62,500	58,000
		Combined	*159,500*	*131,500*	*172,500*	*144,500*
Sydney Harbour Bridge	Cahill Expressway	Southbound	44,000	36,000	48,000	39,000
Sydney Harbour Tunnel	Sydney Harbour	Northbound	56,000	42,000	60,500	45,000
		Southbound	55,000	46,500	60,000	51,000
		Combined	*111,000*	*88,500*	*120,500*	*96,000*
Gladesville Bridge	Parramatta River	Northbound	62,000	65,500	65,500	67,000
		Southbound	51,000	48,500	53,500	51,000
		Combined	*113,000*	*114,000*	*119,000*	*118,000*
Western Harbour Tunnel	Birchgrove	Northbound	N/A	*37,000*	N/A	*45,000*
		Southbound	N/A	*30,000*	N/A	*38,000*
		Combined	*N/A*	*67,000*	*N/A*	*83,000*
Sydney Harbour screenline		**Northbound**	**219,500**	**222,000**	**236,000**	**243,500**
		Southbound	**208,000**	**215,000**	**224,000**	**237,000**
		Combined	***427,500***	***437,000***	***460,000***	***480,500***
ANZAC Bridge	Pyrmont	Eastbound	91,500	81,000	95,500	85,500
		Westbound	84,500	79,000	89,500	82,000
		Combined	*176,000*	*160,000*	*185,000*	*167,500*
Western Distributor	Sydney CBD	Northbound	60,000	32,500	64,000	36,500
		Southbound	49,000	35,500	53,500	38,000
		Combined	*109,000*	*68,000*	*117,500*	*74,500*

Note: Comparing the 'Do something' scenario with the 'Do minimum' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Analysis of the modelled forecast traffic demands across Sydney Harbour with the project shows growth in peak period cross harbour trips of up to 13 per cent and 10 per cent for morning and evening peaks respectively when compared to the 'Do minimum' scenario in 2037. For the same period, the growth in daily trips is lower, with a five per cent increase in trips across Sydney Harbour.

Analysis of forecast traffic demands with and without the project shows that the project would reduce demands on the Sydney Harbour Bridge, Sydney Harbour Tunnel, ANZAC Bridge and connecting road corridors. This demonstrates that the project would provide an attractive alternative to the current Western Distributor and Sydney Harbour Bridge route, particularly for trips travelling across Sydney Harbour between Rozelle, North Sydney and the Lower North Shore.

Although no decision on tolls has yet been made, provision for new toll gantries would also be included on northbound locations of the Sydney Harbour Bridge and Sydney Harbour Tunnel, should the Government elect to apply northbound tolls to these crossings. Traffic volumes on Gladesville Bridge and Victoria Road would not substantially change across the day with the introduction of the project, indicating that the potential introduction of a northbound toll on Sydney Harbour Bridge, Sydney Harbour Tunnel and Western Harbour Tunnel would not result in any major diversion to Victoria Road, and that the project would generate sufficient time savings to offset any cost increase as a result of the implementation of potential northbound tolls.

Overall, forecast demands across Sydney Harbour show that the project would allow for growth in cross harbour trips while also reducing traffic demands and consequent congestion on the existing crossings without any substantial diversionary impacts as a result of changes to tolling. The low elasticity of traffic to toll levels means the toll regime does not have a material impact on the traffic volumes. Tolling scenarios for the purpose of this assessment are detailed in Section 7.2.4. Difference plots showing changes in forecast traffic volumes across the road network in the study area between the 'Do minimum' and 'Do something' scenarios are provided in Appendix B.

A summary of forecast travel times during peak periods for key routes in the vicinity of the project is provided in Figure 7-1 and Figure 7-2

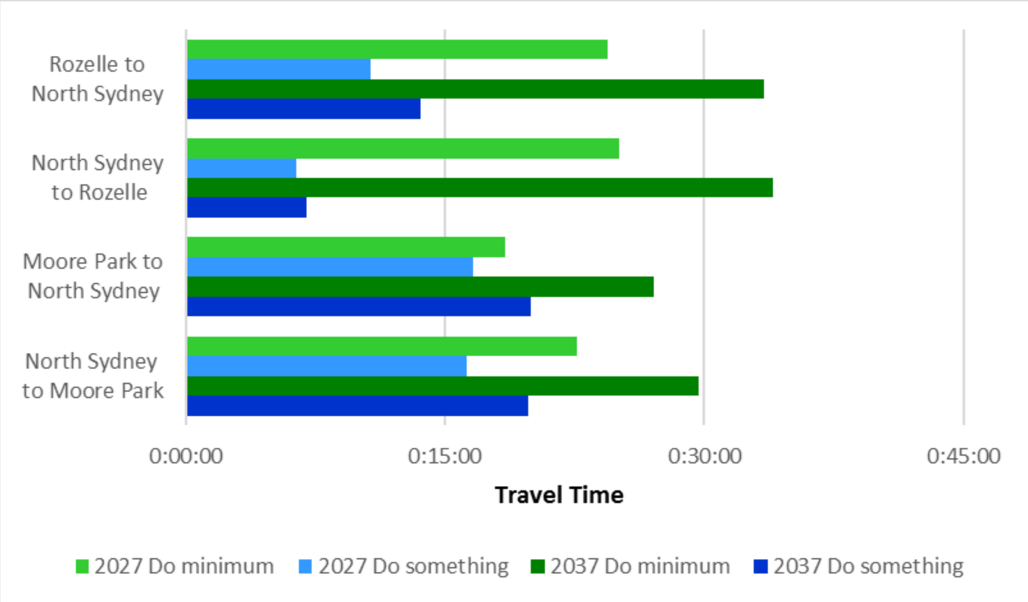


Figure 7-1 Modelled 'Do something' morning peak hour travel times along key corridors (SMPM)

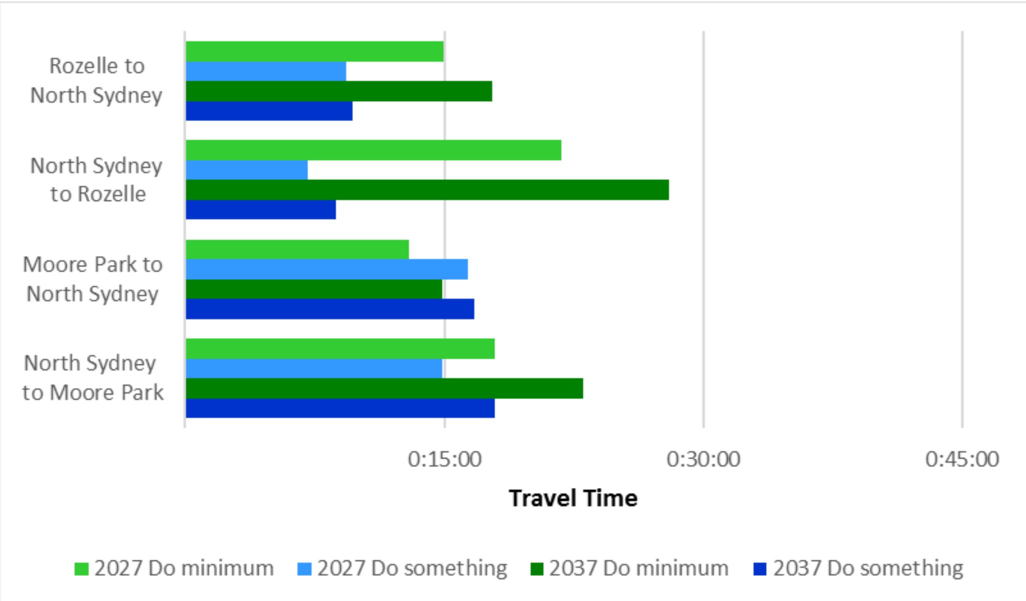


Figure 7-2 Modelled 'Do something' evening peak hour travel times along key corridors (SMPM)

Analysis of the modelled forecast travel times along key routes in the vicinity of the Western Harbour Tunnel shows that the project would substantially improve travel times across Sydney Harbour. The greatest benefits would be for trips travelling between North Sydney and Rozelle. This trip is currently circuitous, requiring travel via ANZAC Bridge, Western Distributor and Sydney Harbour Bridge. The project would allow the bypass of these three highly congested sections of motorway and reduce travel times by up to 75 per cent.

Travel times would also be reduced for trips via the Sydney Harbour Tunnel and the Eastern Suburbs, primarily as a result of decreased congestion on this motorway corridor with longer-distance north–south trips transferring to the WestConnex-Western Harbour Tunnel corridor.

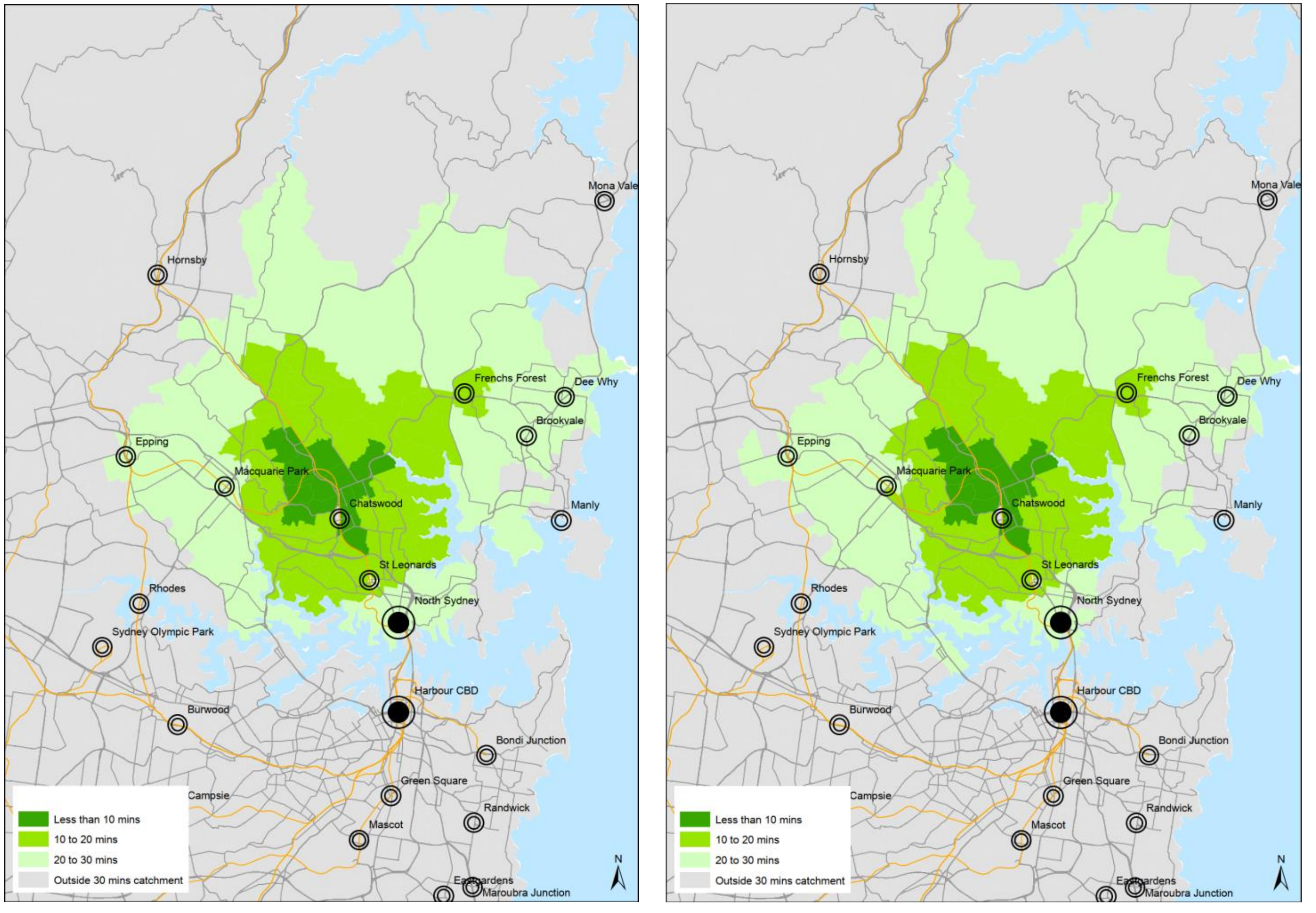
7.2.2 30-minute city catchments

Plots of the forecast 30-minute catchments by road for strategic centres in the vicinity of the project are provided in Figure 7-3 to Figure 7-5.

Analysis of the 30-minute catchments for the 'Do something' scenarios shows:

- The Western Harbour Tunnel would have minimal impact on road accessibility from Chatswood
- Accessibility from North Sydney by road would increase substantially as a result of the Western Harbour Tunnel, with accessibility to centres south of Sydney Harbour including Burwood, Mascot, Randwick and Bondi Junction becoming accessible by road within 30 minutes
- Access to Sydney CBD would increase as a result of Western Harbour Tunnel, with trips from North Sydney being able to access Sydney CBD within 30 minutes by road.

Overall, the Western Harbour Tunnel would substantially increase accessibility across Sydney Harbour, particularly for North Sydney, which would have access to centres south of Sydney Harbour that would not be accessible within 30 minutes otherwise. This reduction in road-based travel times would also result in reduced travel times for public transport and would increase the size of equivalent public transport catchments, particularly if express buses operate through the Western Harbour Tunnel.



2037 'Do minimum'

2037 'Do something'

Figure 7-3 Modelled 2037 'Do something' morning peak 30-minute catchment by road from Chatswood (SMPM)

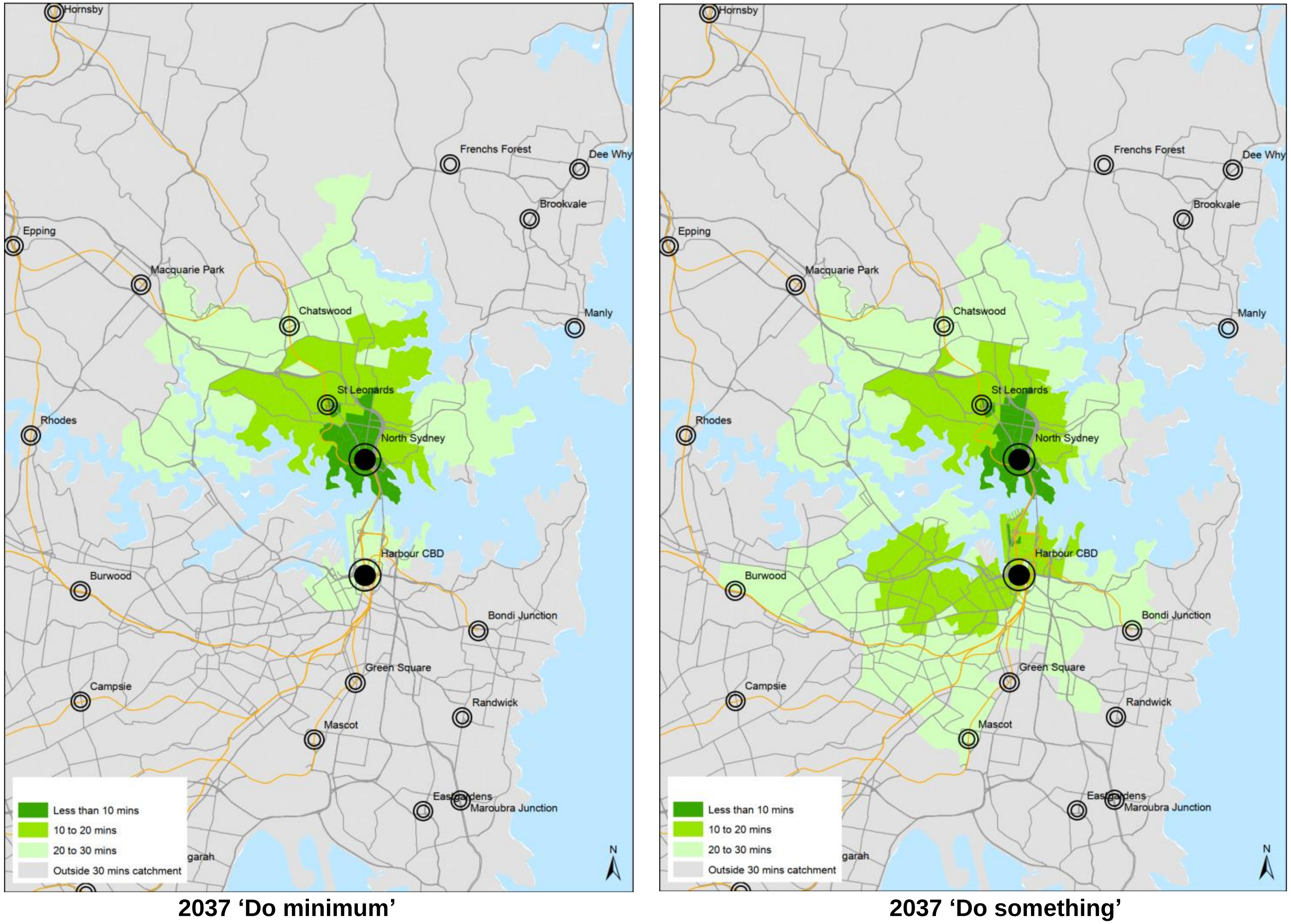
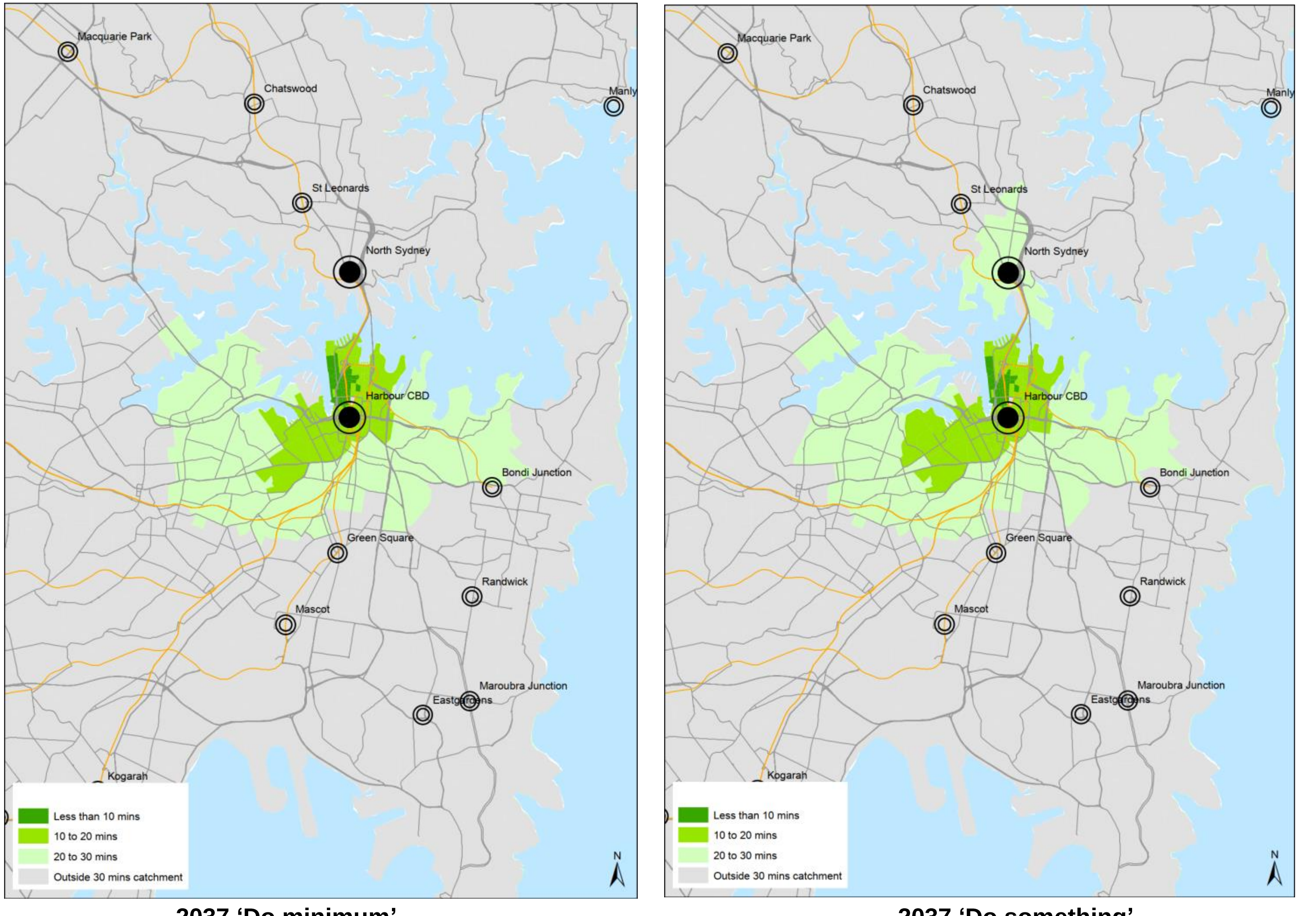


Figure 7-4 Modelled 2037 'Do something' morning peak 30-minute catchment by road from North Sydney (SMPM)



2037 'Do minimum' **2037 'Do something'**

Figure 7-5 Modelled 2037 'Do something morning' peak 30-minute catchment by road from Sydney CBD (SMPM)

7.2.3 Heavy vehicles and freight

A summary of the forecast heavy vehicle demands crossing Sydney Harbour under the 'Do something' scenario for the 2027 and 2037 forecast years is provided in Table 7-4 to Table 7-6.

Analysis of the modelled forecast heavy vehicle demands across Sydney Harbour under the 'Do something' scenario in 2037 shows:

- Peak period heavy vehicle demands across Sydney Harbour would increase by up to 15 per cent
- Daily heavy vehicle demands across Sydney Harbour would increase by 10 per cent
- Peak period heavy vehicle demands would decrease on Sydney Harbour Bridge, Sydney Harbour Tunnel, ANZAC Bridge and Gladesville Bridge, with the largest peak period reduction being on Sydney Harbour Bridge (55 per cent and 28 per cent reductions in morning and evening peak periods respectively). This reflects the substantial travel time savings provided by the project, particularly for northbound trips during the morning peak, when tidal flow traffic conditions on the Sydney Harbour Bridge generally favour southbound trips at the expense of northbound trips.

Overall, the project would provide substantial travel time savings for freight vehicles, improving their productivity and increasing the efficiency of the freight network, particularly for freight trips that currently use the Sydney Harbour Bridge. The movement of these trips from existing constrained corridors such as the Western Distributor and Bradfield Highway to a new high-standard motorway would also increase the safety of these trips by providing a route that has been specifically designed to meet the requirements of B-Double high-productivity vehicles. This is in keeping with the motorway network strategy established for the WestConnex program, which facilitates a strategic shift of freight movements from surface arterials to high-standard motorways. The Western Harbour Tunnel would extend this concept of operation to the Sydney Harbour crossings and connect with motorway links north of Sydney Harbour.

Table 7-4 Modelled 'Do something' morning peak hour heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Sydney Harbour Bridge	Bradfield Highway	Northbound	210	110	240	110
		Southbound	190	100	200	90
		Combined	*400*	*210*	*440*	*200*
Sydney Harbour Bridge	Cahill Expressway	Southbound	20	30	20	30
Sydney Harbour Tunnel	Sydney Harbour	Northbound	170	140	190	160
		Southbound	180	130	210	140
		Combined	*350*	*270*	*400*	*300*
Gladesville Bridge	Parramatta River	Northbound	180	100	230	120
		Southbound	250	190	300	210
		Combined	*430*	*290*	*530*	*330*
Western Harbour Tunnel	Birchgrove	Northbound	N/A	310	N/A	400
		Southbound	N/A	260	N/A	340
		Combined	*N/A*	*570*	*N/A*	*740*
Sydney Harbour screenline		**Northbound**	**560**	**660**	**660**	**790**
		Southbound	**640**	**710**	**730**	**810**
		Combined	***1200***	***1370***	***1390***	***1600***
ANZAC Bridge	Pyrmont	Eastbound	320	250	370	300
		Westbound	250	150	260	160
		Combined	*570*	*400*	*630*	*460*
Western Distributor	Sydney CBD	Northbound	180	70	200	60
		Southbound	170	80	170	60
		Combined	*350*	*150*	*370*	*120*

Note: Comparing the 'Do something' scenario with the 'Do minimum' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Table 7-5 Modelled 'Do something' evening peak hour heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Sydney Harbour Bridge	Bradfield Highway	Northbound	320	240	360	270
		Southbound	140	80	140	90
		Combined	*460*	*320*	*500*	*360*
Sydney Harbour Bridge	Cahill Expressway	Southbound	10	10	10	10
Sydney Harbour Tunnel	Sydney Harbour	Northbound	150	120	170	130
		Southbound	150	110	170	120
		Combined	*300*	*230*	*340*	*250*
Gladesville Bridge	Parramatta River	Northbound	90	60	110	70
		Southbound	200	120	270	150
		Combined	*290*	*180*	*380*	*220*
Western Harbour Tunnel	Birchgrove	Northbound	N/A	180	N/A	220
		Southbound	N/A	220	N/A	310
		Combined	*N/A*	*400*	*N/A*	*530*
Sydney Harbour screenline		**Northbound**	**560**	**600**	**640**	**690**
		Southbound	**500**	**540**	**590**	**680**
		Combined	***1060***	***1140***	***1230***	***1370***
ANZAC Bridge	Pyrmont	Eastbound	220	160	250	180
		Westbound	220	160	240	180
		Combined	*440*	*320*	*490*	*360*
Western Distributor	Sydney CBD	Northbound	250	150	280	160
		Southbound	120	70	130	70
		Combined	*370*	*220*	*410*	*230*

Note: Comparing the 'Do something' scenario with the 'Do minimum' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Table 7-6 Modelled 'Do something' daily heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Sydney Harbour Bridge	Bradfield Highway	Northbound	5300	3300	5900	3600
		Southbound	2500	1700	2700	1700
		Combined	*7800*	*5000*	*8600*	*5300*
Sydney Harbour Bridge	Cahill Expressway	Southbound	800	300	900	400
Sydney Harbour Tunnel	Sydney Harbour	Northbound	2500	2000	2900	2300
		Southbound	2400	1700	2800	2100
		Combined	*4900*	*3700*	*5700*	*4400*
Gladesville Bridge	Parramatta River	Northbound	1900	1400	2300	1600
		Southbound	2700	2100	3500	2500
		Combined	*4600*	*3500*	*5800*	*4100*
Western Harbour Tunnel	Birchgrove	Northbound	N/A	3800	N/A	4600
		Southbound	N/A	3300	N/A	4200
		Combined	*N/A*	*7100*	*N/A*	*8800*
Sydney Harbour screenline		**Northbound**	**9700**	**10,500**	**11,100**	**12,100**
		Southbound	**8400**	**9100**	**9900**	**10,900**
		Combined	***18,100***	***19,600***	***21,000***	***23,000***
ANZAC Bridge	Pyrmont	Eastbound	4900	3400	5600	3800
		Westbound	4900	3500	5300	4000
		Combined	*9800*	*6900*	*10,900*	*7800*
Western Distributor	Sydney CBD	Northbound	4300	2000	4800	2200
		Southbound	3000	1600	3200	1600
		Combined	*7300*	*3600*	*8000*	*3800*

Note: Comparing the 'Do something' scenario with the 'Do minimum' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

7.2.4 Tolling scenarios and implications

Although no decision has yet been made, provision for new toll gantries would also be included on northbound locations of the Sydney Harbour Bridge and Sydney Harbour Tunnel, should the Government elect to apply northbound tolls to these crossings. As described in Section 7.2.1, the low elasticity of traffic to toll levels means the toll regime does not have a material impact on the traffic volumes. This assessment therefore assumes that tolls would apply to northbound traffic on the Sydney Harbour Bridge and Sydney Harbour Tunnel in the future, as part of the following integrated tolling scheme assumptions:

- Western Harbour Tunnel: two-way tolling, with price equalised with Sydney Harbour Bridge/Sydney Harbour Tunnel
- Beaches Link Tunnel (in the 'Do something cumulative' scenario): two-way tolling
- Sydney Harbour Tunnel: two-way tolling, with price equalised with Sydney Harbour Bridge/Western Harbour Tunnel

- Sydney Harbour Bridge (including Cahill Expressway): two-way tolling, with price equalised with Sydney Harbour Tunnel/Western Harbour Tunnel.

The primary potential change in tolling as a result of the project would be the introduction of a consistent single-price toll on all Sydney Harbour crossings in each direction. Northbound trips across Sydney Harbour via Sydney Harbour Bridge and Sydney Harbour Tunnel that are not currently tolled would become tolled with the introduction of the Western Harbour Tunnel.

The primary effects of the potential two-way tolling rationalisation across Sydney Harbour would be:

- Simpler and more legible tolling scheme for Harbour crossings
- Minimal impact on vehicle kilometres travelled due to the additional capacity provided by the Western Harbour Tunnel
- Reduction of distorted traffic patterns that currently occur as a result of toll-avoidance behaviour for southbound trips, particularly on Victoria Road
- Reductions in congestion for northbound trips on the Sydney Harbour Bridge and Sydney Harbour Tunnel.

Overall, any changes to the cost of travelling north across Sydney Harbour via tolled roads would be offset by the substantial capacity increases and associated reduction in travel times provided by the project.

7.2.5 Strategic model road network performance

A summary of the forecast daily VKT and VHT of the Sydney region and the Western Harbour Tunnel and Beaches Link study area under the ‘Do something’ scenario for the 2027 and 2037 forecast years is provided in Table 7-7.

Analysis of the forecast daily VKT and VHT under the ‘Do something’ scenario shows that:

- The project would improve network productivity due to an increase in motorway daily VKT and decrease in daily VHT
- The road network would accommodate more or longer trips in a shorter time
- Traffic would shift from arterial (non-motorway) roads to the project (motorway) as evident in the similar or reduction in daily VHT and VKT on the non-motorway road network.

Table 7-7 Modelled 'Do something' daily VKT and VHT (SMPM)

Network measure	Road	2027 ‘Do minimum’	2027 ‘Do something’	2037 ‘Do minimum’	2037 ‘Do something’
Sydney region					
Daily VKT	Motorway	27,135,000	27,399,000	31,810,000	32,170,000
	Other	87,592,000	87,570,000	103,604,000	103,601,000
	Total	114,727,000	114,969,000	135,414,000	135,772,000
Daily VHT	Motorway	513,000	501,000	758,000	737,000
	Other	3,248,000	3,244,000	5,174,000	5,167,000
	Total	3,761,000	3,745,000	5,931,000	5,904,000
Western Harbour Tunnel and Beaches Link study area					
Daily VKT	Motorway	6,377,000	6,623,000	6,891,000	7,253,000
	Other	15,315,000	15,286,000	16,654,000	16,656,000
	Total	21,693,000	21,909,000	23,545,000	23,909,000
Daily VHT	Motorway	149,000	136,000	187,000	165,000

Network measure	Road	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
	Other	656,000	655,000	774,000	773,000
	Total	805,000	791,000	961,000	938,000

7.2.6 Impacts on road safety

The Western Harbour Tunnel would substantially change the volume of traffic travelling on arterial roads at the metropolitan level. Trips through the Western Harbour Tunnel on the motorway network would be on a higher standard of road than urban arterials. This would have an impact on the number of crashes for roads on which traffic volumes would decrease when the Western Harbour Tunnel is in operation. Key existing roads that would have materially reduced daily traffic demands include:

- Victoria Road
- Western Distributor/ANZAC Bridge
- Bradfield Highway
- Cahill Expressway
- Sydney Harbour Tunnel.

A summary of the change in VKT from arterial standard to motorway standard roads as a result of the project is presented in Table 7-8. The change in arterial and motorway VKT, along with the associated average crash rates for arterial roads (based on the last five years of crash data) and motorways (based on the last five years of crash data for the Sydney Harbour Tunnel), indicate that overall crashes across the network would decrease by up to 375 crashes per year as a result of the Western Harbour Tunnel.

Table 7-8 Forecast crash reduction due to Western Harbour Tunnel

Western Harbour Tunnel Forecast Annual VKT	Arterial crash rate (crashes per million VKT)	Tunnel Crash Rate (crashes per million VKT)	Reduction in Annual Crashes
28,525,389	24	11	375

In addition to these likely road safety benefits associated with a reduction in the number of crashes, the project would substantially reduce the volumes of trucks travelling on arterial corridors. This would also increase road safety on these arterial corridors and potentially reduce the severity of crashes, which would be less likely to involve heavy vehicles.

7.3 Western Harbour Tunnel

7.3.1 Midblock Level of Service

A summary of midblock performance of the Western Harbour Tunnel main-line at various locations along the tunnel is provided in Table 7-9 and Table 7-10, and indicates that the tunnel and associated ramps would perform efficiently under the forecast volumes.

Table 7-9 Modelled 'Do something' morning peak hour tunnel performance

Segment	Direction	Minimum number of lanes	2027		2037	
			Density (PCU/km/lane)	Level of Service	Density (PCU/km/lane)	Level of Service
Western Harbour Tunnel (main carriageway)	Northbound	3	14.2	C	19.6	D
	Southbound	3	14.0	C	19.0	D
Rozelle on ramp	Northbound	1	13.5	C	20.2	D
Rozelle off ramp	Southbound	2	11.1	C	17.3	D
M4-M5 Link on ramp	Northbound	3	10.0	C	13.7	C
M4-M5 Link off ramp	Southbound	3	6.5	B	10.4	B
North Sydney on ramp	Southbound	2	10.2	B	15.1	C
North Sydney off ramp	Northbound	2	9.9	C	15.3	C

Table 7-10 Modelled 'Do something' evening peak hour tunnel performance

Segment	Direction	Minimum number of lanes	2027		2037	
			Density (PCU/km/lane)	Level of Service	Density (PCU/km/lane)	Level of Service
Western Harbour Tunnel (main carriageway)	Northbound	3	12.0	C	14.3	C
	Southbound	3	10.1	B	14.0	C
Rozelle on ramp	Northbound	1	10.0	B	13.2	C
Rozelle off ramp	Southbound	2	5.3	A	7.6	B
M4-M5 Link on ramp	Northbound	3	8.7	B	10.1	B
M4-M5 Link off ramp	Southbound	3	7.9	B	10.9	B
North Sydney on ramp	Southbound	2	10.8	B	13.5	C
North Sydney off ramp	Northbound	2	8.7	B	11.3	B

7.4 Rozelle and surrounds

7.4.1 Network performance

A summary of future network performance statistics for the Rozelle area under the 'Do something' scenario is provided in Table 7-11 and Table 7-12. Analysis of the network performance with the project indicates:

- Traffic demand through the Rozelle and surrounds study area is forecast to increase by up to 14 per cent as a result of the project. The project would also result in a greater amount of forecast demand being able to travel as desired during peak periods. This is reflected in the reduced number of unreleased trips at the end of the modelled period when compared with the 'Do minimum' scenario
- Average travel speeds through the Rozelle area would increase by up to 60 per cent as a result of the project, despite the increase in demand. This is a result of the large volumes of traffic that would be diverted from the ANZAC Bridge and Western Distributor to the Western Harbour Tunnel, substantially reducing delays on this part of the existing motorway network
- The number of stops through the study area would reduce by up to 40 per cent. This is also a result of the reduction in demand and congestion on the ANZAC Bridge and Western Distributor to the Western Harbour Tunnel.

Network statistics for the Rozelle and surrounds study area show that forecast traffic conditions would improve substantially as a result of the project. This is primarily due to the reduction in congestion along both ANZAC Bridge and the Western Distributor, resulting in improved travel times and fewer delays.

Table 7-11 Modelled 'Do something' morning peak network performance – Rozelle and surrounds

Network measure	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Network statistics for all vehicles				
Total traffic demand (veh)	53,200	59,000	58,400	66,600
Total VKT through network	146,200	208,200	150,600	231,400
Total vehicle travel time through the network (hours)	7630	7170	8190	7820
Total number of stops	543,700	321,100	600,900	351,500
Average vehicle statistics				
Average vehicle trip length through the network (km)	3.0	3.6	3.2	3.8
Average vehicle trip time through the network (hours)	0:09:24	0:07:30	0:10:23	0:07:46
Average number of stops per trip	11.2	5.6	12.7	5.8
Average trip speed (km/hr)	19.2	29.0	18.4	29.6
Unreleased traffic				
Total unreleased trips	8150	5690	12,310	9100
% of demand unreleased	13%	8%	17%	12%

Table 7-12 Modelled ‘Do something’ evening peak network performance – Rozelle and surrounds

Network measure	2027 ‘Do minimum’	2027 ‘Do something’	2037 ‘Do minimum’	2037 ‘Do something’
Network statistics for all vehicles				
Total traffic demand (veh)	55,400	59,500	60,500	66,500
Total VKT through network	168,800	213,300	173,400	235,200
Total vehicle travel time through the network (hours)	4480	4750	4990	5510
Total number of stops	142,700	98,300	167,600	131,100
Average vehicle statistics				
Average vehicle trip length through the network (km)	3.1	3.5	3.3	3.6
Average vehicle trip time through the network (hours)	0:04:59	0:04:42	0:05:37	0:05:06
Average number of stops per trip	2.6	1.6	3.1	2.0
Average trip speed (km/hr)	37.6	44.9	34.7	42.7
Unreleased traffic				
Total unreleased trips	8450	5370	13,550	7490
% of demand unreleased	13%	8%	18%	10%

7.4.2 General traffic travel times

Modelled general traffic travel times for key routes through the Rozelle and surrounds study area are provided in Table 7-13 and Table 7-14. Analysis of the modelled travel times under the ‘Do something’ scenario shows:

- Travel times along City West Link and Western Distributor would improve substantially as a result of the project in the eastbound direction during the morning peak. This is due to the transfer of traffic from ANZAC Bridge and Western Distributor to the Western Harbour Tunnel, which would reduce the delays generated by merging and weaving of surface traffic through this section
- Travel times on Victoria Road in the northbound direction during the morning peak are forecast to increase as a result of the project. This could occur due to the increased local traffic being able to access the corridor due to the reduction in congestion caused by through traffic in the area, following the transfer of traffic to the Western Harbour Tunnel. Northbound traffic would also merge with traffic from the M4-M5 Link at the Victoria Road off ramp south of Iron Cove Bridge, contributing to delays
- Travel times on Victoria Road southbound would reduce as a result of the project, again due to the reduction in downstream congestion along ANZAC Bridge and Western Distributor.

Overall, the project is expected to generally maintain or improve travel times due to reduced congestion along key routes through Rozelle, resulting from substantial changes in traffic patterns with regional trips using Western Harbour Tunnel in preference to ANZAC Bridge and Western Distributor.

Table 7-13 Modelled ‘Do something’ morning peak hour general traffic travel times – Rozelle and surrounds

Route	Direction	2027 ‘Do minimum’	2027 ‘Do something’	2037 ‘Do minimum’	2037 ‘Do something’
City West Link and Western Distributor (Balmain Road to Druitt Street ramp)	Eastbound	0:21:59	0:12:03	0:21:33	0:14:28
	Westbound	0:04:59	0:05:31	0:05:29	0:05:47
Victoria Road (Evans Street to ANZAC Bridge)	Northbound	0:02:15	0:07:08	0:02:18	0:07:04
	Southbound	0:05:38	0:01:57	0:05:58	0:01:48

Table 7-14 Modelled 'Do something' evening peak hour general traffic travel times – Rozelle and surrounds

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
City West Link and Western Distributor (Balmain Road to Druitt Street ramp)	Eastbound	0:05:14	0:06:28	0:05:01	0:07:06
	Westbound	0:06:04	0:07:06	0:06:57	0:07:29
Victoria Road (Evans Street to ANZAC Bridge)	Northbound	0:02:57	0:02:54	0:03:02	0:03:02
	Southbound	0:02:00	0:01:59	0:02:07	0:02:07

7.4.3 Intersection performance

Modelled future performance for key intersections in the Rozelle and surrounds study area under the 'Do something' scenario are presented in Table 7-15 and Table 7-16. Modelled intersection performance indicates the following when compared to equivalent 'Do minimum' scenarios:

- The majority of intersections within the Rozelle area would perform better as a result of the project. This is due to the substantial demand that would be diverted from ANZAC Bridge and Western Distributor into Western Harbour Tunnel. This would reduce the delays generated by merging and weaving, and in turn reduce queues that would extend back to these intersections
- The intersection of The Crescent and City West Link would experience relatively minor increased delays in the evening peak as a result of the project, due to the additional movements introduced by the inclusion of the Western Harbour Tunnel portal at this location.
- Queuing at the intersection of City West Link and The Crescent would also affect the intersections of City West Link with James Craig Road, Catherine Street and Balmain Road. However, these intersections would still perform acceptably with the project
- The intersection of Victoria Road and Darling Street would continue to perform at capacity resulting in LoS F both with and without the project in the morning peak
- The intersection of Johnston Street and The Crescent would perform substantially better with the project, due to the reduction in surface traffic and queuing in the area as a result of the project
- The intersection of Victoria Road and Robert Street would marginally improve under the project, however evening peak performance would remain at LoS F with demand exceeding capacity.

Table 7-15 Modelled 'Do something' morning peak hour intersection performance – Rozelle and surrounds

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
Victoria Road/Darling Street	>100	F	>100	F	>100	F	83	F
Victoria Road/Evans Street	33	C	33	C	35	C	33	C
Victoria Road/Gordon Street	27	B	27	B	27	B	26	B
Victoria Road/Robert Street	23	B	21	B	27	B	29	C
Victoria Road/The Crescent	28	B	24	B	55	D	39	C
The Crescent/James Craig Road	29	C	9	A	36	C	17	B
The Crescent/City West Link	43	D	46	D	47	D	46	D
The Crescent/Johnston Street	>100	F	17	B	>100	F	20	B
City West Link/Catherine Street	30	C	25	B	34	C	24	B
City West Link/Balmain Road	55	D	49	D	79	F	53	D
City West Link/M5 ramps	38	C	24	B	51	D	25	B

Table 7-16 Modelled 'Do something' evening peak hour intersection performance – Rozelle and surrounds

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
Victoria Road/Darling Street	57	E	50	D	62	E	54	D
Victoria Road/Evans Street	19	B	19	B	58	E	32	C
Victoria Road/Gordon Street	16	B	16	B	49	D	37	C
Victoria Road/Robert Street	28	B	27	B	87	F	75	F
Victoria Road/The Crescent	19	B	27	B	37	C	47	D
The Crescent/James Craig Road	13	A	16	B	28	B	34	C
The Crescent/City West Link	22	B	41	C	22	B	42	C
The Crescent/Johnston Street	56	D	19	B	56	D	19	B
City West Link/Catherine Street	33	C	41	C	24	B	43	D
City West Link/Balmain Road	41	C	41	C	46	D	59	E
City West Link/M5 ramps	20	B	28	B	20	B	30	C

7.4.4 Road network changes and access arrangements

Surface road access to the project would be provided from City West Link at its intersection with The Crescent. The on and off ramps would be constructed as part of the approved M4-M5 Link project and the project would carry out the fit out and commissioning of these ramps. An underground connection would also be provided to and from the M4-M5 Link.

Some minor changes to the alignment of road surface works approved as part of the M4-M5 Link would also be required and would be managed within the scope of the approval of that project. Modifications and additions would be carried out within the disturbance area assessed for the M4-M5 Link.

Traffic impacts due to these road network changes are outlined in Sections 7.4.1 and 7.4.2.

7.4.5 Public transport impacts

Modelled future bus travel times for key routes through the Rozelle and surrounds study area under the 'Do something' scenario are presented in Table 7-17 and Table 7-18. Analysis of modelled bus travel times under the 'Do something' scenario indicates:

- During the morning peak, southbound bus travel times would improve with the project. This is a result of reduced congestion on the ANZAC Bridge and Western Distributor, which would reduce merging and weaving and reduce queues that would block access to the Druitt Street bus lane from this this corridor
- During the morning peak, counter-peak northbound bus travel times along Victoria Road are forecast to increase as a result of the project. This would be due to increased local traffic being able to access the corridor, joining from side roads and merging with M4-M5 link traffic exiting to Victoria Road south of Iron Cove Bridge. As there is currently no bus lane in the northbound direction until Iron Cove Bridge, these general traffic delays would also affect buses
- In the evening peak, bus travel times on Victoria Road would not change substantially as a result of the project.

As Western Harbour Tunnel is expected to maintain or reduce traffic demand on Victoria Road, the forecast impact on morning peak travel times is considered unlikely to be realised. Despite this, it is reflected in the assessment results to represent a conservative scenario. Consequently, a network conditions monitoring approach is proposed for this area to identify any realised impacts and confirm any action mitigations required.

Table 7-17 Modelled 'Do something' morning peak hour bus travel times – Rozelle and surrounds

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Victoria Road (Evans Street to ANZAC Bridge)	Northbound	0:01:50	0:11:50	0:03:47	0:12:02
	Southbound	0:06:00	0:02:41	0:04:27	0:02:40

Table 7-18 Modelled 'Do something' evening peak hour bus travel times – Rozelle and surrounds

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Victoria Road (Evans Street to ANZAC Bridge)	Northbound	0:02:43	0:04:10	0:04:18	0:04:19
	Southbound	0:01:57	0:02:21	0:02:31	0:02:29

7.4.6 Active transport impacts

There would be no direct impacts on the active transport network within the Rozelle and surrounds study area.

7.5 Warringah Freeway and surrounds

7.5.1 Network performance

A summary of network performance statistics for the Warringah Freeway and surrounds study area under the ‘Do something’ scenario is provided in Table 7-19 and Table 7-20. Analysis of the modelled network statistics shows:

- Peak period traffic demand through the Warringah Freeway and surrounds study area would increase by 10 per cent in the morning peak and six per cent in the evening peak by 2037. The project would also result in a greater amount of forecast demand being able to travel as desired during peak periods. This is reflected in the reduction of unreleased trips at the end of the model period when compared with the ‘Do minimum’ scenario
- Average travel speeds through the Warringah Freeway and surrounds study area would increase as a result of the project. This is due to the transfer of demand to the Western Harbour Tunnel which would also result in reduced congestion on the Sydney Harbour Bridge and Sydney Harbour Tunnel
- The number of stops would decrease substantially as a result of the project. This would be a result of the large shift in traffic demand from the Sydney Harbour Bridge and Sydney Harbour Tunnel to the Western Harbour Tunnel, where traffic flows would be largely uninterrupted.

Table 7-19 Modelled ‘Do something’ morning peak network performance – Warringah Freeway and surrounds

Network measure	2027 ‘Do minimum’	2027 ‘Do something’	2037 ‘Do minimum’	2037 ‘Do something’
Network statistics for all vehicles				
Total traffic demand (veh)	104,500	114,400	112,400	126,500
Total VKT through network	340,400	392,500	350,700	416,500
Total vehicle travel time through the network (hours)	9000	9140	10,160	10,780
Total number of stops	616,200	259,400	746,100	485,100
Average vehicle statistics				
Average vehicle trip length through the network (km)	3.5	3.6	3.5	3.6
Average vehicle trip time through the network (hours)	0:05:32	0:05:04	0:06:01	0:05:37
Average number of stops per trip	6.3	2.4	7.4	4.2
Average trip speed (km/hr)	37.8	42.9	34.5	38.6
Unreleased traffic				
Total unreleased trips	6890	5970	11,270	11,450
% of demand unreleased	7%	5%	10%	9%

Table 7-20 Modelled 'Do something' evening peak network performance – Warringah Freeway and surrounds

Network measure	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Network statistics for all vehicles				
Total traffic demand (veh)	109,500	114,200	118,100	124,700
Total VKT through network	344,900	350,200	349,000	365,200
Total vehicle travel time through the network (hours)	9880	10,300	12,370	11,800
Total number of stops	621,100	558,100	980,300	711,000
Average vehicle statistics				
Average vehicle trip length through the network (km)	3.3	3.3	3.2	3.4
Average vehicle trip time through the network (hours)	0:05:37	0:05:51	0:06:51	0:06:31
Average number of stops per trip	5.9	5.3	9.1	6.5
Average trip speed (km/hr)	34.9	34.0	28.2	30.9
Unreleased traffic				
Total unreleased trips	3900	8540	9800	15,900
% of demand unreleased	4%	8%	8%	13%

7.5.2 General traffic travel times

Modelled general traffic travel times for key routes through the Warringah Freeway and surrounds study area are provided in Table 7-21 and Table 7-22. Analysis of modelled travel times under the 'Do something' scenarios shows:

- Travel times for trips travelling along the Warringah Freeway between Gore Hill Freeway and Sydney Harbour Bridge and Sydney Harbour Tunnel would generally improve. This is due to the reduction in demand for both facilities as a result of the project
- Travel times along Miller Street would experience localised delays in the evening peak of up to four minutes in the northbound direction due to changes in demands and traffic patterns
- Localised southbound travel times to the Sydney Harbour Tunnel from Falcon Street would increase marginally in the morning peak as a result of the project. This is due to changes to the configuration of the Falcon Street on ramp, which would be fed by an additional lane from the Falcon Street interchange with no additional outbound capacity
- Northbound travel times along Warringah Freeway to Falcon Street would generally improve as a result of the project. This is partially due to the increased capacity provided by the reconfiguration of the Falcon Street interchange to a diverging diamond configuration, which would reduce conflicts between traffic exiting the freeway and through-traffic on Falcon Street.

Table 7-21 Modelled 'Do something' morning peak hour general traffic travel times – Warringah Freeway and surrounds

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Sydney Harbour Bridge to Warringah Freeway/Falcon Street interchange	Northbound	0:04:40	0:03:39	0:04:51	0:03:31
	Southbound	0:04:03	0:04:09	0:04:02	0:04:07
Sydney Harbour Tunnel to Warringah Freeway/Falcon Street interchange	Northbound	0:03:55	0:03:43	0:04:08	0:03:28
	Southbound	0:04:03	0:04:33	0:04:02	0:04:22
Sydney Harbour Bridge to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:06:13	0:05:27	0:06:16	0:05:26
	Southbound	0:13:35	0:06:59	0:15:22	0:07:36
Sydney Harbour Tunnel to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:26	0:05:22	0:05:30	0:05:23
	Southbound	0:11:39	0:07:19	0:12:37	0:07:52
Berry Street to Amherst Street via Miller Street	Northbound	0:03:42	0:04:10	0:03:53	0:04:12
	Southbound	0:04:25	0:04:16	0:05:43	0:06:10

Table 7-22 Modelled 'Do something' evening peak hour general traffic travel times – Warringah Freeway and surrounds

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Sydney Harbour Bridge to Warringah Freeway/Falcon Street interchange	Northbound	0:04:02	0:03:23	0:07:51	0:04:12
	Southbound	0:06:09	0:04:35	0:05:02	0:04:33
Sydney Harbour Tunnel to Warringah Freeway/Falcon Street interchange	Northbound	0:03:57	0:06:43	0:07:36	0:03:52
	Southbound	0:14:54	0:05:28	0:14:59	0:05:37
Sydney Harbour Bridge to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:35	0:05:20	0:06:45	0:05:22
	Southbound	0:13:56	0:06:08	0:17:31	0:06:07
Sydney Harbour Tunnel to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:28	0:08:37	0:06:46	0:05:13
	Southbound	0:25:21	0:07:00	0:30:09	0:07:11
Berry Street to Amherst Street via Miller Street	Northbound	0:03:52	0:04:54	0:03:50	0:08:03
	Southbound	0:05:01	0:05:00	0:08:39	0:06:13

7.5.3 Intersection performance

Modelled future performance for key intersections in the Warringah Freeway and surrounds study area under the ‘Do something’ scenario are presented in Table 7-23 and Table 7-24. Analysis of the modelled intersection performance under the ‘Do something’ scenario indicates:

- The proposed phasing and access changes around the intersection of Miller Street and Berry Street would simplify the operation and increase the capacity of these corridors to offset potential additional delays associated with increased demand along these corridors under the project during the morning peak. During the evening peak, poor intersection level of service would still occur along these corridors
- Intersection performance along Brook Street in the vicinity of the Warringah Freeway would improve substantially in the morning peak as a result of the project. This would be due to reduced queuing and congestion on the Warringah Freeway, as well as the changes in access to Brook Street from the Warringah Freeway, which under the project would be limited to trips from the Sydney Harbour Bridge and Berry Street
- Intersections along the Pacific Highway would generally operate with longer delays with the project. Due to the proposed removal of the right turn from Miller Street northbound into Berry Street eastbound, traffic would divert to turn right into Berry Street from the Pacific Highway, increasing demand and delays at this intersection. The removal of a left turn lane from the Pacific Highway southbound into Berry Street would also result in increased delays on the northern approach of the Pacific Highway, which could extend past Bay Road in the morning peak
- The intersection of Ben Boyd Road and Military Road would operate with longer delays as a result of the project due to changes to access and travel patterns at the Ernest Street and Falcon Street interchanges.

Overall, although the project would generally improve network performance for roads surrounding North Sydney, it would not resolve localised performance issues at a number of intersections. However, considering that the project would facilitate an overall net increase in traffic flows and average network speeds in North Sydney, this is considered a balanced and acceptable outcome.

The proposed road integration works and resultant traffic performance in the North Sydney area have been developed in the context of the growing North Sydney CBD environment. The works in the area proposed by the project seek to maintain an appropriate level of traffic movement while also preserving capacity and connectivity for other customers whose needs conflict with traffic – particularly pedestrians. Options to further increase traffic performance at intersections throughout the area have been investigated. However, these alternative options would result in further impacts on other customers. The proposed works are considered to provide the most equitable outcomes from the perspective of maintaining a balanced and integrated transport network through North Sydney. Further refinements and changes to network operations within the North Sydney CBD may occur as part of the North Sydney Integrated Transport Program works.

Table 7-23 Modelled 'Do something' morning peak hour intersection performance – Warringah Freeway and surrounds

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Willoughby Road/Gore Hill Freeway interchange	>100	F	8	A	>100	F	9	A
Brook Street/Warringah Freeway on ramp	>100	F	7	A	>100	F	58	E
Brook Street/Warringah Freeway off ramp	61	E	10	A	67	E	49	D
Brook Street/Merrenburn Avenue	>100	F	28	B	>100	F	44	D
Amherst Street/West Street	5	A	9	A	5	A	>100	F
Amherst Street/Miller Street	21	B	38	C	20	B	50	D
Miller Street/Warringah Freeway on ramp	7	A	6	A	6	A	9	A
Miller Street/Warringah Freeway off ramp	12	A	10	A	13	A	10	A
Miller Street/Ernest Street	25	B	44	D	32	C	44	D
Miller Street/Falcon Street	35	C	27	B	38	C	41	C
Ernest Street/Warringah Freeway on ramp	5	A	19	B	5	A	21	B
Ernest Street/Warringah Freeway off ramp (off ramp in PM, on ramp in AM)	5	A	19	B	5	A	21	B
Falcon Street/Warringah Freeway ramps	29	C	31	C	15	B	47	D
Watson Street/Military Road	18	B	27	B	26	B	36	C
Military Road/Ben Boyd Road	15	B	64	E	23	B	71	F
Falcon Street/Merlin Street	24	B	35	C	32	C	81	F
Berry Street/Walker Street	29	C	48	D	39	C	55	D
Berry Street/Miller Street	55	D	53	D	69	E	55	D
Mount Street/Arthur Street	46	D	27	B	59	E	33	C
Mount Street/Walker Street	36	C	35	C	48	D	46	D
Pacific Highway/High Street/Arthur Street	19	B	23	B	38	C	25	B
Pacific Highway/Walker Street/Blue Street	36	C	38	C	65	E	33	C
Pacific Highway/Miller Street/Mount Street	38	C	63	E	41	C	65	E
Pacific Highway/Berry Street	56	E	35	C	52	D	61	E
Pacific Highway/Bay Road	55	D	22	B	77	F	89	F
Miller Street/McLaren Street	23	B	41	C	72	F	50	D
Miller Street/Ridge Street	38	C	45	D	53	D	66	E
Miller Street/Carlow Street	13	A	9	A	13	A	24	B
High Street/Clark Road	18	B	32	C	55	D	59	E
High Street/Alfred Street	13	A	18	B	62	E	21	B
Mount Street/Alfred Street	<5	A	12	A	<5	A	13	A
Ernest Street/Ben Boyd Road	12	A	17	B	12	A	29	C
Pedestrian crossing at Military Road	6	A	6	A	5	A	8	A

Table 7-24 Modelled 'Do something' evening peak hour intersection performance – Warringah Freeway and surrounds

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Willoughby Road/Gore Hill Freeway interchange	38	C	10	A	76	F	9	A
Brook Street/Warringah Freeway on ramp	14	B	23	B	17	B	42	D
Brook Street/Warringah Freeway off ramp	22	B	18	B	20	B	48	D
Brook Street/Merrenburn Avenue	11	A	45	D	13	A	46	D
Amherst Street/West Street	9	A	75	F	14	A	87	F
Amherst Street/Miller Street	29	C	59	E	31	C	63	E
Miller Street/Warringah Freeway on ramp	6	A	7	A	6	A	6	A
Miller Street/Warringah Freeway off ramp	15	B	9	A	15	B	9	A
Miller Street/Ernest Street	41	C	42	C	43	D	57	E
Miller Street/Falcon Street	44	D	65	E	49	D	79	F
Ernest Street/Warringah Freeway on ramp	15	B	14	B	15	B	14	A
Ernest Street/Warringah Freeway off ramp (off ramp in PM, on ramp in AM)	17	B	23	B	17	B	18	B
Falcon Street/Warringah Freeway ramps	72	F	79	F	>100	F	89	F
Watson Street/Military Road	46	D	31	C	59	E	40	C
Military Road/Ben Boyd Road	54	D	80	F	70	E	86	F
Falcon Street/Merlin Street	>100	F	>100	F	>100	F	>100	F
Berry Street/Walker Street	44	D	75	F	73	F	76	F
Berry Street/Miller Street	46	D	56	D	70	F	>100	F
Mount Street/Arthur Street	49	D	34	C	92	F	63	E
Mount Street/Walker Street	32	C	93	F	75	F	>100	F
Pacific Highway/High Street/Arthur Street	46	D	16	B	61	E	23	B
Pacific Highway/Walker Street/Blue Street	40	D	71	F	80	F	70	F
Pacific Highway/Miller Street/Mount Street	41	C	63	E	58	E	>100	F
Pacific Highway/Berry Street	23	B	97	F	56	E	>100	F
Pacific Highway/Bay Road	15	B	50	D	41	C	96	F
Miller Street/McLaren Street	21	B	41	C	55	D	76	F
Miller Street/Ridge Street	40	C	18	B	91	F	38	C
Miller Street/Carlow Street	8	A	7	A	19	B	7	A
High Street/Clark Road	61	E	94	F	97	F	82	F
High Street/Alfred Street	>100	F	58	E	>100	F	53	D
Mount Street/Alfred Street	12	A	12	A	10	A	11	A
Ernest Street/Ben Boyd Road	44	D	14	B	94	F	46	D
Pedestrian crossing at Military Road	27	B	5	A	34	C	<5	A

7.5.4 Road network changes and access arrangements

The Western Harbour Tunnel component of the project would connect to North Sydney with provision of an on ramp from Berry Street for vehicles travelling southbound and an off ramp to Falcon Street (westbound only) for vehicles travelling northbound. In addition, the tunnel would connect to the Warringah Freeway with ramps to be located around Ernest Street in Cammeray.

The Warringah Freeway Upgrade component of the project is proposed to substantially improve the efficiency of the motorway and arterial road interfaces. The upgrade would involve extensive changes to surface roads and existing connections that would:

- Connect and integrate with the Western Harbour Tunnel
- Separate traffic on the freeway based on trip function (through-traffic, traffic for arterial distribution and traffic for local destinations), reducing the number of people taking wrong turns.

Separation of traffic based on trip function is shown conceptually in Figure 7-6. The trip distribution strategy, which is based on differentiating and optimising the use of the Harbour crossing locations would be implemented as follows:

- The central carriageway would act as the mainline motorway corridor connecting Gore Hill Freeway/M1 North, Warringah Freeway and Western Harbour Tunnel
- The southbound outer carriageway would act as the access distributor for North Sydney, Sydney CBD and journeys on to the Eastern Suburbs (including the Sydney Harbour Bridge and Sydney Harbour Tunnel)
- The northbound outer carriageway would act as the access distributor for North Sydney, Sydney CBD and journeys from the Eastern Suburbs (including the Sydney Harbour Bridge and Sydney Harbour Tunnel).

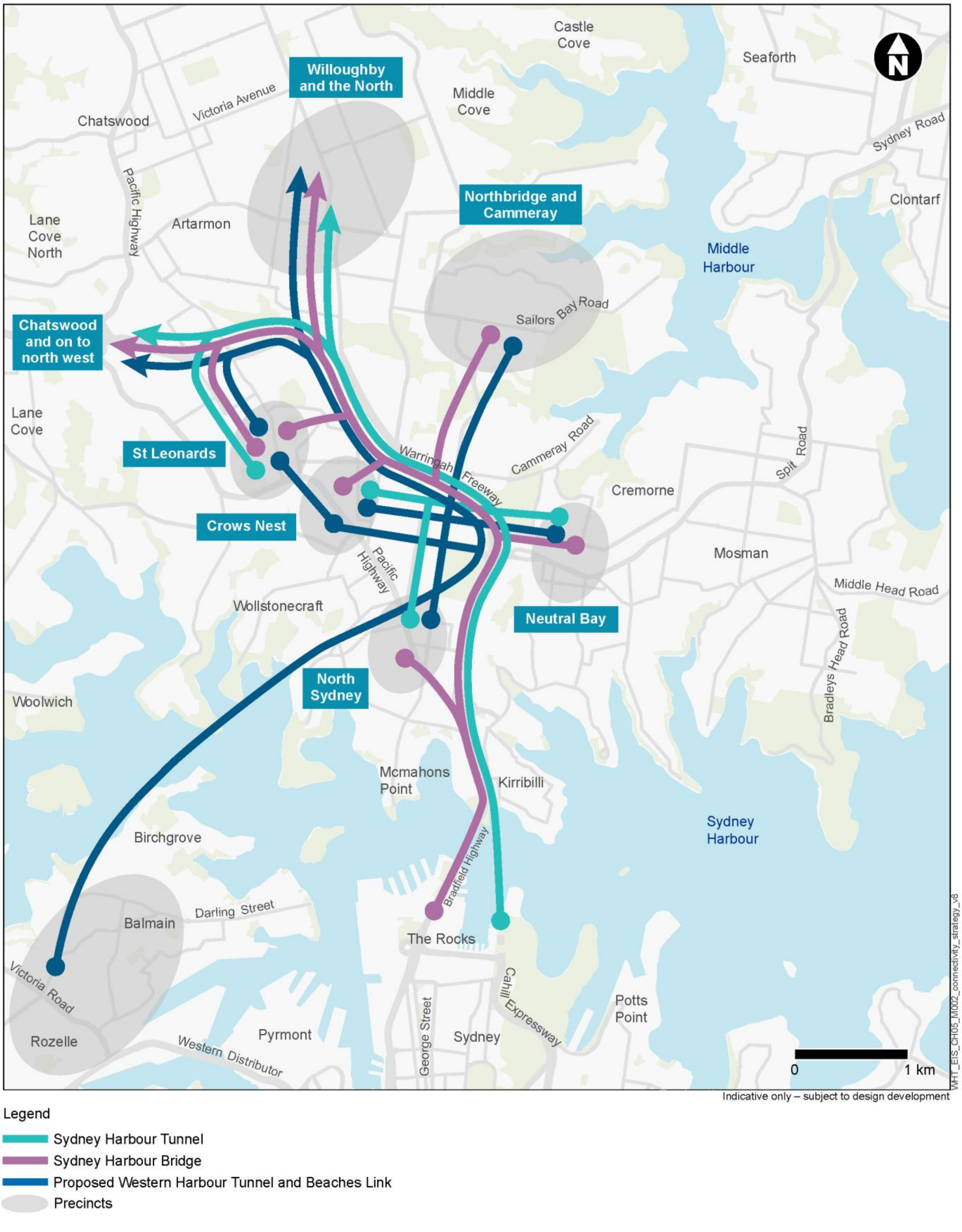


Figure 7-6 Conceptual trip distribution strategy

The upgrade would include the removal of tidal flow arrangements on the Warringah Freeway, while existing tidal flow arrangements on the Sydney Harbour Bridge would not be directly affected by the project. In addition, the upgraded Warringah Freeway would simplify traffic flow and improve wayfinding by providing the following traffic lanes:

- A northbound outer carriageway that would comprise:
  - An outer western carriageway, carrying northbound traffic from the Sydney Harbour Bridge to the Beaches Link northbound on ramp and for local distribution to local destinations such as North Sydney and Crows Nest
  - Inner western carriageways carrying northbound traffic from the Sydney Harbour Bridge and Sydney Harbour Tunnel
- A central carriageway that would carry northbound and southbound motorway traffic between the Western Harbour Tunnel, Gore Hill Freeway and Willoughby Road
- A southbound outer carriageway that would comprise:
  - Inner eastern carriageways, carrying southbound traffic to the Sydney Harbour Tunnel and for distribution to local destinations such as Neutral Bay
  - The outer eastern carriageway, carrying southbound traffic for the Sydney Harbour Bridge (both the Bradfield Highway and Cahill Expressway) and for distribution to local destinations such as North Sydney and Kirribilli
  - A dedicated bus lane between Miller Street, Cammeray and the Sydney Harbour Bridge, Milsons Point which would carry southbound buses and other permitted bus lane vehicles.

Access restrictions proposed by the project are as follows:

- The existing Falcon Street westbound off ramp from the Warringah Freeway would be converted to the northbound off ramp from Western Harbour Tunnel, thereby removing connectivity between the Warringah Freeway northbound and Falcon Street westbound. Adjacent interchanges north and south of Falcon Street would provide similar alternative connectivity
- Existing connectivity between Sydney Harbour Tunnel in the northbound direction to Falcon Street (in the westbound direction only), Miller Street and Brook Street would be removed. Alternative connectivity would be retained by providing a new northbound access between Sydney Harbour Tunnel and Ernest Street
- There would be no access from the Berry Street northbound on ramp to the Falcon Street eastbound off ramp (in addition to the Falcon Street westbound off ramp identified above), or to the Warringah Freeway mainline. Connections to Western Harbour Tunnel, Beaches Link, and the Miller Street and Brook Street off ramps would only be provided from the Berry Street northbound on ramp. Traffic would be required to travel via the North Sydney road network to access the new High Street northbound on ramp, Falcon Street eastbound, or the Warringah Freeway via the Falcon Street interchange
- Access from the Falcon Street southbound on ramp to the Cahill Expressway would be removed. Access would be maintained from the Falcon Street southbound on ramp to Sydney Harbour Bridge (Bradfield Highway) and Sydney Harbour Tunnel, providing connectivity to the Sydney CBD and Western Suburbs, and the Eastern Suburbs, respectively
- Access between the ramps at Falcon Street and Brook Street via the Warringah Freeway would be removed. Traffic would instead be required to travel via alternative roads to access these locations
- Access would be removed from the Alfred Street North southbound off ramp to Alfred Street North in the northbound direction. Traffic would be required to exit the Warringah Freeway at Falcon Street or continue onto High Street and travel via alternative roads to access Alfred Street North.

The Warringah Freeway Upgrade would involve a number of modifications to existing bridges that span the Warringah Freeway between Sydney Harbour Bridge and Willoughby Road in Naremburn. These modifications are outlined in Table 7-25.

Table 7-25 Bridge modifications along the Warringah Freeway

Location	Modifications
High Street	High Street bridge would be widened to provide an additional westbound traffic lane and a new shared user path on the southern side. A new northbound on ramp and southbound off ramp connection (with associated upgrade works along Alfred Street North) to and from Warringah Freeway would also be provided.
Mount Street	Mount Street bridge would be widened at its south-eastern and south-western corners to support new or modified on and off ramps. A new single lane underpass would be constructed beneath Mount Street as part of a new dedicated southbound bus lane.
Alfred Street North	A new bridge structure would be provided over the southbound bus lane and the Alfred Street North connection to Mount Street.
Ridge Street	Ridge Street shared user bridge would be replaced and constructed further south from its existing location.
Falcon Street	Falcon Street bridge would be widened to accommodate a diverging diamond interchange configuration. This involves the signalisation of the interchange at its eastern and western ends. In addition, the footpath on the southern side would be removed and replaced by a traffic lane and the alignment of the northbound off ramp would be moved and widened. The pedestrian underpass on the eastern side of the bridge would also be removed.
Falcon Street Pedestrian Bridge	The existing Falcon Street pedestrian bridge would be demolished and replaced with a new bridge that would provide the same connectivity as the existing pedestrian bridge. The new pedestrian bridge would be constructed prior to the demolition of the existing bridge, maintaining the existing connectivity for pedestrians and cyclists through the course of the project.
Ernest Street	A new active transport bridge between Cammeray Park and ANZAC Park would be constructed on the same alignment as Ernest Street and would deliver the same connectively as is currently provided by the existing Ernest Street cycleway A new bridge would be constructed to the east of the existing bridge prior to the Merlin Street and Ernest Street intersection. Referred to as the 'mouse-hole', this would be a cut and cover underpass (underpass for road lanes) on the eastern side of Ernest Street bridge.
Miller Street/Brook Street	A new on ramp bridge would be constructed to accommodate traffic from Miller Street and Brook Street onto the Warringah Freeway.

The diverging diamond configuration at the Falcon Street interchange would comprise cross-over intersections at each end of the interchange, requiring vehicles to travel on the right side of the road to avoid conflicting right turn movements. This configuration would reduce the number of signal phases required and the number of opposing turning movements, which would improve road safety and traffic efficiency. As a result of these changes, connections between the upgraded Warringah Freeway and arterial road network would be provided at:

- Willoughby Road
- Brook Street
- Miller Street
- Ernest Street
- Falcon Street
- Berry Street
- Mount Street
- High Street
- Pacific Highway.

In addition to the bridge modifications outlined in Table 7-25, other local road changes would be required as part of the Warringah Freeway Upgrade to integrate the project with the existing road network. These changes are outlined in Table 7-26.

Table 7-26 Local road and intersection changes

Location	Upgrade or change
High Street	• The High Street interchange would be upgraded and reconfigured as discussed in Table 7-25 • The roundabout at High Street/Alfred Street (east of Warringah Freeway) would be converted to a signalised intersection • Kerbside parking on High Street on the approach to the intersection with Clark Road would be prohibited during the morning and evening peak periods.
Clark Road	• Kerbside parking on Clark Road on the approach to the intersection with High Street would be prohibited during the morning and evening peak periods.
Alfred Street North	• Alfred Street North would be realigned to the east of its existing alignment from around the existing Ridge Street pedestrian bridge to Wyagdon Street • The road would be widened to provide a two-lane off ramp from the Warringah Freeway around Darley Street to Mount Street, one lane to the Cahill Expressway from around Darley Street, two lanes continuing on Alfred Street North to around Mount Street, and three lanes from around Mount Street to High Street.
Pacific Highway	• The existing raised median separating northbound traffic on lane 2 and lane 3 between Arthur Street and Walker Street would be replaced and shifted to separate northbound traffic on lane 3 and lane 4 • At the Pacific Highway/Berry Street intersection, the Pacific Highway southbound approach would be reconfigured to one left turn lane and two through lanes, and the Pacific Highway northbound approach would be reconfigured to two dedicated right turn lanes and two through lanes.
Arthur Street	• Existing traffic lanes on Arthur Street from Pacific Highway to Mount Street would be reconfigured to include a northbound kerbside traffic lane, allowing for three right turn traffic lanes and one left turn lane into Mount Street • The existing bus lane would be removed.
Berry Street	• Kerb build outs would be removed to provide an additional eastbound lane at the intersection with Miller Street • An eastbound clearway on the southern side of Berry Street between Pacific Highway and Walker Street would be introduced • At the Berry Street/Miller Street intersection, an exclusive pedestrian phase would be implemented and the right turn from Miller Street northbound into Berry Street would be closed (buses excepted) • Reconfiguration of Berry Street east of Walker Street with provision of two traffic lanes connecting to the Western Harbour Tunnel, one traffic lane providing connection to the Warringah Freeway northbound and Arthur Street southbound, and one traffic lane connecting to Arthur Street southbound only.
Falcon Street	• The Falcon Street interchange would be upgraded and reconfigured as discussed in Table 7-25 • At the Falcon Street/Miller Street intersection: - A new shared left turn and through movement short lane would be provided on the Falcon Street eastbound approach - A new left turn short lane would be provided on the Miller Street southbound approach - The shared through movement and right turn traffic lane would be converted to a right turn only lane on the Falcon Street northbound approach.
West Street	• Parking restrictions on both sides of West Street would be implemented on the approach to the intersection with Falcon Street.
Ben Boyd Road	• Parking restrictions on both sides of Ben Boyd Road would be implemented on the approach to the intersection with Military Road.
Miller Street	• Parking restrictions on Miller Street northbound between Pacific Highway and Berry Street would be implemented • At the Miller Street/Amherst Street intersection, the Miller Street northbound right turn bay would be extended • The Miller Street/Warringah Freeway southbound on ramp intersection would be upgraded to a signalised

Location	Upgrade or change
	intersection.
Amherst Street	• Parking restrictions on Amherst Street in the westbound direction would be extended from around 50 metres to 100 metres between Miller Street and Tarella Place • Parking restrictions on Amherst Street in the eastbound direction would be extended from around 60 metres to 100 metres between Miller Street and Ixion Lane.

The proposed local road and intersection changes identified in Table 7-26 would improve traffic flow and increase capacity. The performance of the road network and intersections is discussed in sections 7.5.1 and 7.5.3. Some proposed changes would require motorists to change their route due to the closure of movements at intersections. These include the closure of the right turn from Miller Street northbound into Berry Street, which would divert traffic onto Pacific Highway northbound to access Berry Street from its western end.

7.5.5 Public transport impacts

Modelled future bus travel times for key routes through the Warringah Freeway and surrounds study area under the 'Do something' scenario are presented in Table 7-27 and Table 7-28. Analysis of the modelled bus travel times indicates:

- Travel times for buses from Gore Hill Freeway to the Sydney Harbour Bridge would improve substantially, particularly southbound during peak periods. This is due to the reconfiguration of the southbound bus lane between Miller Street and the Cahill Expressway, which has been separated from the general traffic lanes, removing two existing weave movements between buses and cars. Buses would no longer be required to merge from left to right to access the bus lane from the north, and cars would no longer be able to cross the bus lane between Falcon Street and the Cahill Expressway
- Travel times for buses travelling to and from Falcon Street would improve as a result of the reconfiguration of the southbound bus lane, which removes the existing conflict with general traffic, and also as a result of the reduction in traffic demand to the Willoughby Road and Falcon Street ramps, which would otherwise block access to the northbound bus off ramp to Falcon Street
- Travel times on bus routes through North Sydney via Miller Street would generally be maintained, although some localised delays could occur during the busiest peak periods
- Travel times on bus routes through North Sydney from Pacific Highway would increase during the busiest peak periods. This is due to the increase in demand and congestion between Berry Street and Miller Street as a result of redirecting traffic from Miller Street (resulting from the removal of the existing right turn from Miller Street northbound to Berry Street eastbound).

Table 7-27 Modelled 'Do something' morning peak hour bus travel times – Warringah Freeway and surrounds

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:09:55	0:10:38	0:09:30	0:11:15
	Southbound	0:11:31	0:10:08	0:13:26	0:11:58
Sydney Harbour Bridge to Bay Street (Via North Sydney Station and Pacific Highway)	Northbound	0:06:05	0:05:57	0:06:29	0:06:22
	Southbound	0:11:35	0:09:46	0:13:31	0:14:48
Sydney Harbour Bridge to Ben Boyd Road	Northbound	0:06:28	0:04:59	0:06:43	0:05:05
	Southbound	0:06:28	0:05:13	0:06:33	0:05:49
Sydney Harbour Bridge to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:06:43	0:05:40	0:06:42	0:05:38
	Southbound	0:25:33	0:06:35	0:28:17	0:07:12

Table 7-28 Modelled 'Do something' evening peak hour bus travel times – Warringah Freeway and surrounds

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:11:03	0:13:01	0:13:34	0:23:41
	Southbound	0:13:14	0:19:23	0:19:09	0:15:20
Sydney Harbour Bridge to Bay Street (Via North Sydney Station and Pacific Highway)	Northbound	0:07:13	0:08:12	0:09:52	0:11:30
	Southbound	0:09:17	0:15:15	0:13:59	0:19:45
Sydney Harbour Bridge to Ben Boyd Road	Northbound	0:08:27	0:04:43	0:08:36	0:04:45
	Southbound	0:05:52	0:05:36	0:06:51	0:05:10
Sydney Harbour Bridge to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:06:12	0:06:13	0:06:33	0:06:13
	Southbound	0:15:53	0:06:46	0:20:57	0:06:36

A new dedicated southbound bus lane on the Warringah Freeway would extend from Miller Street to Sydney Harbour Bridge, with new bus lanes connecting bus services to this lane from Falcon Street and Mount Street. This would remove direct interaction between buses and general traffic on the approach to the Sydney Harbour Bridge, improving southbound bus operations.

Bus lanes at the Falcon Street interchange would be maintained as part of the diverging diamond configuration.

The project would also relocate existing bus layover facilities on the Warringah Freeway north of Ernest Street to within a widened section of the motorway near Cammeray Golf Course (14 bays and an amenity block for drivers) and on the Cahill Expressway south of High Street (nine bays). Similar layover space would be provided as per the existing arrangement.

As outlined previously in Table 7-26, the northbound bus only lane that operates during the weekday morning peak on Arthur Street would also be removed as part of the project.

7.5.6 Active transport impacts

The project would deliver new or upgraded pedestrian and cycle infrastructure, enhancing pedestrian and cyclist safety, accessibility, and connectivity. This would include:

- A new dedicated cycleway on the eastern side of Warringah Freeway between Miller Street and Ernest Street
- A new shared user path on the southern side of High Street bridge and signalised pedestrian crossings at the upgraded Alfred Street North/High Street intersection
- Replacement of the Ridge Street bridge with a wider structure with dedicated cycle lanes and a pedestrian path
- Replacement of the Falcon Street shared user bridge with a new structure to be constructed prior to the demolition of the existing bridge
- A new shared user bridge, about 10 metres wide, to the north of Ernest Street at Cammeray, to connect the Cammeray Golf Course with ANZAC Park that would provide the same pedestrian and cycle connectivity as the existing shared user path and cycleway on the Ernest Street bridge
- Consolidating pedestrian crossings into a central median shared user path at the Falcon Street interchange as part of the diverging diamond configuration
- Improved pedestrian crossings at the Falcon Street interchange ramp connections and increased pedestrian safety with fencing along the footpath
- Removal of the pedestrian underpass at the eastern side of the Falcon Street Bridge. This underpass would be permanently removed during construction, with users required to travel up to an additional 380 metres, increasing their travel time. However, existing volumes are low and therefore overall impacts would be minor.

7.6 Gore Hill Freeway and Artarmon

7.6.1 Network performance

A summary of future network performance statistics for the Gore Hill Freeway and Artarmon area under the ‘Do something’ scenario is provided in Table 7-29 and Table 7-30. Analysis of the network performance with the project indicates:

- Peak period traffic demand through the Gore Hill Freeway and Artarmon area would increase by three per cent in the morning peak and remain generally unchanged in the evening peak by 2037 with the inclusion of the project
- Average travel speeds through the Gore Hill Freeway and Artarmon area would decrease by up to 25 per cent in the morning peak and 12 per cent in the evening peak. This is a result of potential growth in traffic demand from the Pacific Highway to the Gore Hill Freeway and Warringah Freeway. This demand would exceed the capacity of the eastbound on ramp from the Pacific Highway in the morning peak by 2027, which is currently arranged as a single general traffic lane and a single T2 transit lane
- The capacity restriction of the Pacific Highway eastbound on ramp to Gore Hill Freeway would result in increased queuing on the Pacific Highway, with up to six per cent of the overall demand unable to make their journey within the peak period.

Analysis of network performance measures for the Gore Hill Freeway and Artarmon area indicates that future demand from Pacific Highway to Gore Hill Freeway eastbound would continue to exceed the capacity of this on ramp during peak periods and that the inclusion of the project could exacerbate this issue due to increased demands along the corridor under the ‘Do something’ scenario.

The traffic and transport assessment assumes that all forecast traffic demand will be able to arrive at the desired time and location in the road network defined by the operational traffic model. In other words, this demand would not be restricted by the existing capacity constraints of the broader metropolitan road network to reach the road networks represented by the operational traffic models.

However, it is recognised that growth in traffic demand along the Gore Hill Freeway corridor would be constrained at either end (Lane Cove Tunnel and Warringah Freeway). These broader network constraints would make realisation of the forecast demand unlikely and, in reality, the throughput would be lower than the forecast demand, leading to network performance under the project being more likely to be closer to the ‘Do minimum’ performance than the operational modelling would suggest. Although the forecast level of demand growth in this area is considered unlikely to be realised during peak periods without increases to broader metropolitan network capacity, it is reflected in the assessment results to represent a conservative scenario.

Road integration works associated with the Beaches Link Tunnel could facilitate additional traffic travelling through the corridor at a generally similar or reduced level of delay than under the ‘Do minimum’ scenario as shown in Section 8.6.1. These works could be brought forward and carried out as part of the Western Harbour Tunnel scope to improve traffic conditions under the ‘Do something’ scenario. Consequently, a network conditions monitoring approach is proposed for this area to identify any realised impacts. This would be used to determine if and when the Network Integration works proposed by the Beaches Link project should be delivered by Roads and Maritime to maintain efficient network operations in this area. Although considered unlikely, if the project did materially impact performance in this area during peak periods the conversion of existing T2 lanes could be implemented efficiently over a short duration, supporting the proposed approach.

Table 7-29 Modelled 'Do something' morning peak network performance – Gore Hill Freeway and Artarmon

Network measure	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Network statistics for all vehicles				
Total traffic demand (veh)	31,100	32,500	34,100	35,100
Total VKT through network	79,800	85,700	87,900	89,400
Total vehicle travel time through the network (hours)	1710	2430	2280	3000
Total number of stops	43,100	257,200	113,700	342,900
Average vehicle statistics				
Average vehicle trip length through the network (km)	2.4	2.5	2.4	2.5
Average vehicle trip time through the network (hours)	0:03:08	0:04:14	0:03:48	0:04:56
Average number of stops per trip	1.3	7.5	3.2	9.4
Average trip speed (km/hr)	46.8	35.2	38.5	29.8
Unreleased traffic				
Total unreleased trips	<10	540	530	2370
% of demand unreleased	<1%	2%	1%	6%

Table 7-30 Modelled 'Do something' evening peak network performance – Gore Hill Freeway and Artarmon

Network measure	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Network statistics for all vehicles				
Total traffic demand (veh)	31,100	31,200	34,400	34,100
Total VKT through network	79,400	81,900	85,800	87,100
Total vehicle travel time through the network (hours)	1800	1650	2010	2330
Total number of stops	48,000	39,100	62,400	98,200
Average vehicle statistics				
Average vehicle trip length through the network (km)	2.4	2.5	2.4	2.4
Average vehicle trip time through the network (hours)	0:03:17	0:02:59	0:03:23	0:03:55
Average number of stops per trip	1.5	1.2	1.8	2.8
Average trip speed (km/hr)	44.0	49.7	42.6	37.5
Unreleased traffic				
Total unreleased trips	260	<10	820	800
% of demand unreleased	1%	<1%	2%	2%

7.6.2 General traffic travel times

Modelled future traffic travel times for key routes through the Gore Hill Freeway and Artarmon study area under the 'Do something' scenario are presented in Table 7-31 and Table 7-32. Analysis of the modelled general traffic travel times indicates:

- Eastbound travel times from the Lane Cove Tunnel and Longueville Road to Gore Hill Freeway would increase with the project during the morning peak. This is due to the increased traffic volumes from both Longueville Road and the Pacific Highway to the Gore Hill Freeway. The existing lane arrangements from Longueville Road to Gore Hill Freeway currently force eastbound traffic west of the Lane Cove Tunnel to diverge, with transit lane traffic going to the left and general traffic to the right. This general traffic lane merges with general traffic from Pacific Highway further east, where the combined demand would exceed the capacity of this single lane
- Evening peak eastbound travel times from Longueville Road to Gore Hill Freeway would also increase, although not to the extent of the morning peak
- Travel times for other trips along the Gore Hill Freeway would remain largely unchanged as a result of the project.

Reallocating the existing eastbound capacity at critical network locations by removing the transit lane, would allow excess traffic to rebalance across both lanes from Longueville Road and reduce the forecast delays.

In addition, although eastbound traffic would be impacted by a localised increase in travel times approaching Gore Hill Freeway, modelling of the Warringah Freeway indicates that this traffic would generally benefit from substantial travel time savings on the Warringah Freeway and Sydney Harbour crossings (see Section 7.5). Consequently, traffic impacted on the Gore Hill Freeway is still anticipated to receive a net benefit due to downstream efficiency improvements delivered by the project.

Table 7-31 Modelled 'Do something' morning peak hour general traffic travel times through Gore Hill Freeway and Artarmon

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Longueville Road to Gore Hill Freeway	Eastbound	0:01:28	0:06:24	0:01:24	0:05:33
	Westbound	0:01:24	0:01:26	0:01:28	0:01:28
Lane Cove Tunnel to Gore Hill Freeway via transit lanes	Eastbound	0:01:24	0:01:25	0:01:18	0:01:26
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:18	0:04:42	0:01:24	0:05:55
	Westbound	0:01:17	0:01:18	0:02:16	0:01:18

Table 7-32 Modelled 'Do something' evening peak hour general traffic travel times through Gore Hill Freeway and Artarmon

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Longueville Road to Gore Hill Freeway	Eastbound	0:01:26	0:01:28	0:01:25	0:02:02
	Westbound	0:01:23	0:01:24	0:01:23	0:01:46
Lane Cove Tunnel to Gore Hill Freeway via transit lanes	Eastbound	0:01:20	0:01:20	0:01:20	0:01:20
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:22	0:01:23	0:01:23	0:01:25
	Westbound	0:01:12	0:01:13	0:01:12	0:01:15

7.6.3 Intersection performance

Modelled future performance for key intersections in the Gore Hill Freeway and Artarmon study area under the 'Do something' scenario are presented in Table 7-33 and Table 7-34. Analysis of intersection performance with the project indicates:

- The Longueville Road and Epping Road intersection would operate at capacity during peak periods with signal phasing and timing that would maximise traffic throughput from the motorway and ensure that queues from this location would not substantially impact operation of the Gore Hill Freeway. This would mean that, by 2037, there would still be delays at this location
- The intersection of Longueville Road and Pacific Highway would continue to operate at a poor Level of Service in the evening peak by 2037 when compared with the 'Do minimum' scenario. This is due to the impact of queues approaching Epping Road on the short weave from Pacific Highway to Longueville Road for trips turning right into Parklands Avenue. The difficulty of this movement during peak periods is likely to result in these trips taking alternative routes, for example via Burley Street or Norton Lane. Diversion to alternative routes would result in delays on Longueville Road being lower than indicated by traffic modelling, which does not take into account this diversion
- Modification of the phase arrangements at the Reserve Road interchange would reduce delays at this intersection and improve the operation of adjacent intersections, particularly at the Reserve Road/Barton Road intersection during the morning peak.

Analysis of the modelled intersection performance for the Gore Hill Freeway and Artarmon area shows that the project would result in changes in travel patterns through the area, primarily resulting in potential additional demand on Gore Hill Freeway and Longueville Road/Epping Road. The proposed changes to network operations would facilitate this additional travel without substantially increasing delays at most of the critical intersections on the arterial road network. The one exception is the intersection of Epping Road and Longueville Road, where existing constraints do not allow any scope for intersection optimisation. Some trips impacted by increased flows at this intersection are likely to divert to alternative routes via Pacific Highway. The use of these routes would result in lower intersection delays than those forecast, which do not take account of this diversion.

Table 7-33 Modelled 'Do something' morning peak hour intersection performance in Gore Hill Freeway and Artarmon

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
Epping Road/Longueville Road/Parklands Avenue	52	D	51	D	83	F	63	E
Longueville Road/Pacific Highway	40	C	39	C	54	D	45	D
Pacific Highway/Howarth Road/Norton Lane	20	B	25	B	28	B	27	B
Pacific Highway/Gore Hill Freeway interchange	29	B	40	C	41	C	39	C
Reserve Road/Gore Hill Freeway interchange	61	E	43	C	47	D	53	D
Reserve Road/Dickson Road	14	A	17	B	19	B	19	B
Reserve Road/Barton Road	69	E	10	A	>100	F	>100	F

Table 7-34 Modelled 'Do something' evening peak hour intersection performance in Gore Hill Freeway and Artarmon

Intersection	2027 'Do minimum'		2027 'Do something'		2037 'Do minimum'		2037 'Do something'	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
Epping Road/Longueville Road/Parklands Avenue	80	F	72	F	87	F	97	F
Longueville Road/Pacific Highway	42	C	37	C	49	D	76	F
Pacific Highway/Howarth Road/Norton Lane	13	A	16	B	13	A	24	B
Pacific Highway/Gore Hill Freeway interchange	29	C	22	B	23	B	27	B
Reserve Road/Gore Hill Freeway interchange	55	D	30	C	57	E	53	D
Reserve Road/Dickson Road	73	F	21	B	85	F	39	C
Reserve Road/Barton Road	49	D	7	A	66	E	>100	F

7.6.4 Road network changes and access arrangements

There would be no road network changes within the Gore Hill Freeway and Artarmon study area, other than minor optimisation of existing traffic signal operation. Impacts on the road network are discussed in sections 7.6.1 and 7.6.3 while potential mitigation measures to improve the performance of the road network in the Gore Hill Freeway and Artarmon study area are discussed in Section 9.

7.6.5 Public transport impacts

Modelled future bus travel times for key routes through the Gore Hill Freeway and Artarmon study area under the 'Do something' scenario are presented in Table 7-35 and Table 7-36. Analysis of the modelled bus travel times indicates that there would not be any substantial change in bus delays along Gore Hill Freeway as a result of the project.

Table 7-35 Modelled 'Do something' morning peak hour bus travel times through Gore Hill Freeway and Artarmon

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:26	0:01:27	0:01:26	0:01:27
	Westbound	0:01:18	0:01:17	0:01:26	0:01:18

Table 7-36 Modelled 'Do something' evening peak hour bus travel times through Gore Hill Freeway and Artarmon

Route	Direction	2027 'Do minimum'	2027 'Do something'	2037 'Do minimum'	2037 'Do something'
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:22	0:01:21	0:01:22	0:01:22
	Westbound	0:01:13	0:01:12	0:01:13	0:01:15

7.6.6 Active transport impacts

There would be no direct impacts on the active transport network within the Gore Hill Freeway and Artarmon study area.

7.7 Maritime movements and activities

The project would not result in a reduction in water depth at the proposed Harbour crossing and would therefore have no impact on navigation given the current depth is typically around 15 metres below chart datum at the crossing location.

Moorings impacted during construction would be reinstated. All moorings would be reinstated as close as practical to their current locations.

There would be no operational impacts to maritime movements and activities as a result of the project.

8. Cumulative operational impact assessment

8.1 Overview

The Western Harbour Tunnel has been designed to allow for extension to the proposed Beaches Link and Gore Hill Freeway Connection project, providing a full motorway-standard corridor from Rozelle to Frenchs Forest and Balgowlah.

This section provides an assessment of the impacts of the full Western Harbour Tunnel and Warringah Freeway Upgrade project and the Beaches Link and Gore Hill Freeway Connection project scenario (the 'Do something cumulative' scenario) on the following performance measures:

- Strategic road network performance based on vehicle hours of travel (VHT), vehicle kilometres of travel (VKT) and average network speed
- Intersection performance Level of Service
- General traffic and bus travel times for key corridors.

Strategic traffic modelling of the project indicates that the project combined with the Beaches Link Tunnel would deliver substantial benefits to traffic travelling on the strategic road network, with trips between strategic centres saving up to 22 minutes when travelling across Sydney Harbour from the Northern Beaches during peak periods. These travel time savings would also substantially increase accessibility for these centres, increasing the catchment of residents that can travel to and from their place of work within the '30-minute city' window that is critical to maintaining the vision of a productive city promoted by the Greater Sydney Commission.

Increasing the size of this 30-minute city catchment would not be limited to private vehicles; public transport customers would also benefit substantially from the inclusion of the Beaches Link Tunnel with the project. This cumulative project would further facilitate the operation of express buses that would provide direct access between major centres in the Northern Beaches to the Lower North Shore and Inner West.

The substantial additional travel that would be facilitated by the addition of the Beaches Link Tunnel to the project would also increase traffic demands at either ends of the project where it would integrate with the existing transportation network. There would be some residual delays surrounding these interface precincts. However, the additional delay associated with these precincts would be offset by the large travel time benefits provided by the project and the Beaches Link Tunnel at the strategic network level. This section identifies the key trips that would benefit from the project and the locations where integration works have been identified and incorporated into the design. These integration works have been developed to minimise the impact of additional travel facilitated by the project and ensure that the competing needs of customers (including private vehicles, public transport passengers, cyclists and pedestrians) have been incorporated into a balanced, equitable outcome.

8.2 Metropolitan road network performance

8.2.1 Strategic corridors

A summary of the forecast growth at key locations for the 2027 and 2037 forecast years is provided in Table 8-1 to Table 8-3.

Analysis of the modelled forecast traffic demands across Sydney Harbour under the ‘Do something cumulative’ scenario shows further growth in peak period cross Harbour trips of up to four per cent in both peak periods when compared with the ‘Do something’ scenario in 2037. For the same period, the growth in daily trips is smaller, with a three per cent increase in trips across Sydney Harbour.

Analysis of forecast traffic demands with and without the Beaches Link Tunnel shows:

- Traffic demands in both directions in the Sydney Harbour Tunnel would reduce during both peak periods and over the day
- Traffic demand on the Sydney Harbour Bridge and Gladesville Bridge would not change substantially, indicating that the further modifications to the strategic road network in the ‘Do something cumulative’ scenario would not substantially change regional traffic patterns.

Overall, forecast demands across Sydney Harbour under the ‘Do something cumulative’ scenario show that there would be a small increase in traffic demand across Sydney Harbour and some diversion from the Sydney Harbour Tunnel to the Western Harbour Tunnel as result of changes to travel patterns to and from the Northern Beaches. The majority of trips that would transfer from Sydney Harbour Tunnel to Western Harbour Tunnel would be travelling to and from the Warringah Road and Pittwater Road corridors to Sydney Airport and south Sydney. Trips that currently travel from the Northern Beaches to Sydney Airport and south Sydney would have the option in the future to travel to these destinations via Beaches Link, Western Harbour Tunnel, M4-M5 Link and Sydney Gateway instead of via Sydney Harbour Tunnel, the Eastern Distributor and Southern Cross Drive. Difference plots showing changes in forecast traffic demands across the road network in the study area between the ‘Do minimum’ and ‘Do something cumulative’ scenarios are provided in Appendix B.

Table 8-1 Modelled 'Do something cumulative' morning peak hour traffic demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Sydney Harbour Bridge	Bradfield Highway	Northbound	5500	5500	5450	6000	5800	5800
		Southbound	6050	5600	5650	6600	5950	6000
		Combined	*11,550*	*11,100*	*11,100*	*12,600*	*11,750*	*11,800*
Sydney Harbour Bridge	Cahill Expressway	Southbound	2900	2650	2600	3200	2850	2800
Sydney Harbour Tunnel	Sydney Harbour	Northbound	4200	2900	2300	4450	3300	2950
		Southbound	4100	3950	3900	4350	4200	4200
		Combined	*8300*	*6850*	*6200*	*8800*	*7500*	*7150*
Gladesville Bridge	Parramatta River	Northbound	3800	3750	3750	4150	3950	3950
		Southbound	4050	3800	3700	4300	4050	4000
		Combined	*7850*	*7550*	*7450*	*8450*	*8000*	*7950*
Western Harbour Tunnel	Birchgrove	Northbound	N/A	2650	3600	N/A	3700	4600
		Southbound	N/A	2650	3600	N/A	3500	4550
		Combined	*N/A*	*5300*	7200	*N/A*	*7200*	9150
Sydney Harbour screenline		**Northbound**	**13,500**	**14,800**	**15,100**	**14,600**	**16,750**	**17,300**
		Southbound	**17,100**	**18,650**	**19,450**	**18,450**	**20,550**	**21,550**
		Combined	***30,600***	***33,450***	***34,550***	***33,050***	***37,300***	***38,850***
ANZAC Bridge	Pyrmont	Eastbound	6250	5950	5900	6600	6500	6450
		Westbound	3850	3300	3200	3900	3300	3150
		Combined	*10,100*	*9250*	*9100*	*10,500*	*9800*	*9600*
Western Distributor	Sydney CBD	Northbound	3050	2200	2200	3300	2300	2400
		Southbound	3100	2400	2400	3350	2400	2400
		Combined	*6150*	*4600*	*4600*	*6650*	*4700*	*4800*

Note: Comparing the 'Do something cumulative' scenario with the 'Do something' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Table 8-2 Modelled 'Do something cumulative' evening peak hour traffic demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Sydney Harbour Bridge	Bradfield Highway	Northbound	6650	5450	5350	7200	6250	6200
		Southbound	3450	3500	3500	3750	3700	3700
		Combined	*10,100*	*8950*	*8850*	*10,950*	*9950*	*9900*
Sydney Harbour Bridge	Cahill Expressway	Southbound	2650	2500	2500	2850	2600	2550
Sydney Harbour Tunnel	Sydney Harbour	Northbound	3900	3050	2600	4100	3200	2800
		Southbound	3400	2900	2800	3800	3300	3200
		Combined	*7300*	*5950*	*5400*	*7900*	*6500*	*6000*
Gladesville Bridge	Parramatta River	Northbound	4050	4200	4150	4250	4250	4200
		Southbound	3250	3000	2950	3550	3350	3250
		Combined	*7300*	*7200*	*7100*	*7800*	*7600*	*7450*
Western Harbour Tunnel	Birchgrove	Northbound	N/A	2500	3550	N/A	3050	4200
		Southbound	N/A	1950	2550	N/A	2650	3400
		Combined	*N/A*	*4450*	*6100*	*N/A*	*5700*	*7600*
Sydney Harbour screenline		**Northbound**	**14,600**	**15,200**	**15,650**	**15,550**	**16,750**	**17,400**
		Southbound	**12,750**	**13,850**	**14,300**	**13,950**	**15,600**	**16,100**
		Combined	***27,350***	***29,050***	***29,950***	***29,500***	***32,350***	***33,500***
ANZAC Bridge	Pyrmont	Eastbound	5300	4600	4500	5450	4800	4700
		Westbound	5850	5650	5750	6200	5850	6000
		Combined	*11,150*	*10,250*	*10,250*	*11,650*	*10,650*	*10,700*
Western Distributor	Sydney CBD	Northbound	3750	2100	2050	4000	2300	2350
		Southbound	2150	1950	1900	2300	2000	1950
		Combined	*5900*	*4050*	*3950*	*6300*	*4300*	*4300*

Note: Comparing the 'Do something cumulative' scenario with the 'Do something' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Table 8-3 Modelled ‘Do something cumulative’ daily traffic demands at key locations (SMPM)

Road	Location	Direction	2027 ‘Do minimum’	2027 ‘Do something’	2027 ‘Do something cumulative’	2037 ‘Do minimum’	2037 ‘Do something’	2037 ‘Do something cumulative’
Sydney Harbour Bridge	Bradfield Highway	Northbound	101,500	77,500	76,000	110,000	86,500	86,000
		Southbound	58,000	54,000	54,500	62,500	58,000	59,000
		Combined	*159,500*	*131,500*	*130,500*	*172,500*	*144,500*	*145,000*
Sydney Harbour Bridge	Cahill Expressway	Southbound	44,000	36,000	35,500	48,000	39,000	38,500
Sydney Harbour Tunnel	Sydney Harbour	Northbound	56,000	42,000	34,000	60,500	45,000	37,500
		Southbound	55,000	46,500	43,000	60,000	51,000	48,000
		Combined	*111,000*	*88,500*	*77,000*	*120,500*	*96,000*	*85,500*
Gladesville Bridge	Parramatta River	Northbound	62,000	65,500	65,500	65,500	67,000	66,500
		Southbound	51,000	48,500	48,000	53,500	51,000	50,500
		Combined	*113,000*	*114,000*	*113,500*	*119,000*	*118,000*	*117,000*
Western Harbour Tunnel	Birchgrove	Northbound	N/A	37,000	49,000	N/A	45,000	58,500
		Southbound	N/A	30,000	38,000	N/A	38,000	48,000
		Combined	*N/A*	*67,000*	*87,000*	*N/A*	*83,000*	*106,500*
Sydney Harbour screenline		**Northbound**	**219,500**	**222,000**	**224,500**	**236,000**	**243,500**	**248,500**
		Southbound	**208,000**	**215,000**	**219,000**	**224,000**	**237,000**	**244,000**
		Combined	***427,500***	***437,000***	***443,500***	***460,000***	***480,500***	***492,500***
ANZAC Bridge	Pyrmont	Eastbound	91,500	81,000	80,500	95,500	85,500	84,500
		Westbound	84,500	79,000	79,000	89,500	82,000	82,000
		Combined	*176,000*	*160,000*	*159,500*	*185,000*	*167,500*	*166,500*
Western Distributor	Sydney CBD	Northbound	60,000	32,500	32,000	64,000	36,500	36,000
		Southbound	49,000	35,500	35,000	53,500	38,000	37,500
		Combined	*109,000*	*68,000*	*67,000*	*117,500*	*74,500*	*73,500*

Note: Comparing the ‘Do something cumulative’ scenario with the ‘Do something’ scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

A summary of forecast travel times during peak periods for key routes in the vicinity of the project are provided in Figure 8-1 and Figure 8-2.

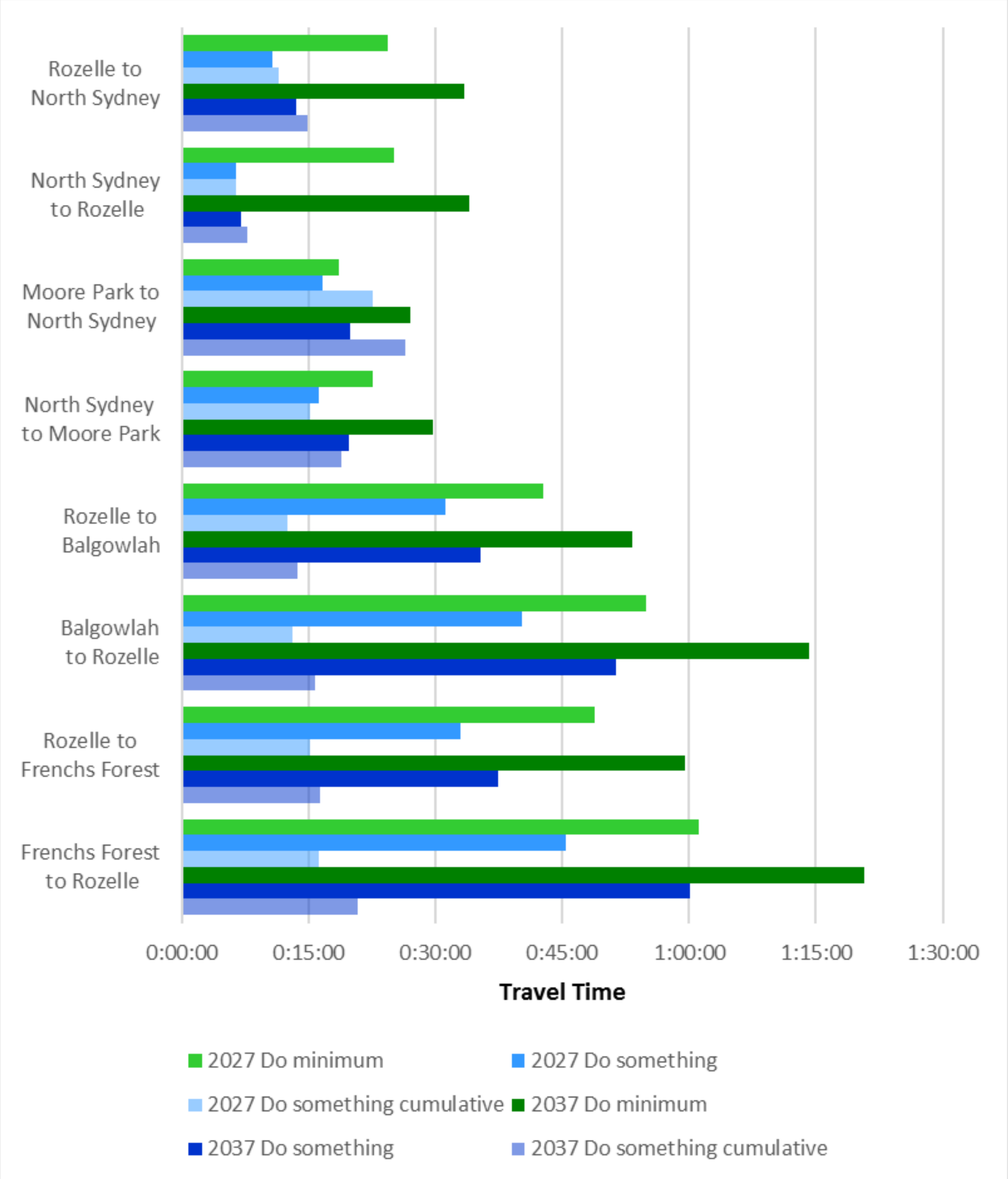


Figure 8-1 Modelled 'Do minimum', 'Do something' and 'Do something cumulative' morning peak hour travel times along key corridors (SMPM)

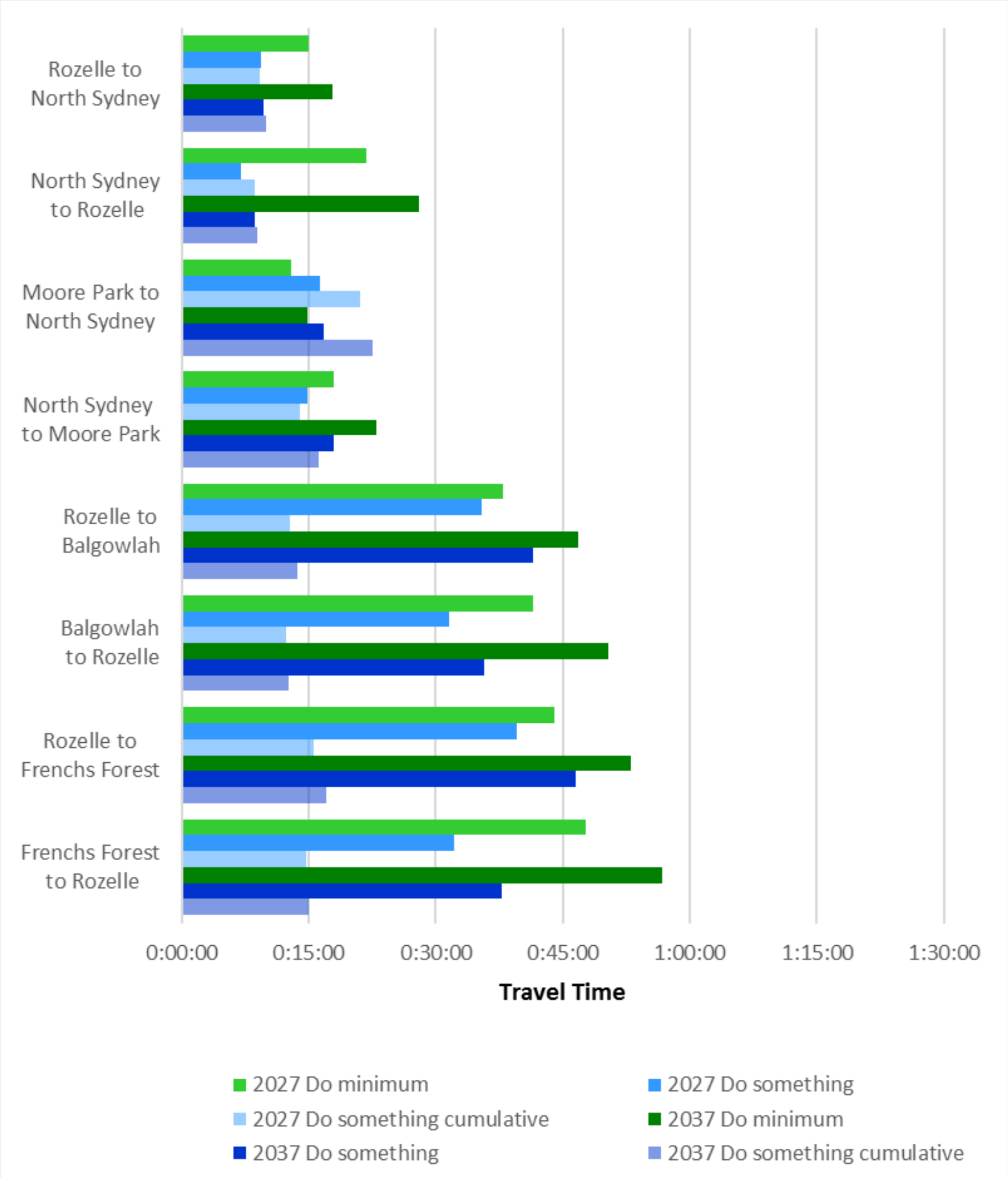


Figure 8-2 Modelled 'Do minimum', 'Do something' and 'Do something cumulative' evening peak hour travel times along key corridors (SMPM)

Analysis of the modelled forecast travel times along key routes in the vicinity of the Western Harbour Tunnel shows that travel time reductions as a result of the 'Do something cumulative' scenarios are generally a consequence of reduced travel time for trips that would have the option to use the Beaches Link Tunnel. The additional forecast traffic in the Western Harbour Tunnel would not materially increase travel time via Western Harbour Tunnel, indicating that there would be sufficient capacity to maintain efficient performance.

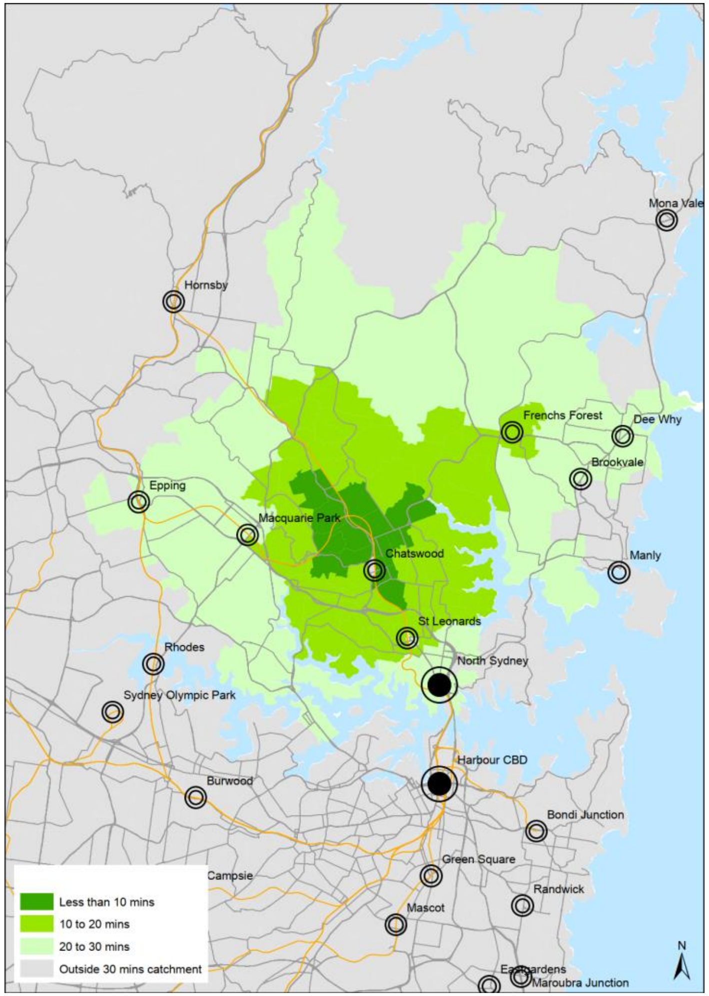
8.2.2 30-minute city catchments

Plots of the forecast 30-minute catchments by road for strategic centres in the vicinity of the project are provided in Figure 8-3 to Figure 8-5.

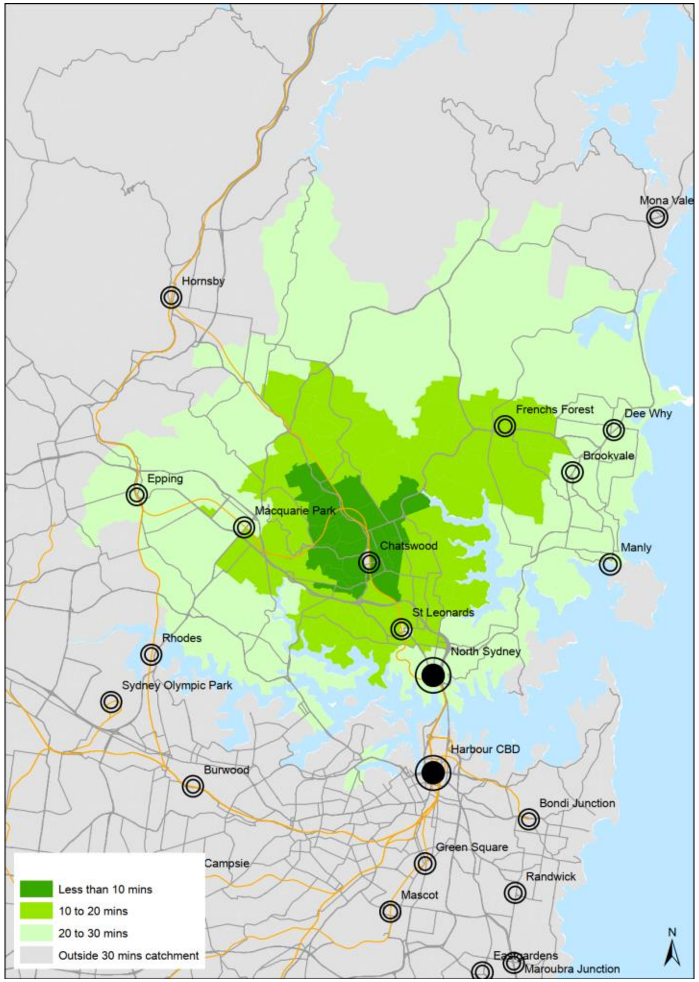
Analysis of the 30-minute catchments for the ‘Do something cumulative’ scenario shows:

- Access from Chatswood would improve as a result of faster access to Frenchs Forest provided by the Beaches Link Tunnel
- Accessibility from North Sydney would increase substantially with accessibility to Frenchs Forest, Brookvale and Manly falling within 30 minutes due to reduced travel times created by Beaches Link Tunnel
- Access to Sydney CBD would remain largely unchanged.

Overall, inclusion of the Beaches Link Tunnel in the ‘Do something cumulative’ scenario would not negatively impact the 30-minute catchments for trips using Western Harbour Tunnel. The ‘Do something cumulative’ scenario would further improve accessibility from North Sydney to the Northern Beaches but would have limited to no impact on accessibility to the Sydney CBD for centres on the Lower North Shore, demonstrating that accessibility for the Lower North Shore would not be adversely affected as a consequence of additional traffic in the corridor from the Beaches Link Tunnel. This reduction in road-based travel times would also result in reduced travel times for public transport and would increase the size of equivalent public transport catchments, particularly if express buses operate through both Beaches Link Tunnel and Western Harbour Tunnel, substantially increasing the catchment size for centres north of Sydney Harbour.

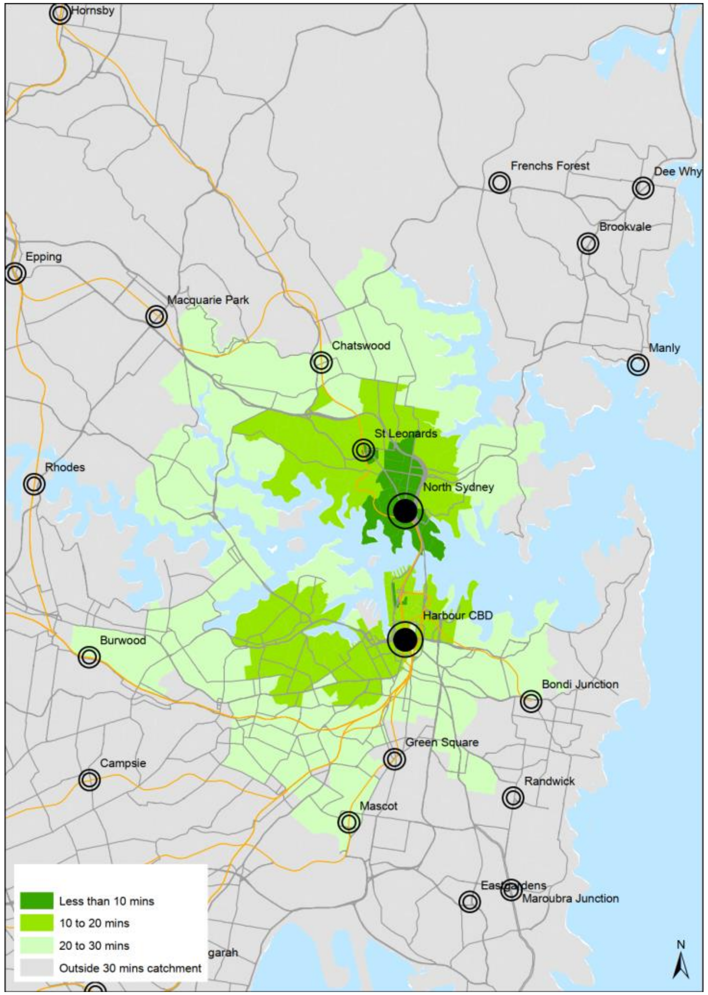


2037 'Do something'

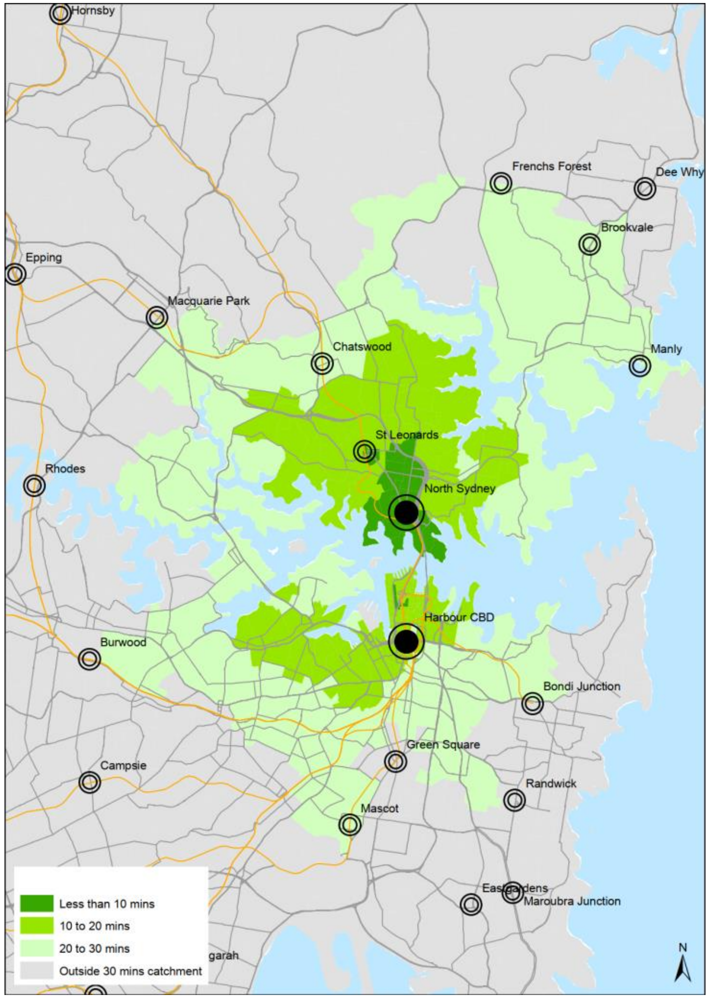


2037 'Do something cumulative'

Figure 8-3 Modelled 2037 'Do something' and 'Do something cumulative' morning peak 30-minute catchments by road from Chatswood (SMPM)

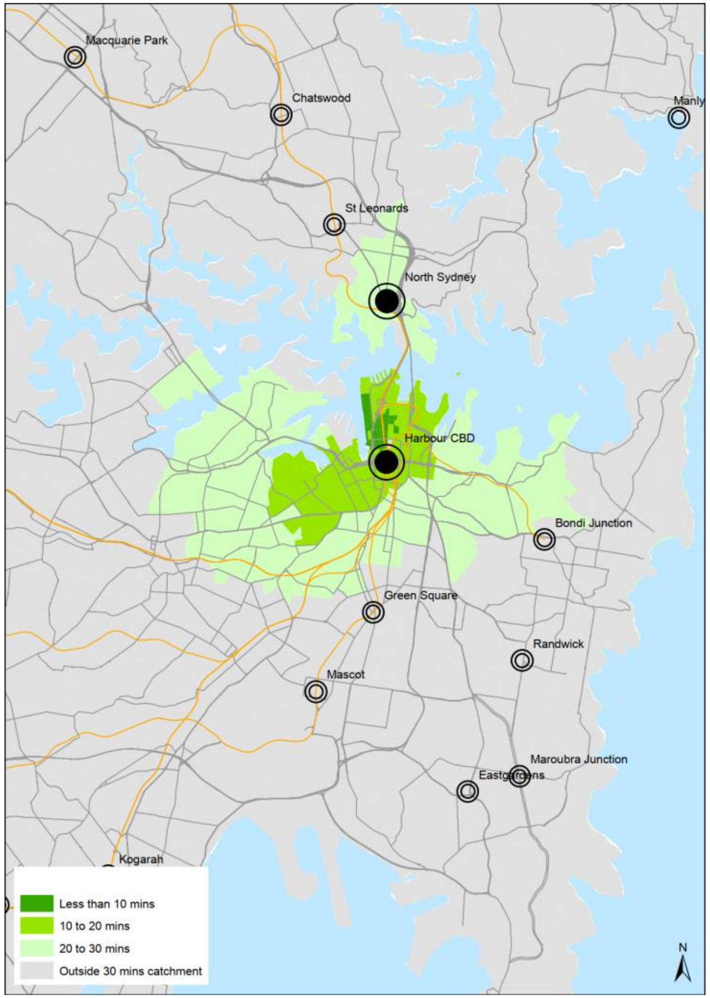


2037 'Do something'

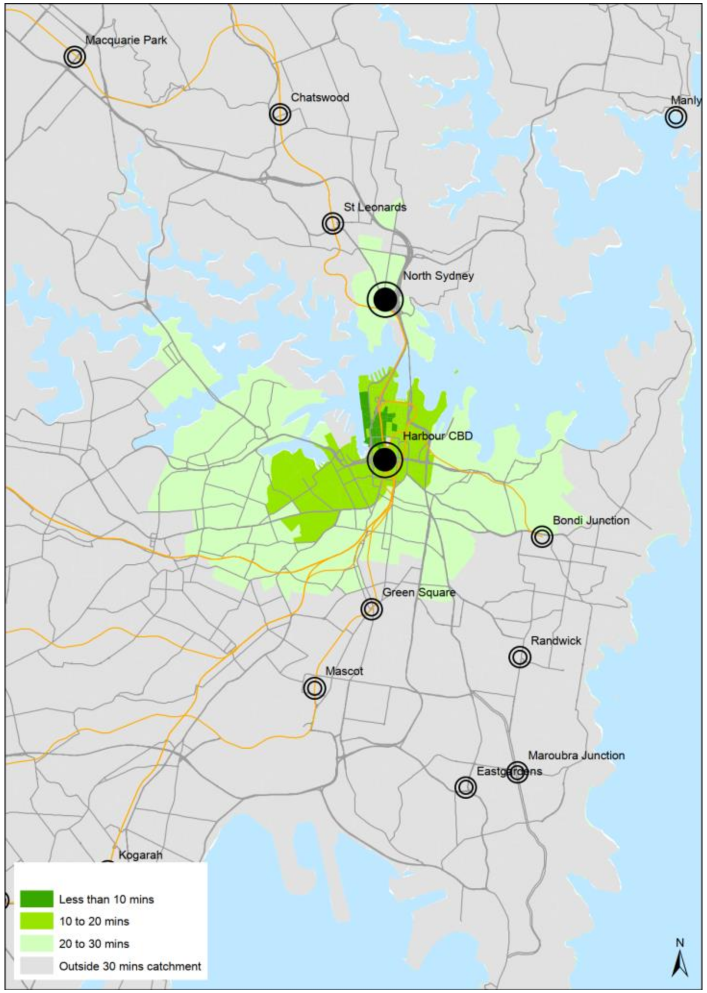


2037 'Do something cumulative'

Figure 8-4 Modelled 2037 'Do something' and 'Do something cumulative' morning peak 30-minute catchments by road from North Sydney



2037 'Do something'



2037 'Do something cumulative'

Figure 8-5 Modelled 2037 'Do something' and 'Do something cumulative' morning peak 30-minute catchments by road from Sydney CBD

8.2.3 Heavy vehicle movements

A summary of the forecast heavy vehicle demands at key crossing points across Sydney Harbour under the 'Do something cumulative' scenario for the 2027 and 2037 forecast years is provided in Table 8-4 to Table 8-6.

Analysis of the modelled forecast heavy vehicle demands across Sydney Harbour under the 'Do something cumulative' scenario in 2037 shows:

- Peak period heavy vehicle volumes across Sydney Harbour would increase by up to four per cent when compared to the 'Do something' scenario
- Daily heavy vehicle demands across Sydney Harbour would increase by two per cent when compared to the 'Do something' scenario
- Heavy vehicle demand in the Sydney Harbour Tunnel would decrease by up to 40 per cent, during both peak periods and over the day, when compared with the 'Do something' scenario. This is a result of the changes to the access to Western Harbour Tunnel from the Warringah Road and Pittwater Road corridors, which would be able to directly access Western Harbour Tunnel via Beaches Link Tunnel under the 'Do something cumulative' scenario.

Overall, the 'Do something cumulative' scenario would result in minimal changes to total heavy vehicle movements across Sydney Harbour, with the primary change being a switch from the Sydney Harbour Tunnel to the Western Harbour Tunnel as a result of direct access being provided between Western Harbour Tunnel and Beaches Link.

Table 8-4 Modelled 'Do something cumulative' morning peak hour heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Sydney Harbour Bridge	Bradfield Highway	Northbound	210	110	120	240	110	130
		Southbound	190	100	80	200	90	80
		Combined	*400*	*210*	*200*	*440*	*200*	*210*
Sydney Harbour Bridge	Cahill Expressway	Southbound	20	30	40	20	30	50
Sydney Harbour Tunnel	Sydney Harbour	Northbound	170	140	100	190	160	120
		Southbound	180	130	80	210	140	80
		Combined	*350*	*270*	*180*	*400*	*300*	*200*
Gladesville Bridge	Parramatta River	Northbound	180	100	90	230	120	120
		Southbound	250	190	180	300	210	200
		Combined	*430*	*290*	*270*	*530*	*330*	*320*
Western Harbour Tunnel	Birchgrove	Northbound	N/A	310	350	N/A	400	440
		Southbound	N/A	260	350	N/A	340	430
		Combined	*N/A*	*570*	*700*	*N/A*	*740*	*870*
Sydney Harbour screenline		**Northbound**	**560**	**660**	**660**	**660**	**790**	**810**
		Southbound	**640**	**710**	**730**	**730**	**810**	**840**
		Combined	***1200***	***1370***	***1390***	***1390***	***1600***	***1650***
ANZAC Bridge	Pyrmont	Eastbound	320	250	240	370	300	280
		Westbound	250	150	150	260	160	160
		Combined	*570*	*400*	*390*	*630*	*460*	*440*
Western Distributor	Sydney CBD	Northbound	180	70	60	200	60	70
		Southbound	170	80	60	170	60	60
		Combined	*350*	*150*	*120*	*370*	*120*	*130*

Note: Comparing the 'Do something cumulative' scenario with the 'Do something' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Table 8-5 Modelled 'Do something cumulative' evening peak hour heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Sydney Harbour Bridge	Bradfield Highway	Northbound	320	240	240	360	270	270
		Southbound	140	80	80	140	90	80
		Combined	*460*	*320*	*320*	*500*	*360*	*350*
Sydney Harbour Bridge	Cahill Expressway	Southbound	10	10	10	10	10	20
Sydney Harbour Tunnel	Sydney Harbour	Northbound	150	120	70	170	130	80
		Southbound	150	110	70	170	120	70
		Combined	*300*	*230*	*140*	*340*	*250*	*150*
Gladesville Bridge	Parramatta River	Northbound	90	60	60	110	70	70
		Southbound	200	120	110	270	150	140
		Combined	*290*	*180*	*170*	*380*	*220*	*210*
Western Harbour Tunnel	Birchgrove	Northbound	N/A	180	240	N/A	220	290
		Southbound	N/A	220	290	N/A	310	400
		Combined	*N/A*	*400*	*530*	*N/A*	*530*	*690*
Sydney Harbour screenline		**Northbound**	**560**	**600**	**610**	**640**	**690**	**710**
		Southbound	**500**	**540**	**560**	**590**	**680**	**710**
		Combined	***1060***	***1140***	***1170***	***1230***	***1370***	***1420***
ANZAC Bridge	Pyrmont	Eastbound	220	160	130	250	180	150
		Westbound	220	160	160	240	180	180
		Combined	*440*	*320*	*290*	*490*	*360*	*330*
Western Distributor	Sydney CBD	Northbound	250	150	120	280	160	130
		Southbound	120	70	70	130	70	60
		Combined	*370*	*220*	*190*	*410*	*230*	*190*

Note: Comparing the 'Do something cumulative' scenario with the 'Do something' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

Table 8-6 Modelled 'Do something cumulative' daily heavy vehicle demands at key locations (SMPM)

Road	Location	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Sydney Harbour Bridge	Bradfield Highway	Northbound	5300	3300	3400	5900	3600	3900
		Southbound	2500	1700	1300	2700	1700	1400
		Combined	*7800*	*5000*	*4700*	*8600*	*5300*	*5300*
Sydney Harbour Bridge	Cahill Expressway	Southbound	800	300	500	900	400	500
Sydney Harbour Tunnel	Sydney Harbour	Northbound	2500	2000	1200	2900	2300	1400
		Southbound	2400	1700	1200	2800	2100	1400
		Combined	*4900*	*3700*	*2400*	*5700*	*4400*	*2800*
Gladesville Bridge	Parramatta River	Northbound	1900	1400	1400	2300	1600	1600
		Southbound	2700	2100	2000	3500	2500	2300
		Combined	*4600*	*3500*	*3400*	*5800*	*4100*	*3900*
Western Harbour Tunnel	Birchgrove	Northbound	N/A	3800	4500	N/A	4600	5400
		Southbound	N/A	3300	4500	N/A	4200	5600
		Combined	*N/A*	*7100*	*9000*	*N/A*	*8800*	*11,000*
Sydney Harbour screenline		**Northbound**	**9700**	**10,500**	**10,500**	**11,100**	**12,100**	**12,300**
		Southbound	**8400**	**9100**	**9500**	**9900**	**10,900**	**11,200**
		Combined	***18,100***	***19,600***	***20,000***	***21,000***	***23,000***	***23,500***
ANZAC Bridge	Pyrmont	Eastbound	4900	3400	3100	5600	3800	3500
		Westbound	4900	3500	3200	5300	4000	3600
		Combined	*9800*	*6900*	*6300*	*10,900*	*7800*	*7100*
Western Distributor	Sydney CBD	Northbound	4300	2000	1900	4800	2200	2100
		Southbound	3000	1600	1200	3200	1600	1300
		Combined	*7300*	*3600*	*3100*	*8000*	*3800*	*3400*

Note: Comparing the 'Do something cumulative' scenario with the 'Do something' scenario, a reduction in demand greater than 10 per cent is highlighted in green while an increase in demand greater than 10 per cent is highlighted in blue.

8.2.4 Strategic model road network performance

A summary of the forecast daily VKT and VHT of the Sydney region and the Western Harbour Tunnel and Beaches Link operational road traffic model area under the 'Do something cumulative' scenario for the 2027 and 2037 forecast years is provided in Table 8-7.

Analysis of the forecast daily VKT and VHT under the 'Do something cumulative' scenario shows that:

- The addition of Beaches Link would further improve network productivity due to an increase in motorway daily VKT
- Motorway daily VHT would also increase and is the consequence of more trips being undertaken on the motorway network due to improved connectivity
- Traffic would shift from the arterial (non-motorway) roads to the project (motorway) as evident in the reduction in daily VHT and VKT on the non-motorway road network.

Table 8-7 Modelled 'Do something cumulative' daily VKT and VHT (SMPM)

Network measure	Road	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Sydney region							
Daily VKT	Motorway	27,135,000	27,399,000	28,614,000	31,810,000	32,170,000	34,186,000
	Other	87,592,000	87,570,000	86,794,000	103,604,000	103,601,000	102,416,000
	Total	114,727,000	114,969,000	115,408,000	135,414,000	135,772,000	136,602,000
Daily VHT	Motorway	513,000	501,000	509,000	758,000	737,000	753,000
	Other	3,248,000	3,244,000	3,193,000	5,174,000	5,167,000	5,065,000
	Total	3,761,000	3,745,000	3,702,000	5,931,000	5,904,000	5,819,000
Western Harbour Tunnel and Beaches Link study area							
Daily VKT	Motorway	6,377,000	6,623,000	7,711,000	6,891,000	7,253,000	8,605,000
	Other	15,315,000	15,286,000	14,673,000	16,654,000	16,656,000	16,027,000
	Total	21,693,000	21,909,000	22,384,000	23,545,000	23,909,000	24,632,000
Daily VHT	Motorway	149,000	136,000	142,000	187,000	165,000	173,000
	Other	656,000	655,000	616,000	774,000	773,000	718,000
	Total	805,000	791,000	758,000	961,000	938,000	890,000

8.2.5 Impacts on road safety

The impact of the 'Do something cumulative' scenario on road safety within the vicinity of the Western Harbour Tunnel would be minimal, and generally a consequence of changes in the traffic patterns along the Warringah Freeway introduced with the Beaches Link Tunnel. The transfer of traffic from Sydney Harbour Tunnel to Western Harbour Tunnel created by Beaches Link would reduce the volumes of traffic on arterial roads along the Spit Road and Warringah Road corridors, reducing the potential for crashes as these trips transfer to a higher standard motorway.

8.3 Western Harbour Tunnel

8.3.1 Midblock Level of Service

A summary of midblock performance of the Western Harbour Tunnel main-line at various locations along the tunnel is provided in Table 8-8 and Table 8-9. The analysis indicates that under the 'Do something cumulative' scenario the tunnel would perform adequately under the forecast volumes. The main tunnel carriageway would be approaching capacity during the morning peak, performing at LoS E. Although this exceeds the desired target of LoS D, the forecast density is only marginally above the threshold for LoS E and forecast travel speeds are anticipated to be maintained over 70km/h.

Table 8-8 Modelled 'Do something cumulative' morning peak hour tunnel performance

Segment	Direction	Min no. of lanes	2027 'Do something'		2027 'Do something cumulative'		2037 'Do something'		2037 'Do something cumulative'	
			Density (PCU/km/lane)	Level of Service	Density (PCU/km/lane)	Level of Service	Density (PCU/km/lane)	Level of Service	Density (PCU/km/lane)	Level of Service
Western Harbour Tunnel (main carriageway)	Northbound	3	14.2	C	18.8	D	19.6	D	24.3	E
	Southbound	3	14.0	C	19.3	D	19.0	D	24.5	E
Rozelle on ramp	Northbound	1	13.5	C	12.5	C	20.2	D	17.0	D
Rozelle off ramp	Southbound	2	11.1	C	13.3	C	17.3	D	19.1	D
M4-M5 Link on ramp	Northbound	3	10.0	C	14.7	C	13.7	C	18.8	D
M4-M5 Link off ramp	Southbound	3	6.5	B	12.7	B	10.4	B	15.2	C
North Sydney on ramp	Southbound	2	10.2	B	12.1	B	15.1	C	15.5	C
North Sydney off ramp	Northbound	2	9.9	C	14.8	C	15.3	C	18.1	C

Table 8-9 Modelled 'Do something cumulative' evening peak hour tunnel performance

Segment	Direction	Min no. of lanes	2027 'Do something'		2027 'Do something cumulative'		2037 'Do something'		2037 'Do something cumulative'	
			Density (PCU/km /lane)	Level of Service	Density (PCU/km /lane)	Level of Service	Density (PCU/km /lane)	Level of Service	Density (PCU/km /lane)	Level of Service
Western Harbour Tunnel (main carriageway)	Northbound	3	12.0	C	17.5	D	14.3	C	21.1	D
	Southbound	3	10.1	B	13.5	C	14.0	C	18.5	D
Rozelle on ramp	Northbound	1	10.0	B	11.4	C	13.2	C	15.6	C
Rozelle off ramp	Southbound	2	5.3	A	6.1	A	7.6	B	8.8	B
M4-M5 Link on ramp	Northbound	3	8.7	B	14.0	C	10.1	B	16.4	D
M4-M5 Link off ramp	Southbound	3	7.9	B	11.0	B	10.9	B	15.0	C
North Sydney on ramp	Southbound	2	10.8	B	13.1	B	13.5	C	16.4	C
North Sydney off ramp	Northbound	2	8.7	B	10.0	A	11.3	B	13.2	B

8.4 Rozelle and surrounds

8.4.1 Network performance

A summary of future network performance statistics for the Rozelle area under the ‘Do something cumulative’ scenario is provided in Table 8-10 and Table 8-11. Analysis of the network performance indicates that, when compared to the ‘Do something’ scenario:

- Forecast travel demand would increase by up to eight per cent
- Average travel speeds would remain relatively unaffected
- The number of stops would not change materially in the morning peak but increase in the evening peak.

Overall, the introduction of the Beaches Link Tunnel would result in higher traffic volumes through the Rozelle area. In the morning peak, the introduction of the Beaches Link Tunnel would reduce the traffic volumes travelling via Sydney Harbour Bridge, with this traffic travelling to Western Harbour Tunnel instead, reducing overall delays by reducing congestion on ANZAC Bridge and Western Distributor.

During the evening peak, the transfer of vehicles from the Western Distributor and ANZAC Bridge would result in increased traffic exiting Western Harbour Tunnel at The Crescent, which would increase localised delays at this intersection.

Table 8-10 Modelled 'Do something cumulative' morning peak network performance – Rozelle and surrounds

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Network statistics for all vehicles						
Total traffic demand (veh)	53,200	59,000	63,500	58,400	66,600	71,800
Total VKT through network	146,200	208,200	229,500	150,600	231,400	254,300
Total vehicle travel time through the network (hours)	7630	7170	7430	8190	7820	8140
Total vehicles entering the network	48,600	57,400	60,000	47,300	60,400	62,800
Total number of stops	543,700	321,100	322,400	600,900	351,500	354,300
Average vehicle statistics						
Average vehicle trip length through the network (km)	3.0	3.6	3.8	3.2	3.8	4.0
Average vehicle trip time through the network (hours)	0:09:24	0:07:30	0:07:26	0:10:23	0:07:46	0:07:46
Average number of stops per trip	11.2	5.6	5.4	12.7	5.8	5.6
Average trip speed (km/hr)	19.2	29.0	30.9	18.4	29.6	31.2
Unreleased traffic						
Total unreleased trips	8150	5690	6930	12,310	9100	11,110
% of demand unreleased	13%	8%	9%	17%	12%	13%

Table 8-11 Modelled 'Do something cumulative' evening peak network performance – Rozelle and surrounds

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Network statistics for all vehicles						
Total traffic demand (veh)	55,400	59,500	63,800	60,500	66,500	71,800
Total VKT through network	168,800	213,300	237,500	173,400	235,200	260,900
Total vehicle travel time through the network (hours)	4480	4750	5310	4990	5510	6440
Total vehicles entering the network	53,900	60,600	65,200	53,300	64,900	67,700
Total number of stops	142,700	98,300	111,800	167,600	131,100	180,300
Average vehicle statistics						
Average vehicle trip length through the network (km)	3.1	3.5	3.6	3.3	3.6	3.9
Average vehicle trip time through the network (hours)	0:04:59	0:04:42	0:04:53	0:05:37	0:05:06	0:05:42
Average number of stops per trip	2.6	1.6	1.7	3.1	2.0	2.7
Average trip speed (km/hr)	37.6	44.9	44.7	34.7	42.7	40.5
Unreleased traffic						
Total unreleased trips	8450	5370	5490	13,550	7490	9660
% of demand unreleased	13%	8%	7%	18%	10%	11%

8.4.2 General traffic travel times

Modelled general traffic travel times for key routes through the Rozelle and surrounds study area under the ‘Do something cumulative’ scenario are provided in Table 8-12 and Table 8-13. Modelled general traffic travel times indicate that there would be minimal change in travel times along the main routes of City West Link/Western Distributor and Victoria Road. This is a result of traffic signals along these routes being optimised to maintain flows along the primary arterial roads.

Table 8-12 Modelled ‘Do something cumulative’ morning peak hour general traffic travel times – Rozelle and surrounds

Route	Direction	2027 ‘Do minimum’	2027 ‘Do something’	2027 ‘Do something cumulative’	2037 ‘Do minimum’	2037 ‘Do something’	2037 ‘Do something cumulative’
City West Link and Western Distributor (Balmain Road to Druitt Street Ramp)	Eastbound	0:21:59	0:12:03	0:12:21	0:21:33	0:14:28	0:13:09
	Westbound	0:04:59	0:05:31	0:04:03	0:05:29	0:05:47	0:05:46
Victoria Road (Evans Street to ANZAC Bridge)	Northbound	0:02:15	0:07:08	0:04:32	0:02:18	0:07:04	0:06:27
	Southbound	0:05:38	0:01:57	0:01:49	0:05:58	0:01:48	0:01:44

Table 8-13 Modelled ‘Do something cumulative’ evening peak hour general traffic travel times – Rozelle and surrounds

Route	Direction	2027 ‘Do minimum’	2027 ‘Do something’	2027 ‘Do something cumulative’	2037 ‘Do minimum’	2037 ‘Do something’	2037 ‘Do something cumulative’
City West Link and Western Distributor (Balmain Road to Druitt Street Ramp)	Eastbound	0:05:14	0:06:28	0:06:36	0:05:01	0:07:06	0:06:43
	Westbound	0:06:04	0:07:06	0:06:50	0:06:57	0:07:29	0:07:30
Victoria Road (Evans Street to ANZAC Bridge)	Northbound	0:02:57	0:02:54	0:02:53	0:03:02	0:03:02	0:03:03
	Southbound	0:02:00	0:01:59	0:02:02	0:02:07	0:02:07	0:02:08

8.4.3 Intersection performance

Modelled future performance for key intersections in the Rozelle and surrounds study area under the ‘Do something cumulative’ scenario are presented in Table 8-14 and Table 8-15. Analysis of intersection performance under the ‘Do something cumulative’ scenario indicates that during the evening peak, the increased traffic volumes exiting Western Harbour Tunnel at The Crescent would increase demand at intersections along The Crescent and City West Link, many of which would continue to operate at relatively poor Levels of Service. These increased traffic volumes would be managed via changes to intersection traffic signal timings.

Overall, the operation of intersections in the morning peak would be satisfactory. During the evening peak, some intersections would continue to operate at poor Levels of Service. However, these intersections would still facilitate an overall improvement to traffic flows through the area.

Although traffic could be impacted by an increase in localised intersection delays due to increased traffic, strategic modelling indicates that road users would still generally benefit from improved network capacity and substantial travel time savings on the broader network (via the Western Harbour Tunnel, ANZAC Bridge, and Sydney Harbour Bridge). Consequently, road users who travel through the Rozelle area would still benefit from the Beaches Link Tunnel due to increased connectivity to the area and improved efficiency on the surrounding strategic road network.

Table 8-14 Modelled 'Do something cumulative' morning peak hour intersection performance – Rozelle and surrounds

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Victoria Road/Darling Street	>100	F	>100	F	>100	F	>100	F	83	F	65	E
Victoria Road/Evans Street	33	C	33	C	33	C	35	C	33	C	32	C
Victoria Road/Gordon Street	27	B	27	B	27	B	27	B	26	B	25	B
Victoria Road/Robert Street	23	B	21	B	21	B	27	B	29	C	28	B
Victoria Road/The Crescent	28	B	24	B	24	B	55	D	39	C	47	D
The Crescent/James Craig Road	29	C	9	A	9	A	36	C	17	B	23	B
The Crescent/City West Link	43	D	46	D	50	D	47	D	46	D	52	D
The Crescent/Johnston Street	>100	F	17	B	17	B	>100	F	20	B	28	B
City West Link/Catherine Street	30	C	25	B	25	B	34	C	24	B	29	C
City West Link/Balmain Road	55	D	49	D	47	D	79	F	53	D	56	D
City West Link/M5 ramps	38	C	24	B	31	C	51	D	25	B	35	C

Table 8-15 Modelled 'Do something cumulative' evening peak hour intersection performance – Rozelle and surrounds

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Victoria Road/Darling Street	57	E	50	D	51	D	62	E	54	D	58	E
Victoria Road/Evans Street	19	B	19	B	20	B	58	E	32	C	43	D
Victoria Road/Gordon Street	16	B	16	B	16	B	49	D	37	C	49	D
Victoria Road/Robert Street	28	B	27	B	28	B	87	F	75	F	91	F
Victoria Road/The Crescent	19	B	27	B	28	B	37	C	47	D	49	D
The Crescent/James Craig Road	13	A	16	B	16	B	28	B	34	C	42	C
The Crescent/City West Link	22	B	41	C	46	D	22	B	42	C	58	E
The Crescent/Johnston Street	56	D	19	B	>100	F	56	D	19	B	>100	F
City West Link/Catherine Street	33	C	41	C	38	C	24	B	43	D	50	D
City West Link/Balmain Road	41	C	41	C	46	D	46	D	59	E	80	F
City West Link/M5 ramps	20	B	28	B	30	C	20	B	30	C	49	D

8.4.4 Road network changes and access arrangements

There would be no additional road network changes between the ‘Do something’ and ‘Do something cumulative’ scenarios.

8.4.5 Public transport impacts

Modelled future bus travel times for key routes through the Rozelle and surrounds study area under the ‘Do something cumulative’ scenario are presented in Table 8-16 and Table 8-17. Analysis of modelled bus travel times under the ‘Do something cumulative’ scenario indicates that bus travel times would not change substantially as a result of the introduction of the proposed Beaches Link Tunnel.

Table 8-16 Modelled ‘Do something cumulative’ morning peak hour bus travel times – Rozelle and surrounds

Route	Direction	2027 ‘Do minimum’	2027 ‘Do something’	2027 ‘Do something cumulative’	2037 ‘Do minimum’	2037 ‘Do something’	2037 ‘Do something cumulative’
Victoria Road (Evans Street to ANZAC Bridge)	Northbound	0:01:50	0:11:50	0:07:51	0:03:47	0:12:02	0:11:09
	Southbound	0:06:00	0:02:41	0:02:33	0:04:27	0:02:40	0:02:34

Table 8-17 Modelled ‘Do something cumulative’ evening peak hour bus travel times – Rozelle and surrounds

Route	Direction	2027 ‘Do minimum’	2027 ‘Do something’	2027 ‘Do something cumulative’	2037 ‘Do minimum’	2037 ‘Do something’	2037 ‘Do something cumulative’
Victoria Road (Evans Street to ANZAC Bridge)	Northbound	0:02:43	0:04:10	0:04:10	0:04:18	0:04:19	0:04:22
	Southbound	0:01:57	0:02:21	0:02:23	0:02:31	0:02:29	0:02:30

8.4.6 Active transport impacts

There would be no additional impacts on the active transport network with the introduction of the Beaches Link Tunnel.

8.5 Warringah Freeway and surrounds

8.5.1 Network performance

A summary of network performance statistics for the Warringah Freeway and surrounds study area under the ‘Do something cumulative’ scenario is provided in Table 8-18 and Table 8-19. Analysis of the modelled network statistics shows that, compared to the ‘Do something’ scenario:

- Peak period travel demand through the Warringah Freeway and surrounds study area would increase by up to four per cent by 2037 under the cumulative scenario
- Average travel speeds through the Warringah Freeway and surrounds study area would improve in both morning and evening peak periods
- The number of stops during peak periods would be maintained in the morning peak but decrease in the evening peak.

Network statistics for the Warringah Freeway and surrounds study area show that the introduction of the Beaches Link Tunnel and associated network changes would not impact overall network performance. Changes to connectivity associated with the Beaches Link Tunnel would result in the following localised effects:

- Peak northbound traffic in the evening peak would benefit from the improved capacity provided by the proposed Beaches Link, which would provide an alternative route to existing congested corridors including Military Road
- Beaches Link Tunnel to Western Harbour Tunnel: This connection would provide an alternative to traffic travelling from the Warringah Road and Pittwater Road/Spit Road/Military Road corridors to the Western Harbour Tunnel. The introduction of this connection would reduce traffic volumes through alternative corridors including Falcon Street, Ernest Street/Ourimbah Road, Brook Street and Miller Street, which have limited capacity to accommodate forecast future traffic demand. The impact of this change would be greatest in the morning peak, when the southbound demand for the Western Harbour Tunnel would be highest
- Beaches Link northbound on ramp from Berry Street to Beaches Link: This on ramp would provide an alternative for travel to the Warringah Road or Pittwater Road corridors, which are currently accessible via existing corridors including Falcon Street, Ernest Street, and Brook Street/Willoughby Road
- Beaches Link southbound off ramp to Alfred Street North: This off ramp would provide an alternative for traffic travelling from the Northern Beaches to North Sydney, which currently travels via existing roads including Falcon Street and Miller Street. This traffic would instead exit from the Beaches Link Tunnel at Alfred Street North and use the new upgraded intersection of Alfred Street North and High Street, reducing delays at Falcon Street and Miller Street. Combined with the modifications to access arrangements to North Sydney along High Street and Pacific Highway, this would reduce delays on Miller Street and Falcon Street. The impact of this change would occur in the morning peak when the southbound demand into North Sydney is highest.

Table 8-18 Modelled 'Do something cumulative' morning peak network performance – Warringah Freeway and surrounds

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Network statistics for all vehicles						
Total traffic demand (veh)	104,500	114,400	117,700	112,400	126,500	131,700
Total VKT through network	340,400	392,500	419,800	350,700	416,500	451,600
Total vehicle travel time through the network (hours)	9000	9140	9690	10,160	10,780	11,300
Total number of stops	616,200	259,400	296,500	746,100	485,100	486,600
Average vehicle statistics						
Average vehicle trip length through the network (km)	3.5	3.6	3.7	3.5	3.6	3.7
Average vehicle trip time through the network (hours)	0:05:32	0:05:04	0:05:07	0:06:01	0:05:37	0:05:31
Average number of stops per trip	6.3	2.4	2.6	7.4	4.2	4.0
Average trip speed (km/hr)	37.8	42.9	43.3	34.5	38.6	40.1
Unreleased traffic						
Total unreleased trips	6890	5970	4080	11,270	11,450	9190
% of demand unreleased	7%	5%	4%	10%	9%	7%

Table 8-19 Modelled 'Do something cumulative' evening peak network performance – Warringah Freeway and surrounds

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Network statistics for all vehicles						
Total traffic demand (veh)	109,500	114,200	117,200	118,100	124,700	129,700
Total VKT through network	344,900	350,200	378,700	349,000	365,200	412,700
Total vehicle travel time through the network (hours)	9880	10,300	9070	12,370	11,800	10,500
Total number of stops	621,100	558,100	249,900	980,300	711,000	314,900
Average vehicle statistics						
Average vehicle trip length through the network (km)	3.3	3.3	3.4	3.2	3.4	3.5
Average vehicle trip time through the network (hours)	0:05:37	0:05:51	0:04:55	0:06:51	0:06:31	0:05:17
Average number of stops per trip	5.9	5.3	2.3	9.1	6.5	2.7
Average trip speed (km/hr)	34.9	34.0	41.8	28.2	30.9	39.3
Unreleased traffic						
Total unreleased trips	3900	8540	6670	9800	15,900	10,700
% of demand unreleased	4%	8%	6%	8%	13%	8%

8.5.2 General traffic travel times

Modelled general traffic travel times for key routes through the Warringah Freeway and surrounds study area are provided in Table 8-20 and Table 8-21. Analysis of modelled travel times under the 'Do something cumulative' scenario shows the following localised effects:

- Travel times for morning peak trips travelling along the Warringah Freeway between Gore Hill Freeway and the Sydney Harbour crossings are forecast to marginally increase in the southbound direction in some instances. This is due to the increase in peak direction demand to these crossings, with a greater demand for traffic travelling to the corridor from the Beaches Link Tunnel. Travel times would however be substantially lower than under the 'Do minimum' scenario
- Travel times along Miller Street would increase in the southbound direction in the morning peak as a result of downstream changes to demands around North Sydney (eg Pacific Highway and Berry Street) following the introduction of Beaches Link.

Overall, introduction of the Beaches Link Tunnel would result in generally improved travel times along the Warringah Freeway due to the transfer of traffic from alternative routes, reducing congestion along the Warringah Freeway and its approaches, however this would be accompanied by localised increases in travel times for some routes during the busiest peak periods.

Table 8-20 Modelled 'Do something cumulative' morning peak hour general traffic travel times – Warringah Freeway and surrounds

Route	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Sydney Harbour Bridge to Warringah Freeway/Falcon Street interchange	Northbound	0:04:40	0:03:39	0:03:33	0:04:51	0:03:31	0:04:12
	Southbound	0:04:03	0:04:09	0:04:07	0:04:02	0:04:07	0:04:06
Sydney Harbour Tunnel to Warringah Freeway/Falcon Street interchange	Northbound	0:03:55	0:03:43	0:03:31	0:04:08	0:03:28	0:04:27
	Southbound	0:04:03	0:04:33	0:04:27	0:04:02	0:04:22	0:04:26
Sydney Harbour Bridge to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:06:13	0:05:27	0:05:26	0:06:16	0:05:26	0:05:29
	Southbound	0:13:35	0:06:59	0:08:02	0:15:22	0:07:36	0:07:54
Sydney Harbour Tunnel to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:26	0:05:22	0:05:18	0:05:30	0:05:23	0:05:23
	Southbound	0:11:39	0:07:19	0:07:59	0:12:37	0:07:52	0:08:08
Berry Street to Amherst Street via Miller Street	Northbound	0:03:42	0:04:10	0:04:06	0:03:53	0:04:12	0:04:03
	Southbound	0:04:25	0:04:16	0:06:01	0:05:43	0:06:10	0:07:01

Table 8-21 Modelled 'Do something cumulative' evening peak hour general traffic travel times – Warringah Freeway and surrounds

Route	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Sydney Harbour Bridge to Warringah Freeway/Falcon Street interchange	Northbound	0:04:02	0:03:23	0:03:25	0:07:51	0:04:12	0:03:28
	Southbound	0:06:09	0:04:35	0:04:37	0:05:02	0:04:33	0:04:33
Sydney Harbour Tunnel to Warringah Freeway/Falcon Street interchange	Northbound	0:03:57	0:06:43	0:03:24	0:07:36	0:03:52	0:03:31
	Southbound	0:14:54	0:05:28	0:05:28	0:14:59	0:05:37	0:05:35
Sydney Harbour Bridge to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:35	0:05:20	0:05:21	0:06:45	0:05:22	0:05:24
	Southbound	0:13:56	0:06:08	0:06:10	0:17:31	0:06:07	0:06:10
Sydney Harbour Tunnel to Gore Hill Freeway/Pacific Highway interchange	Northbound	0:05:28	0:08:37	0:05:12	0:06:46	0:05:13	0:05:14
	Southbound	0:25:21	0:07:00	0:07:00	0:30:09	0:07:11	0:07:07
Berry Street to Amherst Street via Miller Street	Northbound	0:03:52	0:04:54	0:04:46	0:03:50	0:08:03	0:05:14
	Southbound	0:05:01	0:05:00	0:04:35	0:08:39	0:06:13	0:05:37

8.5.3 Intersection performance

Modelled future performance for key intersections in the Warringah Freeway and surrounds study area under the 'Do something cumulative' scenario are presented in Table 8-22 and Table 8-23. Analysis of intersection performance under the 'Do something cumulative' scenario indicates:

- The intersections along Pacific Highway, Walker Street and Berry Street would experience marginally increased delays in some instances, with Beaches Link traffic entering North Sydney via High Street/Pacific Highway and exiting via Berry Street
- The Falcon Street interchange would experience reduced delays in the evening peak due to a reduction in traffic using this interchange following the opening of Beaches Link.

Overall, intersection performance in North Sydney under the 'Do something cumulative' scenario would be generally consistent with the 'Do something' scenario, albeit with increased localised demand and delays on routes that provide access to and from the Beaches Link Tunnel.

Although some traffic would be impacted by an increase in localised intersection delays, road users would still generally benefit from substantial travel time savings on the broader network (eg via Beaches Link, Western Harbour Tunnel, ANZAC Bridge, and Sydney Harbour Bridge). Consequently, traffic impacted at individual intersections in the North Sydney area is still anticipated to receive a net benefit due to the broader connectivity and efficiency improvements.

Table 8-22 Modelled 'Do something cumulative' morning peak hour intersection performance – Warringah Freeway and surrounds

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Willoughby Road/Gore Hill Freeway interchange	>100	F	8	A	9	A	>100	F	9	A	10	A
Brook Street/Warringah Freeway on ramp	>100	F	7	A	8	A	>100	F	58	E	64	E
Brook Street/Warringah Freeway off ramp	61	E	10	A	9	A	67	E	49	D	16	B
Brook Street/Merrenburn Avenue	>100	F	28	B	26	B	>100	F	44	D	50	D
Amherst Street/West Street	5	A	9	A	50	D	5	A	>100	F	>100	F
Amherst Street/Miller Street	21	B	38	C	42	C	20	B	50	D	44	D
Miller Street/Warringah Freeway on ramp	7	A	6	A	<5	A	6	A	9	A	5	A
Miller Street/Warringah Freeway off ramp	12	A	10	A	8	A	13	A	10	A	8	A
Miller Street/Ernest Street	25	B	44	D	42	C	32	C	44	D	41	C
Miller Street/Falcon Street	35	C	27	B	30	C	38	C	41	C	44	D
Ernest Street/Warringah Freeway on ramp	5	A	19	B	29	C	5	A	21	B	36	C
Ernest Street/Warringah Freeway off ramp (off ramp in PM, on ramp in AM)	5	A	19	B	28	B	5	A	21	B	34	C
Falcon Street/Warringah Freeway ramps	29	C	31	C	42	C	15	B	47	D	51	D
Watson Street/Military Road	18	B	27	B	28	C	26	B	36	C	30	C
Military Road/Ben Boyd Road	15	B	64	E	47	D	23	B	71	F	43	D
Falcon Street/Merlin Street	24	B	35	C	39	C	32	C	81	F	54	D
Berry Street/Walker Street	29	C	48	D	41	C	39	C	55	D	50	D
Berry Street/Miller Street	55	D	53	D	58	E	69	E	55	D	57	E
Mount Street/Arthur Street	46	D	27	B	18	B	59	E	33	C	33	C

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Mount Street/Walker Street	36	C	35	C	35	C	48	D	46	D	43	D
Pacific Highway/High Street/Arthur Street	19	B	23	B	18	B	38	C	25	B	19	B
Pacific Highway/Walker Street/Blue Street	36	C	38	C	33	C	65	E	33	C	32	C
Pacific Highway/Miller Street/Mount Street	38	C	63	E	62	E	41	C	65	E	62	E
Pacific Highway/Berry Street	56	E	35	C	60	E	52	D	61	E	60	E
Pacific Highway/Bay Road	55	D	22	B	42	D	77	F	89	F	88	F
Miller Street/McLaren Street	23	B	41	C	56	E	72	F	50	D	62	E
Miller Street/Ridge Street	38	C	45	D	63	E	53	D	66	E	70	E
Miller Street/Carlow Street	13	A	9	A	15	B	13	A	24	B	28	C
High Street/Clark Road	18	B	32	C	36	C	55	D	59	E	38	C
High Street/Alfred Street	13	A	18	B	19	B	62	E	21	B	18	B
Mount Street/Alfred Street	<5	A	12	A	14	B	<5	A	13	A	14	A
Ernest Street/Ben Boyd Road	12	A	17	B	18	B	12	A	29	C	26	B
Pedestrian crossing at Military Road	6	A	6	A	5	A	5	A	8	A	6	A

Table 8-23 Modelled 'Do something cumulative' evening peak hour intersection performance – Warringah Freeway and surrounds

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Willoughby Road/Gore Hill Freeway interchange	38	C	10	A	11	A	76	F	9	A	11	A
Brook Street/Warringah Freeway on ramp	14	B	23	B	<5	A	17	B	42	D	25	B
Brook Street/Warringah Freeway off ramp	22	B	18	B	17	B	20	B	48	D	29	C
Brook Street/Merrenburn Avenue	11	A	45	D	17	B	13	A	46	D	39	C
Amherst Street/West Street	9	A	75	F	43	D	14	A	87	F	73	F
Amherst Street/Miller Street	29	C	59	E	43	D	31	C	63	E	48	D
Miller Street/Warringah Freeway on ramp	6	A	7	A	6	A	6	A	6	A	7	A
Miller Street/Warringah Freeway off ramp	15	B	9	A	7	A	15	B	9	A	8	A
Miller Street/Ernest Street	41	C	42	C	34	C	43	D	57	E	39	C
Miller Street/Falcon Street	44	D	65	E	38	C	49	D	79	F	48	D
Ernest Street/Warringah Freeway on ramp	15	B	14	B	13	A	15	B	14	A	13	A
Ernest Street/Warringah Freeway off ramp (off ramp in PM, on ramp in AM)	17	B	23	B	14	A	17	B	18	B	15	B
Falcon Street/Warringah Freeway ramps	72	F	79	F	52	D	>100	F	89	F	60	E
Watson Street/Military Road	46	D	31	C	37	C	59	E	40	C	38	C
Military Road/Ben Boyd Road	54	D	80	F	55	D	70	E	86	F	83	F
Falcon Street/Merlin Street	>100	F	>100	F	83	F	>100	F	>100	F	88	F
Berry Street/Walker Street	44	D	75	F	69	E	73	F	76	F	74	F
Berry Street/Miller Street	46	D	56	D	54	D	70	F	>100	F	63	E
Mount Street/Arthur Street	49	D	34	C	21	B	92	F	63	E	>100	F

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Mount Street/Walker Street	32	C	93	F	78	F	75	F	>100	F	96	F
Pacific Highway/High Street/Arthur Street	46	D	16	B	16	B	61	E	23	B	21	B
Pacific Highway/Walker Street/Blue Street	40	D	71	F	54	D	80	F	70	F	60	E
Pacific Highway/Miller Street/Mount Street	41	C	63	E	50	D	58	E	>100	F	66	E
Pacific Highway/Berry Street	23	B	97	F	85	F	56	E	>100	F	87	F
Pacific Highway/Bay Road	15	B	50	D	27	B	41	C	96	F	33	C
Miller Street/McLaren Street	21	B	41	C	37	C	55	D	76	F	50	D
Miller Street/Ridge Street	40	C	18	B	21	B	91	F	38	C	39	C
Miller Street/Carlow Street	8	A	7	A	7	A	19	B	7	A	7	A
High Street/Clark Road	61	E	94	F	56	D	97	F	82	F	65	E
High Street/Alfred Street	>100	F	58	E	42	C	>100	F	53	D	46	D
Mount Street/Alfred Street	12	A	12	A	12	A	10	A	11	A	13	A
Ernest Street/Ben Boyd Road	44	D	14	B	10	A	94	F	46	D	46	D
Pedestrian crossing at Military Road	27	B	5	A	<5	A	34	C	<5	A	5	A

8.5.4 Road network changes and access arrangements

In addition to the road network changes proposed for the project, other modifications to the road network in North Sydney would be required to accommodate the Beaches Link Tunnel.

The Beaches Link would connect to the Warringah Freeway at Cammeray, north of the Ernest Street Bridge. These connections would include:

- On and off ramps providing direct connection between the Warringah Freeway and Beaches Link
- A northbound on ramp from Berry Street to Beaches Link, providing access from North Sydney
- A southbound off ramp onto Alfred Street North from Beaches Link, providing access to North Sydney.

8.5.5 Public transport impacts

Modelled future bus travel times for key routes through the Warringah Freeway and surrounds study area under the 'Do something cumulative' scenario are presented in Table 8-24 and Table 8-25. Analysis of the modelled bus travel times indicates:

- Bus travel times through North Sydney would not materially change as a result of Beaches Link
- Bus travel times along the Warringah Freeway would not materially change as a result of the project, indicating potential additional demand generated by Beaches Link would not have an adverse impact
- Bus travel times for trips travelling between Warringah Freeway and Military Road would remain largely unchanged. The introduction of the Beaches Link Tunnel would not substantially change traffic conditions for these routes, which would retain the same level of priority.

In general, the introduction of the proposed Beaches Link Tunnel would generally maintain travel times for buses travelling through North Sydney and surrounds.

Table 8-24 Modelled 'Do something cumulative' morning peak hour bus travel times – Warringah Freeway and surrounds

Route	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:09:55	0:10:38	0:10:35	0:09:30	0:11:15	0:10:45
	Southbound	0:11:31	0:10:08	0:10:45	0:13:26	0:11:58	0:12:58
Sydney Harbour Bridge to Bay Street (via North Sydney Station and Pacific Highway)	Northbound	0:06:05	0:05:57	0:05:59	0:06:29	0:06:22	0:06:04
	Southbound	0:11:35	0:09:46	0:11:47	0:13:31	0:14:48	0:15:02
Sydney Harbour Bridge to Ben Boyd Road	Northbound	0:06:28	0:04:59	0:04:52	0:06:43	0:05:05	0:05:11
	Southbound	0:06:28	0:05:13	0:05:20	0:06:33	0:05:49	0:05:23
Sydney Harbour Bridge to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:06:43	0:05:40	0:05:37	0:06:42	0:05:38	0:05:44
	Southbound	0:25:33	0:06:35	0:07:16	0:28:17	0:07:12	0:07:30

Table 8-25 Modelled ‘Do something cumulative’ evening peak hour bus travel times – Warringah Freeway and surrounds

Route	Direction	2027 ‘Do minimum’	2027 ‘Do something’	2027 ‘Do something cumulative’	2037 ‘Do minimum’	2037 ‘Do something’	2037 ‘Do something cumulative’
Sydney Harbour Bridge to Amherst Street (via Miller Street and North Sydney Station)	Northbound	0:11:03	0:13:01	0:12:42	0:13:34	0:23:41	0:13:21
	Southbound	0:13:14	0:19:23	0:12:54	0:19:09	0:15:20	0:21:17
Sydney Harbour Bridge to Bay Street (via North Sydney Station and Pacific Highway)	Northbound	0:07:13	0:08:12	0:08:06	0:09:52	0:11:30	0:07:53
	Southbound	0:09:17	0:15:15	0:11:35	0:13:59	0:19:45	0:16:59
Sydney Harbour Bridge to Ben Boyd Road	Northbound	0:08:27	0:04:43	0:04:50	0:08:36	0:04:45	0:04:47
	Southbound	0:05:52	0:05:36	0:06:03	0:06:51	0:05:10	0:05:45
Sydney Harbour Bridge to Lane Cove Tunnel (via Gore Hill Freeway)	Northbound	0:06:12	0:06:13	0:06:12	0:06:33	0:06:13	0:06:13
	Southbound	0:15:53	0:06:46	0:06:57	0:20:57	0:06:36	0:06:34

8.5.6 Active transport impacts

All changes to the active transport network would remain the same as the ‘Do something’ scenario.

8.6 Gore Hill Freeway and Artarmon

8.6.1 Network performance

A summary of future network performance statistics for the Gore Hill Freeway and Artarmon area under the ‘Do something cumulative’ scenario is provided in Table 8-26 and Table 8-27. Analysis of the network performance with the project indicates that, compared to the ‘Do something’ scenario:

- Peak period traffic demand through the Gore Hill Freeway and Artarmon area would increase by up to 12 per cent by 2037. This is a result of the additional connectivity provided by the Beaches Link Tunnel, which would generate additional demand between the Northern Beaches and the Gore Hill Freeway
- Average travel speeds through the Gore Hill Freeway and Artarmon area during peak periods would increase by up to 56 per cent. This is a result of converting the eastbound transit lane on Gore Hill Freeway to a general traffic lane to improve utilisation, and has the greatest benefit in the morning peak period when eastbound traffic demands would be highest
- Localised delays in the Artarmon area would increase, as the increased traffic volumes along the Gore Hill Freeway would require traffic signals at critical locations such as Longueville Road and Epping Road and Longueville Road and Pacific Highway to be optimised to manage throughput from the motorway, which would result in increased queues on lower order roads during peak periods.

Network performance measures for the Gore Hill Freeway and Artarmon area indicate that the road integration works associated with the proposed Beaches Link Tunnel would facilitate additional traffic travelling through the corridor at a generally similar or reduced level of delay than under the ‘Do something’ scenario. These works could be brought forward and carried out as part of the Western Harbour Tunnel scope to improve traffic conditions under the ‘Do something’ scenario.

Table 8-26 Modelled 'Do something cumulative' morning peak network performance – Gore Hill Freeway and Artarmon

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Network statistics for all vehicles						
Total traffic demand (veh)	31,100	32,500	35,900	34,100	35,100	39,400
Total VKT through network	79,800	85,700	99,100	87,900	89,400	101,000
Total vehicle travel time through the network (hours)	1710	2430	2110	2280	3000	2170
Total number of stops	43,100	257,200	52,700	113,700	342,900	57,500
Average vehicle statistics						
Average vehicle trip length through the network (km)	2.4	2.5	2.6	2.4	2.5	2.6
Average vehicle trip time through the network (hours)	0:03:08	0:04:14	0:03:18	0:03:48	0:04:56	0:03:21
Average number of stops per trip	1.3	7.5	1.4	3.2	9.4	1.5
Average trip speed (km/hr)	46.8	35.2	47.0	38.5	29.8	46.5
Unreleased traffic						
Total unreleased trips	<10	540	540	530	2370	590
% of demand unreleased	<1%	2%	1%	1%	6%	1%

Table 8-27 Modelled 'Do something cumulative' evening peak network performance – Gore Hill Freeway and Artarmon

Network measure	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum	2037 'Do something'	2037 'Do something cumulative'
Network statistics for all vehicles						
Total traffic demand (veh)	31,100	31,200	34,200	34,400	34,100	37,100
Total VKT through network	79,400	81,900	90,800	85,800	87,100	101,200
Total vehicle travel time through the network (hours)	1800	1650	1980	2010	2330	2500
Total number of stops	48,000	39,100	50,300	62,400	98,200	89,000
Average vehicle statistics						
Average vehicle trip length through the network (km)	2.4	2.5	2.5	2.4	2.4	2.6
Average vehicle trip time through the network (hours)	0:03:17	0:02:59	0:03:19	0:03:23	0:03:55	0:03:52
Average number of stops per trip	1.5	1.2	1.4	1.8	2.8	2.3
Average trip speed (km/hr)	44.0	49.7	45.9	42.6	37.5	40.5
Unreleased traffic						
Total unreleased trips	260	<10	150	820	800	1500
% of demand unreleased	1%	<1%	<1%	2%	2%	4%

8.6.2 General traffic travel times

A summary of modelled general traffic travel times under the ‘Do something cumulative’ scenario is provided in Table 8-28 and Table 8-29. Analysis of travel times under the ‘Do something cumulative’ scenario shows:

- Eastbound general travel times would improve as a result of the removal of the transit lane from Lane Cove Tunnel and Longueville Road to Gore Hill Freeway. This would enable the improved utilisation of existing road space, benefitting all road users in the area
- Westbound general traffic travel times would remain largely unchanged under the ‘Do something cumulative’ scenario. The additional demand associated with the introduction of the Beaches Link Tunnel would not substantially change general traffic performance in the Gore Hill Freeway corridor.

Table 8-28 Modelled 'Do something cumulative' morning peak hour general traffic travel times – Gore Hill Freeway and Artarmon

Route	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Longueville Road to Gore Hill Freeway	Eastbound	0:01:28	0:06:24	0:01:29	0:01:24	0:05:33	0:01:29
	Westbound	0:01:24	0:01:26	0:01:23	0:01:28	0:01:28	0:01:23
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:18	0:04:42	0:01:16	0:01:24	0:05:55	0:01:17
	Westbound	0:01:17	0:01:18	0:01:18	0:02:16	0:01:18	0:01:18

Table 8-29 Modelled 'Do something cumulative' evening peak hour general traffic travel times – Gore Hill Freeway and Artarmon

Route	Direction	2027 'Do minimum'	2027 'Do something'	2027 'Do something cumulative'	2037 'Do minimum'	2037 'Do something'	2037 'Do something cumulative'
Longueville Road to Gore Hill Freeway	Eastbound	0:01:26	0:01:28	0:01:26	0:01:25	0:02:02	0:01:27
	Westbound	0:01:23	0:01:24	0:01:23	0:01:23	0:01:46	0:02:02
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:22	0:01:23	0:01:16	0:01:23	0:01:25	0:01:18
	Westbound	0:01:12	0:01:13	0:01:17	0:01:12	0:01:15	0:01:17

8.6.3 Intersection performance

Modelled future performance for key intersections in the Gore Hill Freeway and Artarmon study area under the ‘Do something cumulative’ scenario is presented in Table 8-30 and Table 8-31. Analysis of intersection performance under the ‘Do something cumulative’ scenario indicates:

- Delays at the intersection of Longueville Road and Epping Road would increase due to the increase in traffic through this intersection from the Beaches Link Tunnel, with the intersection continuing to operate beyond its practical capacity. The operation of this intersection would be optimised to manage traffic volumes from the motorway and ensure that queues from this location would not impact the operation of the Gore Hill Freeway
- The intersection of Longueville Road and Pacific Highway would continue to operate at a poor Level of Service in the evening peak by 2037. As for the ‘Do something’ scenario, this is due to the impact of the short weave from Pacific Highway to Longueville Road for traffic to turn right into Parklands Avenue, combined with increased delays at this intersection due to overall increases in eastbound and westbound traffic
- The Reserve Road interchange would operate with comparable delays to the ‘Do something’ scenario, with delays on off ramps managed during peak periods to ensure the efficient operation of Gore Hill Freeway under the increased traffic demands of the ‘Do something cumulative’ scenario. This would increase localised delays at adjacent intersections along Reserve Road, with Dickson Road and Barton Road continuing to operate at a relatively poor LoS F.

Analysis of the modelled intersection performance for the Gore Hill Freeway and Artarmon area shows that increased traffic demands through the area would result in some increased localised delays for intersections in the area, but that these intersections could be optimised to ensure that Gore Hill Freeway would continue to operate satisfactorily. A consequence of this optimisation would be increased delays on side streets and surface roads during peak periods.

Although traffic would be impacted by an increase in localised intersection delays, broader modelling indicates that road users would benefit from substantial travel time savings on the broader network (eg via Beaches Link and improved efficiency of the Warringah Freeway and beyond). Consequently, road users who travel on and around the Gore Hill Freeway would still benefit from Beaches Link due to the increased connectivity to the area and on the surrounding strategic road network.

Table 8-30 Modelled 'Do something cumulative' morning peak hour intersection performance – Gore Hill Freeway and Artarmon

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Epping Road/Longueville Road/Parklands Avenue	52	D	51	D	75	F	83	F	63	E	77	F
Longueville Road/Pacific Highway	40	C	39	C	39	C	54	D	45	D	38	C
Pacific Highway/Howarth Road/Norton Lane	20	B	25	B	10	A	28	B	27	B	11	A
Pacific Highway/Gore Hill Freeway interchange	29	B	40	C	25	B	41	C	39	C	25	B
Reserve Road/Gore Hill Freeway interchange	61	E	43	C	52	D	47	D	53	D	60	E
Reserve Road/Dickson Road	14	A	17	B	24	B	19	B	19	B	27	B
Reserve Road/Barton Road	69	E	10	A	77	F	>100	F	>100	F	85	F

Table 8-31 Modelled 'Do something cumulative' evening peak hour intersection performance – Gore Hill Freeway and Artarmon

Intersection	2027 'Do minimum'		2027 'Do something'		2027 'Do something cumulative'		2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Epping Road/Longueville Road/Parklands Avenue	80	F	72	F	81	F	87	F	97	F	>100	F
Longueville Road/Pacific Highway	42	C	37	C	45	D	49	D	76	F	86	F
Pacific Highway/Howarth Road/Norton Lane	13	A	16	B	11	A	13	A	24	B	13	A
Pacific Highway/Gore Hill Freeway interchange	29	C	22	B	29	B	23	B	27	B	29	B
Reserve Road/Gore Hill Freeway interchange	55	D	30	C	48	D	57	E	53	D	51	D
Reserve Road/Dickson Road	73	F	21	B	87	F	85	F	39	C	95	F
Reserve Road/Barton Road	49	D	7	A	>100	F	66	E	>100	F	>100	F

8.6.4 Road network changes and access arrangements

In addition to the road network changes proposed for the project, the Beaches Link Tunnel would connect to the Gore Hill Freeway at Artarmon, west of the North Shore Rail Line. These connections would include:

- Eastbound on ramps to Beaches Link from Epping Road/Lane Cove Tunnel and Reserve Road, providing access from Artarmon and beyond
- Westbound off ramps from Beaches Link onto Reserve Road and Lane Cove Tunnel, providing access to Artarmon and beyond.

Local road changes as part of the Gore Hill Freeway Connection are required to integrate the Beaches Link Tunnel with the existing road network. This would involve:

- Reducing connectivity between Dickson Avenue and Reserve Road to accommodate the Beaches Link westbound off ramp onto Reserve Road. Dickson Avenue east of Reserve Road would be converted to a cul-de-sac, and property access from Reserve Road would be removed. Access to properties would be provided via Hesky Lane and the surrounding road network, such as Taylor Lane, Cleg Street, Herbert Street and Waltham Street. Access to Dickson Avenue west of Reserve Road would be maintained
- Disconnecting Lambs Road from the road network between Punch Street and Cleg Street to facilitate the installation of tunnel support facilities. Lambs Road would connect directly onto Cleg Street at its northern end, while a cul-de-sac would be installed on Punch Street at its eastern end. Vehicles would be required to use Punch Street and Herbert Street, which would not substantially increase travel time given the additional travel distance of up to 480 metres
- Modifying the Reserve Road/Dickson Avenue intersection to accommodate the Beaches Link westbound off ramp
- Installing traffic signals at the Pacific Highway/Dickson Avenue intersection to increase safety and connectivity.

Additional capacity would be provided at the Reserve Road bridge, with the existing footpaths converted to traffic lanes and a new footpath constructed on the eastern side of the bridge. The T2 transit lanes on the Gore Hill Freeway in both directions would be removed and converted to general traffic lanes to improve lane utilisation.

About 10 on-street parking spaces for cars and six on-street parking spaces for motorcycles would be removed at the Pacific Highway/Dickson Avenue intersection.

Beaches Link operational facilities including the Motorway Control Centre would provide sufficient off-street parking and would not generate additional on-street parking demand. Therefore, impacts on parking would not worsen once Beaches Link is operational.

8.6.5 Public transport impacts

Forecast bus travel times for key routes through the Gore Hill Freeway and Artarmon study area under the ‘Do something cumulative’ scenario are presented in Table 8-32 and Table 8-33. Analysis of these modelled bus travel times indicates that there would not be any substantial change to bus travel times as a result of the changes associated with the proposed Beaches Link Tunnel and that the removal of the existing transit lanes is not expected to result in a material increase in bus travel times.

Table 8-32 Modelled ‘Do something cumulative’ morning peak hour bus travel times – Gore Hill Freeway and Artarmon

Route	Direction	2027 ‘Do minimum’	2027 ‘Do something’	2027 ‘Do something cumulative’	2037 ‘Do minimum’	2037 ‘Do something’	2037 ‘Do something cumulative’
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:26	0:01:27	0:01:22	0:01:26	0:01:27	0:01:22
	Westbound	0:01:18	0:01:17	0:01:18	0:01:26	0:01:18	0:01:18

Table 8-33 Modelled ‘Do something cumulative’ evening peak hour bus travel times – Gore Hill Freeway and Artarmon

Route	Direction	2027 ‘Do minimum’	2027 ‘Do something’	2027 ‘Do something cumulative’	2037 ‘Do minimum’	2037 ‘Do something’	2037 ‘Do something cumulative’
Lane Cove Tunnel to Gore Hill Freeway	Eastbound	0:01:22	0:01:21	0:01:21	0:01:22	0:01:22	0:01:22
	Westbound	0:01:13	0:01:12	0:01:17	0:01:13	0:01:15	0:01:18

The southbound bus stop on Pacific Highway would be permanently relocated once the Pacific Highway/Dickson Avenue is signalised. The bus stop would be relocated within 50 metres of its existing location and therefore minor impacts are anticipated given the minor increase in travel distance.

8.6.6 Active transport impacts

As part of the Beaches Link and Gore Hill Freeway Connection, a shared user path would be provided on the southern side of the Gore Hill Freeway between the North Shore Rail Line and Reserve Road, replacing and connecting to the existing path. Pedestrian fencing would also be installed along the northern side of the shared user path, thus improving the safety and quality of the active transport network.

9. Environmental management measures

The majority of long-term impacts of the project have been addressed through the process of design and include:

- Maintenance of access to existing roads and properties to be addressed through an access strategy for affected properties
- Management of capacity constraints to be addressed through the design, operation of existing traffic signals and other road network treatments
- Provision for public transport capacity and priority to be addressed through the design and by provision for double-deck buses through the mainline tunnel
- Provision of active transport to be addressed through the design by maintaining or improving existing active transport facilities within the foot print of the project.

Residual impacts of the project that arise from engineering constraints or from construction activities, and which cannot be removed through the design are considered manageable. The proposed environmental management measures would be reconfirmed as the project progresses to detailed design and as more detailed construction management plans are developed.

A summary of the environmental management measures identified for the project is provided in Table 9-1.

Table 9-1: Summary of environmental management measures

Ref	Impact	Environmental management measures	Location
Construction			
CTT1	Construction traffic	A road dilapidation report will be prepared, in consultation with relevant councils and road owners, identifying existing conditions of local roads and mechanisms to repair damage to the road network caused by heavy vehicle movements associated with the project.	WHT/WFU
CTT2	Maritime construction traffic	Moorings impacted during construction will be relocated elsewhere in Sydney Harbour in consultation with the lease holders.	WHT
CTT3	Maritime construction traffic	Opportunities to relocate the Birchgrove Ferry Wharf will be investigated during construction planning.	WHT
CTT4	Construction traffic	Ongoing consultation will be carried out with (as relevant to the location) the Sydney Coordination Office, the Port Authority of NSW, local councils, emergency services and bus operators in order to minimise traffic and transport impacts during construction.	WHT/WFU
CTT5	Construction traffic	The community will be notified in advance of proposed transport network changes and maritime restrictions through appropriate media and other appropriate forms of community liaison.	WHT/WFU
CTT6	Construction traffic	Construction road traffic will be managed to minimise movements during peak periods.	WHT/WFU
CTT7	Construction traffic	Vehicle access to and from construction sites will be managed to ensure pedestrian, cyclist and motorist safety. Depending on the location, this may require manual supervision, physical barriers, temporary traffic signals and modifications to existing signals or, on occasion, police presence.	WHT/WFU
CTT8	Construction traffic	Directional signage and linemarking will be used to direct and guide drivers, cyclists and pedestrians past construction sites and on the surrounding network. This will be supplemented by Variable Message Signs to advise drivers of potential delays, traffic	WHT/WFU

Ref	Impact	Environmental management measures	Location
		diversions, speed restrictions, or alternative routes.	
CTT9	Construction traffic	Where provision of construction on-site parking cannot accommodate the full construction workforce, feasible and reasonable management measures that minimise impact on parking on local roads will be identified and implemented. Depending on the location, management measures may include workforce buses and the use of public transport.	WHT/WFU
CTT10	Construction traffic	Any adjustments to existing bus stops will be determined in consultation with relevant stakeholders including Transport for NSW and advanced notification will be provided to affected bus customers. Relocations will be as close as feasible and reasonable to their existing position.	WHT/WFU
CTT11	Construction traffic	Truck marshalling areas will be identified and used where feasible and reasonable to minimise potential queueing and traffic and access disruptions in the vicinity of construction support sites.	WHT/WFU
CTT12	Construction traffic	Activities requiring partial and full road closures will be carried out outside of peak periods or during night time to minimise the impact of these activities on the road network where feasible and reasonable.	WHT/WFU
CTT13	Construction traffic	Partial or full closures of Warringah Freeway will be carried out in consultation with the Sydney Coordination Office.	WFU
CTT14	Construction traffic	Haulage of spoil by barge will be considered as an alternative to road based haulage.	WHT
CTT15	Maritime construction traffic	Construction vessels will be required to operate in a manner that minimises wash to sensitive areas of shoreline.	WHT
CTT16	Maritime construction traffic	Construction marine traffic activities will be scheduled to avoid times and locations of high recreational marine traffic where feasible and reasonable.	WHT
CTT17	Maritime construction traffic	Harbour closures scheduling will be carried out in consultation with Port Authority of NSW, Roads and Maritime, Transport for NSW and other relevant stakeholders.	WHT
CTT18	Maritime construction traffic	Construction vessel movements will be managed such that they will not interfere with port operations or the navigation of seagoing ships and ferries, unless prior approval has been obtained from the Harbour Master.	WHT
Operation			
OT1	Operational traffic	A review of operational network performance will be carried out 12 months and five years from the opening of the project to confirm the operational impacts of the project on surrounding arterial roads and major intersections. The assessment will be based on updated traffic data at the time and the methodology used will be comparable with that used in this assessment.	WHT/WFU
OT2	Operational traffic	Conversion of transit lanes to regular traffic lanes along Gore Hill Freeway will be considered if there is a traffic performance requirement/benefit in peak times.	WFU

WHT = Western Harbour Tunnel, WFU = Warringah Freeway Upgrade

10. References

Ackelik and Associates (2016), *Sidra INTERSECTION 7 User Guide*, Ackelik and Associates Pty Ltd, Greyhorn Victoria

Austroads (2014), *Cycling Aspects of Austroads Guides,* Austroads Ltd, Sydney NSW

Austroads (2013), *Guide to Traffic Management – Part 3 Traffic Studies and Analysis*, Austroads Ltd, Sydney NSW

Department of Infrastructure, Planning and Natural Resources (2004), *Planning Guidelines for Walking and Cycling*, Department of Infrastructure, Planning and Natural Resources, Sydney NSW

Forest Coach Lines (2019), *Forest Coach Lines Sydney Region Network Map,* available online: https://forestcoachlines.com.au/network-map/sydney/

Greater Sydney Commission (2018), *A Metropolis of Three Cities – the Greater Sydney Region Plan*, Greater Sydney Commission, Parramatta NSW

Greater Sydney Commission (2018a), *Eastern City District Plan*, Greater Sydney Commission, Parramatta NSW

Greater Sydney Commission (2018b), *North District Plan*, Greater Sydney Commission, Parramatta NSW

Hillsbus (2019), *Hills District Bus Guide*, available online: https://www.cdcbus.com.au/images/files/maps/hillsbus/Region_4_Network_Map.pdf

Infrastructure NSW (2018), *State Infrastructure Strategy 2018-2038*, Infrastructure NSW, Sydney NSW

NSW Government (2018), *Future Transport Strategy 2056*, Transport for NSW, Chippendale NSW

NSW Roads and Traffic Authority (2005), *NSW Bicycle Guidelines Version 1.2*, NSW Roads and Traffic Authority, Sydney NSW

NSW Roads and Traffic Authority (2002), *Guide to Traffic Generating Developments Version 2.2*, NSW Roads and Traffic Authority, Sydney NSW

Port Authority of NSW (2017), *Cruise Schedule,* available online https://www.portauthoritynsw.com.au/cruise/cruise-schedule/

Roads and Maritime Services (2018), *Cycleway Finder,* available online: http://www.rms.nsw.gov.au/maps/cycleway_finder

Roads and Maritime Services (2017), *WestConnex M4-M5 Link environmental impact statement*, Roads and Maritime Services, Sydney NSW

Roads and Maritime Services (2016), *Sydney Harbour mooring map*, available online: http://www.rms.nsw.gov.au/documents/maritime/moorings/mooring-map-sydney.pdf

Roads and Maritime Services (2013), *Traffic Modelling Guideline*s, Roads and Maritime Services, Sydney NSW

Sydney Metro (2019), *Corporate Plan 2019-21*, Sydney NSW

Transdev NSW (2019), *Upper North Shore network map*, available online: https://www.transdevnsw.com.au/uploads/18637_Region_12_Network_Map_20180212_web.pdf

Transit Systems NSW (2019), *Inner West and Southern region network,* available online: https://static1.squarespace.com/static/5a668f1080bd5e34d18a7e76/t/5cc52af88165f562eb83adf6/1556425507677/18329_TS_R6_network_map_20190428.pdf

Transport for NSW (2019a), *North Shore & West region guide*, available online: https://transportnsw.info/document/1697/region-guide-north-shore-west.pdf

Transport for NSW (2019b), *Northern Beaches & Lower North Shore region guide*, available online: https://transportnsw.info/document/1695/region-guide-sydney-northern-beaches-lower-north-shore.pdf

Transport for NSW (2018a), *NSW Freight and Ports Plan 2018-2023*, Transport for NSW, Chippendale NSW

Transport for NSW (2018b), North Sydney Integrated Transport Program, Transport for NSW, Chippendale NSW

Transport for NSW (2018c), *Sydney Ferries Network*, available online: https://transportnsw.info/document/2382/sydney-ferries-network-map-1017.pdf

Transport for NSW (2017), *Journey to Work 2011*, available online: https://opendata.transport.nsw.gov.au/dataset/journey-work-jtw-2011

Transport for NSW (2016), *Sydney Metro City & Southwest Chatswood to Sydenham environmental impact statement,* Transport for NSW, Chippendale NSW

Transport for NSW (2015), *Regional Boating Plan – Sydney Harbour Region*, Transport for NSW, Chippendale NSW

Transport for NSW (2013a), *Sydney City Centre Access Strategy*, Transport for NSW, Chippendale NSW

Transport for NSW (2013b), *Sydney's Bus Future*, Transport for NSW, Chippendale NSW

Transport for NSW (2013c), *Sydney's Cycling Future*, Transport for NSW, Chippendale NSW

Transport for NSW (2013d), *Sydney's Walking Future*, Transport for NSW, Chippendale NSW

Transport for NSW (2013e), *NSW Sustainable Design Guidelines Version 3.0*, Transport for NSW, Chippendale NSW

Transport for NSW (2012), *Sydney's Rail Future*, Transport for NSW, Chippendale NSW

Transportation Research Board (2010), *Highway Capacity Manual 2010*, Transportation Research Board, USA

Transurban (2019), *WestConnex program map*, Electronic format, Sydney NSW