

October 2017

Western Harbour Tunnel and Warringah Freeway Upgrade

Scoping Report



BLANK PAGE

Document controls

Title:	Western Harbour Tunnel and Warringah Freeway Upgrade Scoping report
---------------	--

Approval and authorisation	
Prepared by:	Arcadis Jacobs
Accepted on behalf of Roads and Maritime Services NSW by:	Camilla Drover Executive Director Motorways
	Signed: 
	Date: 30/10/2017

Location	File name
	WHT_Scoping Report_Final

Document status	Date
Final Scoping Report	30 October 2017

BLANK PAGE

Executive summary

Introduction and need

The Western Harbour Tunnel and Beaches Link is a NSW Government initiative to provide additional road network capacity across Sydney Harbour and to improve connectivity with Sydney's northern beaches. The Western Harbour Tunnel and Beaches Link program of works includes:

- The Western Harbour Tunnel and Warringah Freeway Upgrade project, comprising a new tolled motorway tunnel connection across Sydney Harbour, and the Warringah Freeway Upgrade to integrate the new motorway infrastructure with the existing road network and to connect to the Beaches Link and Gore Hill Freeway Connection
- The Beaches Link and Gore Hill Freeway Connection, including a new tolled motorway tunnel connection from the Warringah Freeway to Balgowlah and Frenchs Forest, and upgrade and integration works to connect to the Gore Hill Freeway.

This scoping report relates to the Western Harbour Tunnel and Warringah Freeway Upgrade (the project). A separate application and scoping report has been prepared for the Beaches Link and Gore Hill Freeway Connection project.

The project would involve construction and operation of a seven kilometre, tolled twin tunnel motorway to improve transport connections across Sydney Harbour. The project would create a new western bypass of the Sydney CBD, directly linking northern and southern motorway systems, provide additional road network capacity across Sydney Harbour and reduce congestion on key arterial routes. It will also improve amenity on existing corridors and support freight movements and access between key zones of the Global Economic Corridor.

When completed, the Western Harbour Tunnel and Warringah Freeway Upgrade would increase capacity in the north-south harbour crossing corridor and improve the performance of the Sydney CBD access and distributor roads. In combination with the WestConnex program of works, the project would provide a high-grade CBD bypass for road users travelling between Sydney's west, south-west and south, including the international gateways of Sydney Airport and Port Botany, and strategic centres north of the harbour such as North Sydney, Chatswood and Macquarie Park.

It would also provide faster, more reliable journeys on the Sydney Harbour Bridge and other harbour motorway crossings and reduce congestion on the ANZAC Bridge and Western Distributor. The Western Harbour Tunnel and Warringah Freeway Upgrade would also increase resilience of Sydney's busiest transport corridor, making the inner city road network and connections to the Global Economic Corridor less vulnerable to incidents and disruptions.

In addition to integrating the Western Harbour Tunnel and Beaches Link into the existing surface road network, the Warringah Freeway component of the project would provide improved network efficiency and wayfinding. Upgrade works between Milsons Point and Naremburn would improve separation of through-traffic and bypass functions. These improvements would optimise network capacity and efficiency along this part of the freeway.

Project development and construction

The Western Harbour Tunnel and Warringah Freeway Upgrade (the project) would comprise:

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

The design of the project is currently being developed taking into account community and stakeholder feedback and the outcomes of environmental investigations.

The project is expected to take around five to six years to build.

Planning and assessment process

Clause 94 of the *State Environment Planning Policy (Infrastructure) 2007* (ISEPP) permits development on any land for the purpose of a road or road infrastructure facilities to be carried out by or on behalf of a public authority without consent. As the project is for a road and road infrastructure facilities, and is to be carried out by or on behalf of Roads and Maritime, the project is permissible without development consent under Part 4 of the EP&A Act.

Roads and Maritime, as the proponent, has formed the view that the project is likely to significantly affect the environment. On this basis, the project is declared to be State significant infrastructure under section 115U (2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) by reason of the operation of clause 14 and clause 1 of Schedule 3 of the *State Environmental Planning Policy (State and Regional Development) 2011* (S&RD SEPP).

Accordingly, the project is subject to Part 5.1 of the EP&A Act and requires the preparation of an environmental impact statement and the approval of the Minister for Planning.

Key environmental issues

Based on environmental investigations that have been carried out to date, and feedback received from the community and other stakeholders, key assessment issues for the project have been identified as:

- Traffic and transport, including road safety
- Air quality, including in-tunnel and ambient air quality
- Noise and vibration
- Human health risks
- Non-Aboriginal heritage
- Cumulative impacts.

Proposed scope of the environmental impact statement

The environmental impact statement would be prepared in accordance with the EP&A Act and in particular in accordance with the Secretary's Environmental Assessment Requirements (SEARs). In general terms this would include:

- A detailed description of the project including its components, construction activities and potential staging
- A comprehensive assessment of the potential impacts on the key environmental issues including a description of the existing environment, assessment of potential direct and indirect and construction, operation and staging impacts
- Description of measures and strategies to be implemented to avoid, minimise, manage, mitigate, offset and/or monitor the potential impacts
- Identification and response to issues raised by stakeholders and the community.

Contents

Executive summary	i
Contents	iv
Abbreviations and Glossary	vii
1 Introduction	1
1.1 Overview of the Western Harbour Tunnel and Beaches Link.....	1
1.2 Overview of the project.....	3
1.3 Statutory process.....	4
1.4 Purpose of this scoping report.....	4
2 Background	5
2.1 Strategic context and project need	5
2.2 Project objectives	12
2.3 Selection of the preferred project	12
3 Consultation	25
3.1 Overview.....	25
3.2 Engagement objectives	25
3.3 Community engagement activities to date.....	26
3.4 Engagement with other stakeholders	28
3.5 Feedback received to date	28
3.6 Future engagement activities	36
4 Project description.....	37
4.1 Overview and key elements	37
4.2 Western Harbour Tunnel	37
4.3 Warringah Freeway Upgrade	41
4.4 Construction	42
5 Key assessment issues.....	47
5.1 Overview.....	47
5.2 Transport and traffic	47
5.3 Air quality.....	54
5.4 Noise and vibration.....	57
5.5 Human health risks.....	59
5.6 Non-Aboriginal heritage.....	62
5.7 Cumulative impacts	67
6 Other assessment issues.....	73
6.1 Overview.....	73
6.2 Biodiversity	73

6.3	Aboriginal cultural heritage	81
6.4	Soil and water quality	84
6.5	Groundwater	89
6.6	Socio-economics, land use and property	91
6.7	Urban design and visual amenity	95
6.8	Spoil and waste management	97
6.9	Flooding, hydrology and hydrodynamics	99
6.10	Climate change risk	101
6.11	Sustainability	104
7	Conclusion.....	107
8	References.....	109

Attachments

Attachment A	Requirements of the Environmental Planning and Assessment Regulation 2000 checklist
Attachment B	Relationship of Western Harbour Tunnel to relevant NSW Government transport and city plans

Tables

Table 2-1	Historic development of the Warringah Transport Corridor.....	7
Table 2-2	Historic development of additional cross harbour capacity	8
Table 2-3	Project objectives	12
Table 3-1	Engagement activities during concept design feedback period – 16 March to 31 July 2017*	26
Table 3-2	Number of comments for key topics.....	28
Table 3-3	Key issues and feedback received to date.....	30
Table 5-1	Sydney region projects with potential for cumulative impacts.....	69
Table 6-1	Plant community types within the design development corridor	74
Table 6-2	Soils landscapes of the design development corridor.....	85
Table 6-3	Areas of potential environmental concern.....	86
Table 6-4	Water bearing geological units.....	89

Figures

Figure 1-1	The Western Harbour Tunnel and Beaches Link program of works	2
Figure 1-2	The Sydney Harbour Bridge (left) and Sydney Harbour Tunnel (right)	3
Figure 2-1	Function of CBD distributors with and without the project.....	6
Figure 2-2	Sydney road network performance in 2011 (AM peak) showing congestion hot spots	10
Figure 2-3	Existing and potential future transport links and modes across Sydney	11
Figure 2-4	Western Harbour Tunnel and Warringah Freeway Upgrade main corridor options	16
Figure 2-5	Examples of a tunnel boring machine (left) and a roadheader (right)	19
Figure 2-6	Comparison of tunnel profiles using a tunnel boring machine (left) and a roadheader (right)	19
Figure 2-7	Main vertical alignment options for the harbour tunnels.....	21

Figure 2-8	Construction of the Sydney Harbour Tunnel immersed tube tunnels in the early 1990s	22
Figure 4-1	Western Harbour Tunnel and Warringah Freeway Upgrade design development corridors	38
Figure 5-1	Major transport infrastructure around the design development corridor	49
Figure 5-2	Heritage items within about 100 metres of the design development corridor	65
Figure 5-3	Sydney region projects with potential for cumulative impacts with Western Harbour Tunnel and Warringah Freeway Upgrade	68
Figure 6-1a	Terrestrial biodiversity features within and nearby the harbour crossing between Birchgrove and Waverton	75
Figure 6-2	Marine biodiversity features within and nearby the harbour crossing between Birchgrove and Waverton	79
Figure 6-3	Registered Aboriginal heritage items within the vicinity of the design development corridor	83
Figure 6-4	Major parks and recreational areas near the design development corridor	93

Abbreviations and Glossary

Term	Definition
AHIMS	Aboriginal Heritage Information Management System
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASRIS	Australian Soil Resource Information System
BC Act	<i>Biodiversity Conservation Act 2016</i>
BTEX	Benzene, toluene, ethylbenzene and xylene
CBD	Central business district
CO	Carbon monoxide
DEC	Department of Environment and Conservation (former)
DECCW	Department of Environment, Climate Change and Water (former)
DP&E	Department of Planning and Environment
EPA	Environment Protection Authority
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
Flood tide delta	The bulge of sand formed at the landward mouth of tidal inlets as a result of flow expansion.
FM Act	<i>Fisheries Management Act 1994</i>
LGA	Local government area
NO _x	Oxides of nitrogen
NSW	New South Wales
O ₃	Ozone
OEH	Office of Environment and Heritage
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyls
PM	Particulate matter
Roads and Maritime	Roads and Maritime Services

SEARs	Secretary's environmental assessment requirements
SO ₂	Sulfur dioxide
TBT	Tributyltin
TRH	Total recoverable hydrocarbons
Tunnel portal	The entry/exit structures at each end of a tunnel
VOC	Volatile organic compounds

1 Introduction

1.1 Overview of the Western Harbour Tunnel and Beaches Link

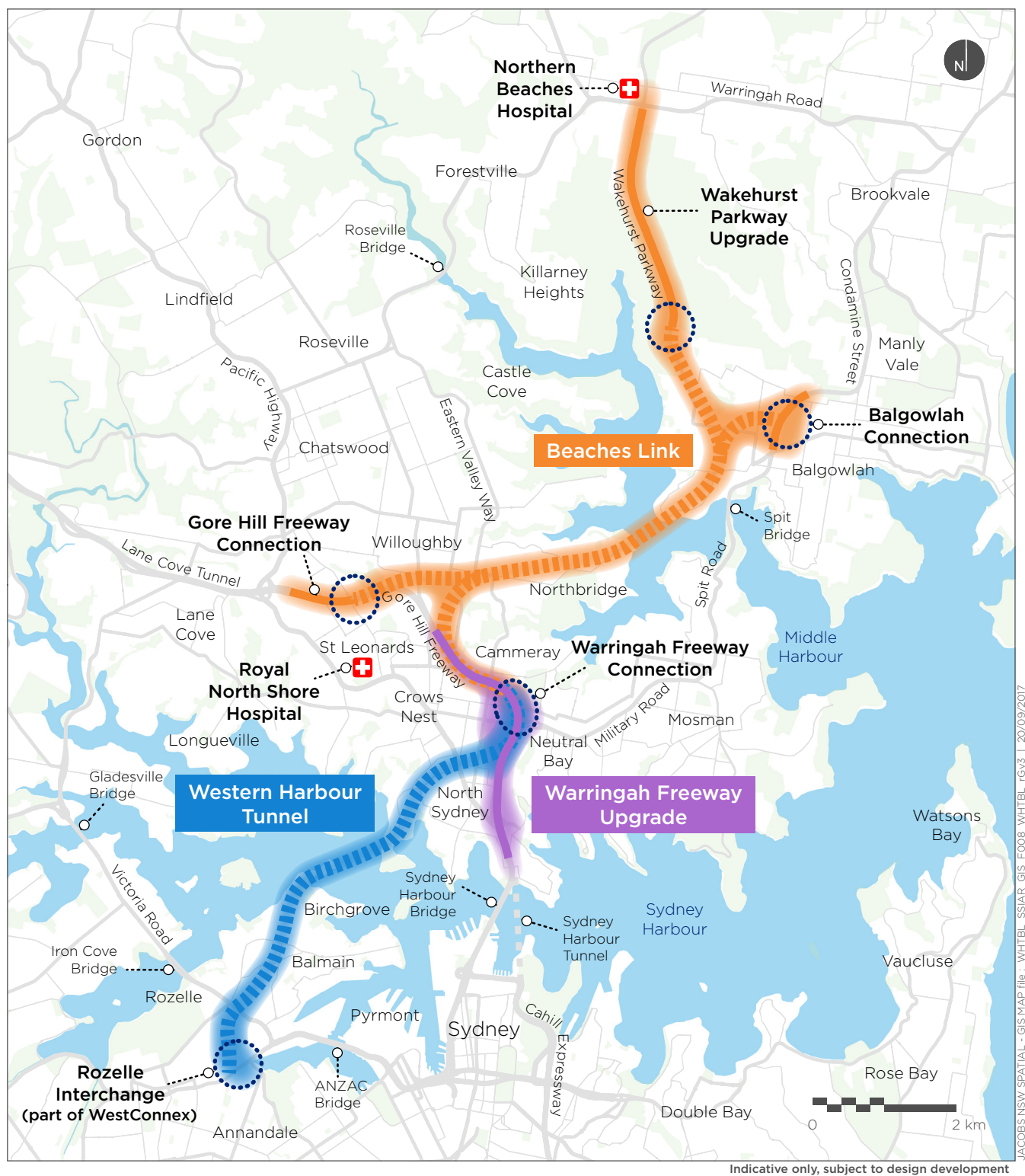
The Western Harbour Tunnel and Beaches Link is a NSW Government initiative to provide additional road network capacity across Sydney Harbour and to improve connectivity with Sydney's northern beaches. The Western Harbour Tunnel and Beaches Link program of works includes:

- The Western Harbour Tunnel and Warringah Freeway Upgrade project, comprising a new tolled motorway tunnel connection across Sydney Harbour, and the Warringah Freeway Upgrade 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, including a new tolled motorway tunnel connection from the Warringah Freeway to Balgowlah and Frenchs Forest, and upgrade and integration works to connect to the Gore Hill Freeway.

The components of the Western Harbour Tunnel and Beaches Link program of works are shown in Figure 1-1.

Together, the Western Harbour Tunnel and Beaches Link program of works would form a new 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. These key benefits are discussed further in Section 2.1.

The Western Harbour Tunnel and Warringah Freeway Upgrade project and the Beaches Link and Gore Hill Freeway Connection project may be delivered as two separate but coordinated construction packages. The two projects would be subject to separate and coordinated State significant infrastructure applications. This scoping report relates to the Western Harbour Tunnel and Warringah Freeway Upgrade project.



Key

- | | |
|---|---|
| Western Harbour Tunnel design development corridor | Road network |
| Warringah Freeway Upgrade design development corridor | Park |
| Beaches Link design development corridor | Water |
| Indicative connection to surface | |
| Indicative surface | |
| Indicative tunnel | |

Figure 1-1 The Western Harbour Tunnel and Beaches Link program of works

1.2 Overview of the project

Roads and Maritime Services (Roads and Maritime) proposes to construct and operate the Western Harbour Tunnel and Warringah Freeway Upgrade (the project), which would comprise:

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

Figure 1-1 shows the location of the project, with a more detailed description of the project provided in Chapter 4.

The project would provide an alternative to the Sydney Harbour Bridge and Sydney Harbour Tunnel (refer to Figure 1-2). It would support freight movements, bus movements, improve amenity and provide better access to employment. Further information on the strategic context and need for the project is provided in Section 2.1.



Figure 1-2 The Sydney Harbour Bridge (left) and Sydney Harbour Tunnel (right)

1.3 Statutory process

The project is State significant infrastructure and requires approval from the Minister for Planning under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Clause 14(1) of the *State Environmental Planning Policy (State and Regional Development) 2011* (S&RD SEPP) provides that development is declared, under section 115U (2) of the EP&A Act, to be State significant infrastructure for the purposes of the Act if:

- The development on the land concerned is, by the operation of a State Environmental Planning Policy, permissible without consent under Part 4 of the EP&A Act, and
- The development is specified in Schedule 3 of the S&RD SEPP.

Clause 94 of the *State Environment Planning Policy (Infrastructure) 2007* (ISEPP) permits development on any land for the purpose of a road or road infrastructure facilities to be carried out by or on behalf of a public authority without consent. As the project is for a road and road infrastructure facilities, and is to be carried out by or on behalf of Roads and Maritime, the project is permissible without development consent under Part 4 of the EP&A Act.

Clause 1(1) of Schedule 3 of the S&RD SEPP identifies as State significant infrastructure, general public authority activities for infrastructure or other development (but for Part 5.1 of the Act and within meaning of Part 5 of the Act) would be an activity for which the proponent is also the determining authority and would, in the opinion of the proponent require an environmental impact statement to be obtained under Part 5 of the Act.

Roads and Maritime, as the proponent, has formed the view that the project is likely to significantly affect the environment. On this basis, the project is declared to be State significant infrastructure under section 115U (2) of the EP&A Act by reason of the operation of clause 14 and clause 1 of Schedule 3 of the S&RD SEPP.

Accordingly, the project is subject to Part 5.1 of the EP&A Act and requires the preparation of an environmental impact statement and the approval of the Minister for Planning.

1.4 Purpose of this scoping report

This scoping report has been prepared by Roads and Maritime to describe the project, to consider the potential environmental issues associated with its construction and operation and to identify likely impacts for further investigation and assessment.

This report satisfies three main statutory purposes:

- To support a State significant infrastructure application under section 115X of the EP&A Act
- To assist the Secretary of Department of Planning and Environment in preparing the secretary's environmental assessment requirements (SEARs) for the project under section 115Y of the EP&A Act
- To address the requirements set out in clause 192 of the *Environmental Planning and Assessment Regulation 2000* for applications seeking approval of the Minister for Planning to carry out State significant infrastructure (refer to Attachment A).

This report will be made publicly available on the Department of Planning and Environment website and on the Roads and Maritime website.

2 Background

2.1 Strategic context and project need

2.1.1 Overview

The project is part of the NSW Government's commitment to deliver the Western Harbour Tunnel and Beaches Link program of works in line with the *Draft Future Transport Strategy 2056* (NSW Government, 2017), the *NSW State Infrastructure Strategy* (Infrastructure NSW, 2012), the *Long Term Transport Master Plan* (Transport for NSW, 2012) and the *Infrastructure Priority List* (Infrastructure Australia, 2016). The project would support the vision presented in *A Plan for Growing Sydney* (NSW Government, 2014a) of Sydney as a strong global city and the economic capital of Australia.

The Western Harbour Tunnel and Warringah Freeway Upgrade (the project), as part of this program of works, would support the objectives of these strategies and plans by:

- Enabling new strategic road links, including connection with the Beaches Link and Gore Hill Freeway Connection project
- Reducing travel times and improving road network reliability
- Supporting growth and productivity in key economic areas of Sydney by improving access and supporting freight and public transport movements
- Enabling improvements in urban amenity of arterial roads that perform a 'place' function including Military Road/Spit Road and roads through and around the Sydney CBD
- Improving the resilience of existing cross harbour connections, and reducing congestion through the CBD and along existing cross harbour connections
- Connecting to WestConnex and forming a new western bypass of the Sydney CBD.

The project would reduce congestion and improve road network performance and efficiency, enabling sustained growth and productivity across Sydney's Global Economic Corridor (refer to Figure 2-3). The Global Economic Corridor is one of Australia's most important economic clusters accounting for around 41 per cent (or \$195 billion) of NSW's gross regional product (NSW Government, 2014a). The project would also provide a strategic response to growing network congestion and enhance the resilience of the road network across Sydney.

2.1.2 Project need

In Sydney, peak period congestion on existing transport routes and modes is already a significant challenge. The size of Sydney means that it is reliant on strategic centres across the metropolitan area to provide services and employment, including over 40 per cent of Sydney's jobs. Each day, more than 630,000 trips are made to the Sydney CBD and over 1.2 million daily journeys pass through and around it (Transport for NSW, 2013a). As Sydney's population grows from 4.3 million to an estimated six million by 2031, so will the pressure on access to these strategic centres. Consequently, improvements to existing transport networks and creation of new transport connections will be essential.

To prepare Sydney for future population growth and to ensure ongoing economic prosperity and functionality of the city, additional cross harbour capacity is required to:

- Increase transport capacity across Sydney Harbour and improve private and public transport journey times through the Global Economic Corridor
- Facilitate CBD distributor functions by adding a significant and high quality western CBD bypass function to the city's motorway network

- Reduce congestion within the CBD and through the Global Economic Corridor, and increase resilience of the existing cross harbour transport network
- Integrate with transport networks including existing cross harbour routes, the Gore Hill Freeway and future road network projects including WestConnex and Beaches Link and Gore Hill Freeway Connection
- Reduce environmental, social and amenity impacts associated with existing and future congestion.

Many of the road network connections through and around the Sydney CBD and North Sydney, including the Sydney Harbour Bridge, Sydney Harbour Tunnel, ANZAC Bridge/Western Distributor, Warringah Freeway and the Eastern Distributor serve two functions. These two functions, as shown in Figure 2-1, are:

- Access to the Sydney CBD and surrounds, North Sydney and the lower north shore (ie a distributor function)
- Connectivity between the south and west of Sydney and the north of Sydney, for trips that do not have the Sydney CBD or North Sydney as an origin or destination (ie a bypass function).

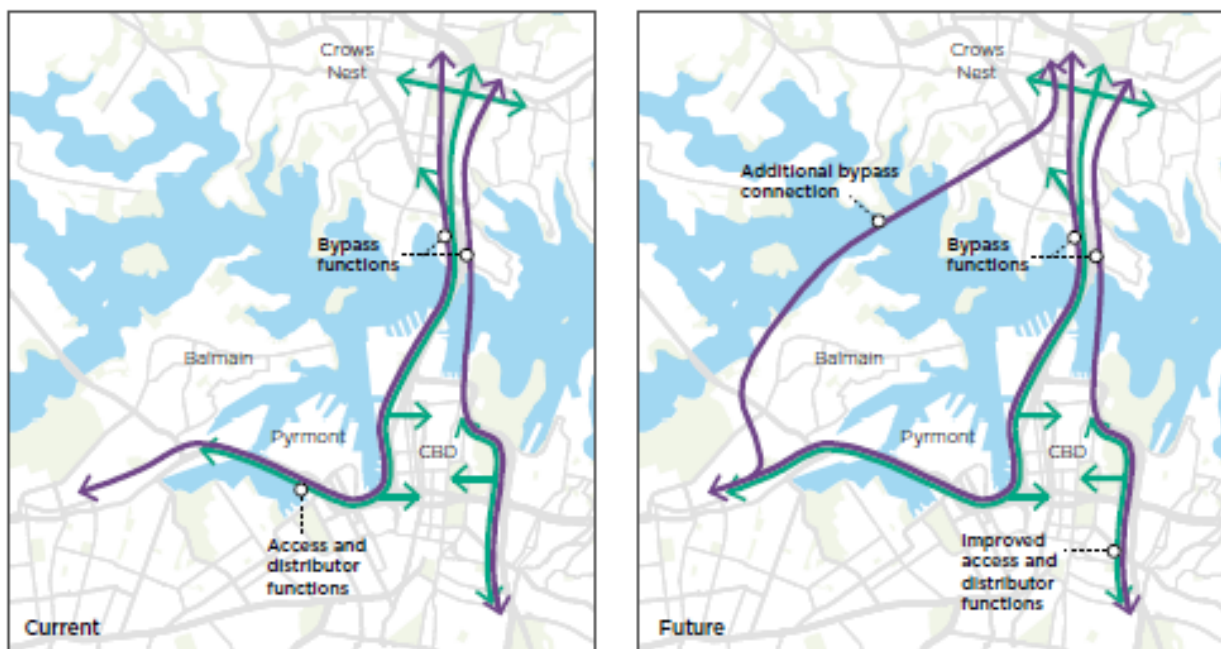


Figure 2-1 Function of CBD distributors with and without the project

The existing road network through and around the Sydney CBD and North Sydney lacks the capacity to support both distributor and existing and future bypass journeys contributing to congestion and longer journey times.

The project would provide a significant new motorway standard connection across Sydney Harbour. This would relieve congestion on the Sydney Harbour Bridge and Sydney Harbour Tunnel, enabling faster, more reliable journeys for bus customers, freight and private vehicle users on all road corridors crossing Sydney Harbour.

By increasing cross harbour capacity and reducing existing congestion, the project would facilitate improvements to the performance of CBD access and distributor roads. By connecting WestConnex to the Warringah Freeway, the project would also provide a further and significant high quality bypass of the Sydney CBD, removing through traffic from the road network through

and immediately around the CBD. This new CBD bypass would serve through journeys between the south and west of Sydney, including the international gateways of Sydney Airport and Port Botany, and strategic centres north of the harbour including North Sydney, Chatswood and Macquarie Park. The Warringah Freeway Upgrade component of the project would provide further connections to the Beaches Link and Gore Hill Freeway Connection project, and improved access to the north and north-east of Sydney.

Currently, a traffic incident either on the Sydney Harbour Bridge or in the Sydney Harbour Tunnel can quickly and severely impact transport movements across Sydney Harbour. The project would boost the resilience of the road network by providing an additional route to maintain the movement of people and goods through the core of the Global Economic Corridor in the event of an incident on one or more of the arterial corridors.

2.1.3 Historic context

The strategic development of the Western Harbour Tunnel and Beaches Link program of works extends back to the 1930s when the need for additional capacity across Sydney Harbour was identified as part of the development of the Warringah Transport Corridor.

Timelines for the historic development of the Warringah Transport Corridor and additional harbour crossing as precursors to the Western Harbour Tunnel and Beaches Link program of works are provided in Table 2-1 and Table 2-2.

Table 2-1 Historic development of the Warringah Transport Corridor

Timeframe	Development of the Warringah Transport Corridor
1930s	Plans were developed for a new Warringah Transport Corridor to the Northern Beaches.
1953	The Warringah Transport Corridor was adopted by the State Government as part of the Main Road Development Plan 1953.
1968	A review of the Main Road Development Plan 1953 was carried out in the Sydney Regional Outline Plan (NSW State Planning Authority, 1968) and further studies were recommended.
1974	The Sydney Area Transportation Study recommended that the Warringah Freeway be part of the long term road network in Sydney.
1983	The Commission of Inquiry into the Warringah Transport Corridor found that a new surface road to the Northern Beaches in the identified corridor would result in unacceptable levels of community and environmental impacts. The Inquiry noted that the feasibility of the proposal would be improved by future tunnelling technology alleviating some of the potential environmental and community impacts.
1985	The Burnt Bridge Creek Deviation at Balgowlah opened to traffic as the first component of the Warringah Transport Corridor.
2012	The NSW Long Term Transport Master Plan (Transport for NSW, 2014) proposed a new harbour crossing and a bus tunnel bypassing Military Road.
2014	Commitments were made in the NSW State Infrastructure Strategy Update 2014 (Infrastructure NSW, 2014) that the Government would commence work on an additional harbour crossing and would further review and develop Beaches Link.
2015-2016	Transport for NSW and Roads and Maritime carried out preliminary work to establish the viability and high level conceptual design for the Western Harbour Tunnel and Beaches Link program of work.

Timeframe	Development of the Warringah Transport Corridor
2016	The draft North District Plan released by the Greater Sydney Commission identified the Western Harbour Tunnel and Beaches Link program of works as an important initiative to improve connections and access to and from northern Sydney.
2017	In March 2017, the NSW Government announced the commencement of a comprehensive community engagement program to inform the development of designs for the Western Harbour Tunnel and Beaches Link program of works.
2017	Roads and Maritime carries out community and stakeholder engagement, preliminary environmental investigations and further design development for the Western Harbour Tunnel and Beaches Link program of works.
2017	In October 2017, the Draft Future Transport 2056 was released which is an update of the 2012 Long Term Transport Master Plan. The Western Harbour Tunnel and Beaches Link project is identified as a Committed initiative (within 0-10 years, subject to the final business case).

Table 2-2 Historic development of additional cross harbour capacity

Timeframe	Development of additional cross harbour capacity
1930s	An additional harbour crossing was investigated as part of developing plans for the Warringah Transport Corridor.
1964	Opening of the Gladesville Bridge provided an additional harbour crossing to the west of the Harbour Bridge
1981	The NSW Government established a Second Harbour Crossing Inquiry which presented alternative proposals for public comment including a route linking Greenwich to Birchgrove with a bridge or tunnel west of the Sydney Harbour Bridge. Due to strong community and stakeholder opposition the government abandoned the Second Harbour Crossing Inquiry without further analysis into the feasibility of the proposals.
1992	Opening of the Sydney Harbour Tunnel provided an additional harbour crossing and eastern bypass of the CBD.
2012	The NSW Government's <i>NSW Long Term Transport Master Plan</i> (Transport for NSW, 2014) proposed a new harbour crossing to the west of the CBD identifying it as a key 'missing link' in the Sydney motorway network.
2014	Commitments were made in the <i>NSW State Infrastructure Strategy Update 2014</i> (Infrastructure NSW, 2014) that the Government would commence work on an additional harbour crossing.
2015-2016	Roads and Maritime carried out preliminary work to establish the viability and high level conceptual design for the Western Harbour Tunnel and Beaches Link program of work.
2017	In March 2017, the NSW Government announced the commencement of a comprehensive community engagement program to inform the development of designs for the Western Harbour Tunnel and Beaches Link program of works, including an additional harbour crossing.
2017	Roads and Maritime carries out community and stakeholder engagement, preliminary environmental investigations and further design development for the Western Harbour Tunnel and Beaches Link program of works, including an additional harbour crossing.

2.1.4 Strategic context

The justification for the project within the context of key strategic policy documents is outlined below. Further detail on these key strategic policy documents and relevance to the project is provided in Attachment B.

State priorities: NSW Making it happen

NSW: Making it happen (NSW Government, 2015) sets out 12 priorities with 30 targets to measure and deliver projects that create a stronger, healthier and safer NSW. Under the building infrastructure priority, there is a target of improving road travel reliability – 90 per cent of peak travel on key travel roads on time. The project would contribute to this target through:

- Improving travel times and reliability on existing cross-harbour motorways (Sydney Harbour Bridge and Sydney Harbour Tunnel)
- Improving travel times and reliability on access and bypass motorways around Sydney's CBD, (Western Distributor, ANZAC Bridge and Eastern Distributor)
- Improving the resilience of the transport network.

NSW Long Term Transport Master Plan

The *NSW Long Term Transport Masterplan* (Transport for NSW, 2012) identifies locations of significant congestion on the Sydney road network and sets out a 20-year plan to improve transport in NSW. One of the key priorities identified in the plan is filling the 'missing links' in the motorway network to reduce the congestion and consequent trip delays that adversely impact across the Sydney road network.

The project would increase cross harbour road network capacity. This would assist in addressing congestion on the existing harbour crossings and meeting the need for a new western bypass of the Sydney CBD. A new western bypass of the Sydney CBD is identified in the *NSW Long Term Transport Masterplan* as one of the key missing links in the Sydney motorway network. The project would also address key congestion zones around North Sydney as indicated in Figure 2-2.

The priorities identified in the *NSW Long Term Transport Master Plan* to investigate a new harbour crossing are also reflected in *Rebuilding NSW State Infrastructure Strategy 2014* (NSW Government, 2014b) and *A Plan for Growing Sydney (2014)* (NSW Government, 2014a). *A Plan for Growing Sydney* shows how the project would fit with existing and potential future transport links and modes across Sydney (refer to Figure 2-3).

Other strategic planning policies

Other NSW policies and plans for transport relevant to the project include:

- *Draft North District Plan* (Greater Sydney Commission, 2016)
- *Sydney's Bus Future* (Transport for NSW, 2013b)
- *Sydney's Cycling Future* (Transport for NSW, 2013c)
- *Draft NSW Roads Plan* (Transport for NSW, undated)
- *Northern Beaches Transport Action Plan* (Transport for NSW, 2016).

Further detail on the relevance of these plans to the Western Harbour Tunnel and Warringah Freeway Upgrade is included in Attachment B.

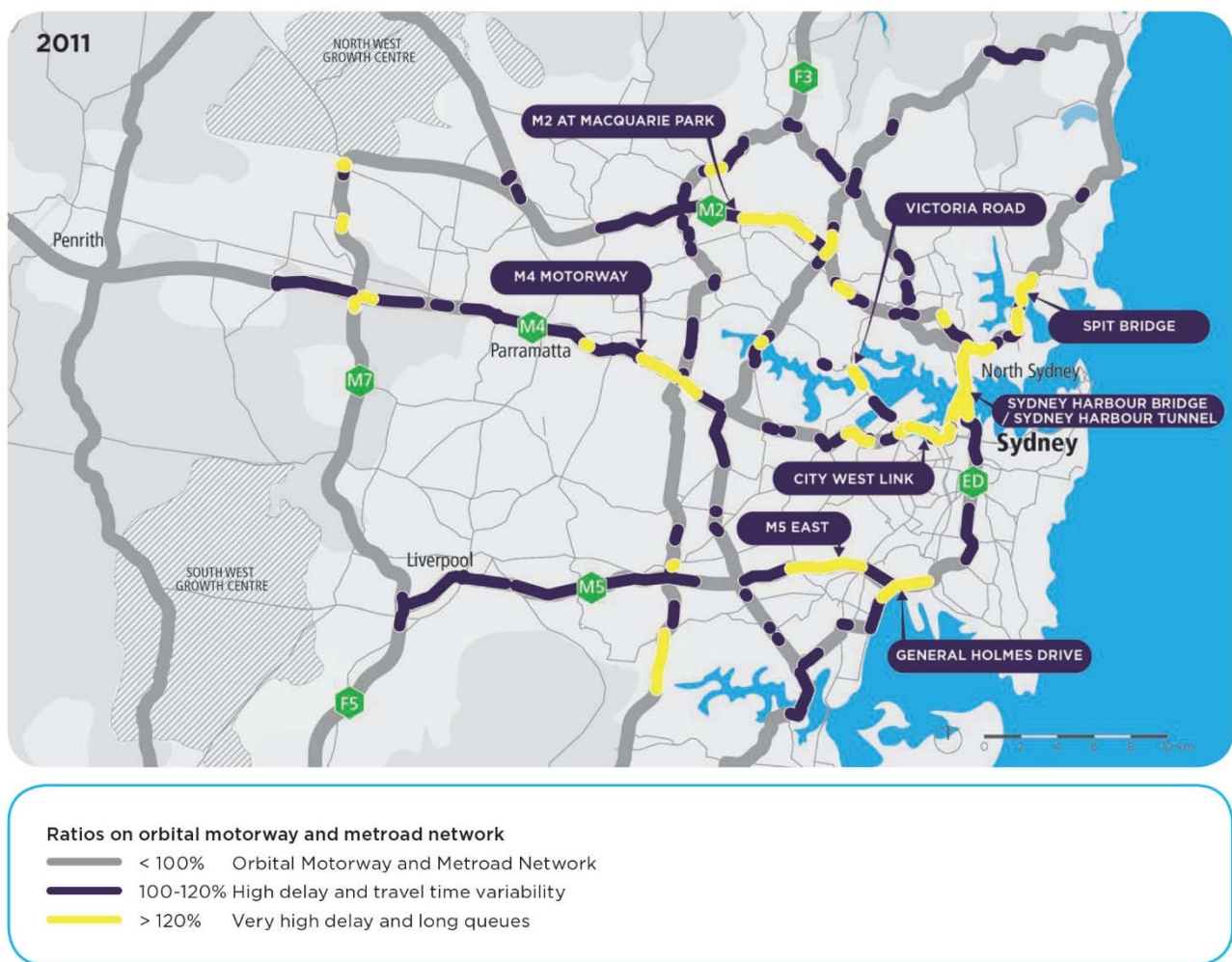


Figure 2-2 Sydney road network performance in 2011 (AM peak) showing congestion hot spots
(Source: NSW Long Term Transport Masterplan)

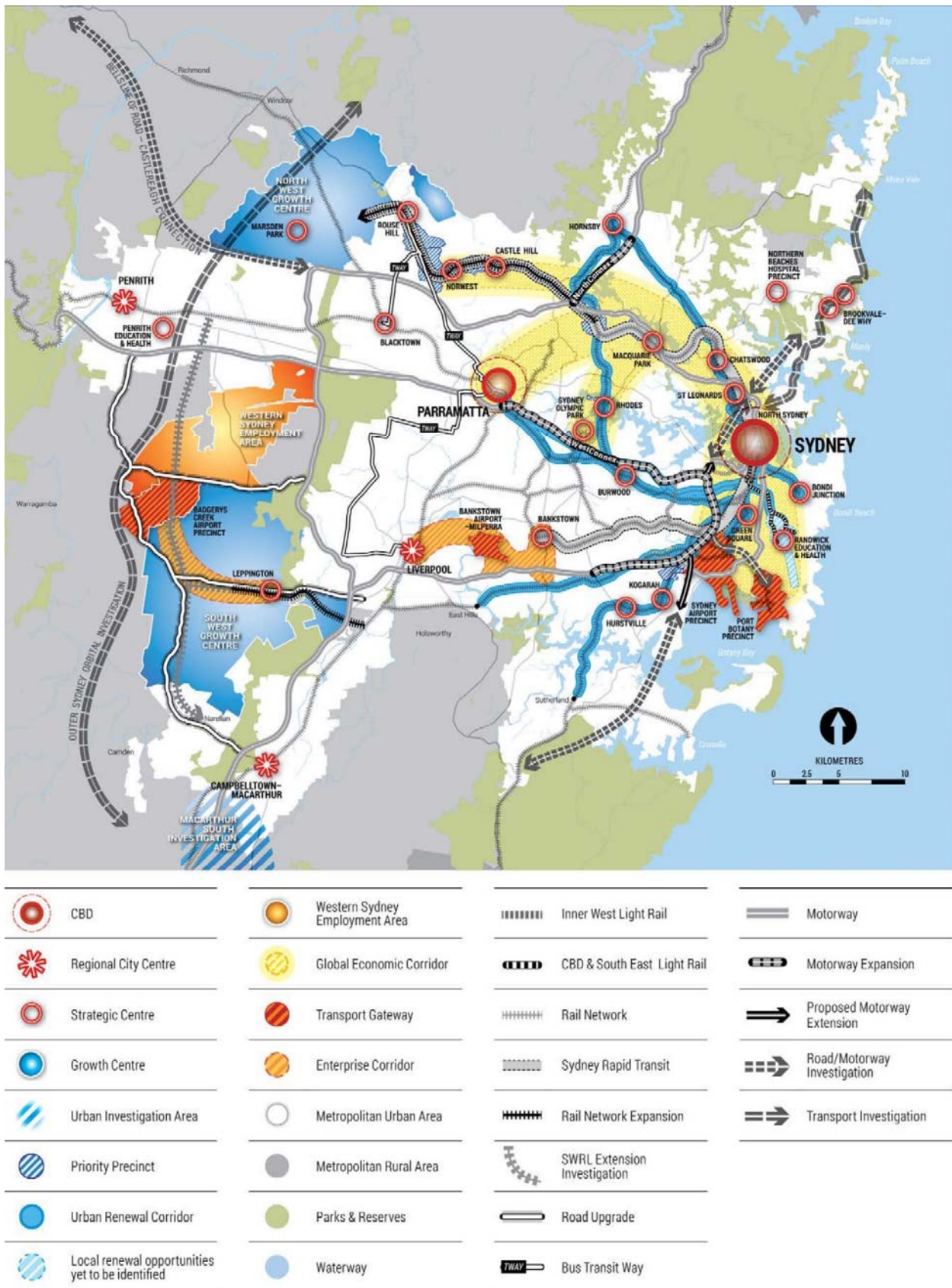


Figure 2-3 Existing and potential future transport links and modes across Sydney
(Source: *A Plan for Growing Sydney 2014*)

2.2 Project objectives

Project objectives have been identified to address key road network issues and project need outlined in Section 2.1. The objectives for the project (refer to Table 2-3) have been grouped according to the key focus areas of transport, economic productivity, city shaping, community and environment.

Table 2-3 Project objectives

Focus area	Objective
Transport	• Improve travel times and reliability on the Sydney Harbour Bridge and through the Sydney Harbour Tunnel • Improve travel times and reliability on access and bypass routes around the Sydney CBD, including the Western Distributor and ANZAC Bridge • Improve the resilience of the road transport network in and around the Sydney CBD and North Sydney • Enhance the efficiency and effectiveness of the Warringah Freeway by separating bypass and distributor functions, improving bus access and improving connectivity with the Sydney Harbour Bridge • Improve road safety by reducing road network congestion.
Productivity	• Support efficient movement of people and freight • Support the future growth and productivity of Global Sydney by improving access to labour markets in other regions of Sydney.
City shaping	• Fill a key missing link in the Sydney motorway network • Enable improvements to urban amenity by reducing congestion.
Community and environment	• Minimise property acquisition • Minimise adverse impacts on the environment and the community during construction and operation • Enhance community amenity.

2.3 Selection of the preferred project

2.3.1 Strategic alternatives

The following strategic alternatives have been considered against their ability to deliver on the identified project objectives:

- Base case ('do nothing')
- Improvements to the existing arterial road network
- Improvements to public transport
- Construction and operation of a new motorway connection (the project).

Base case

The base case option is to do nothing and to rely on the continued operation of the existing road network to meet future transport demand. As outlined in Section 2.1, the existing road network is significantly congested under peak period demand and is vulnerable to extensive network delays creating long and unreliable journey times. Significant congestion and a lack of resilience to network delays are particularly pronounced around and across existing harbour crossings.

As Sydney's population continues to grow, this network vulnerability to congestion and significant delay will worsen with significant congestion incidents likely to become more frequent. Accordingly, this option would not meet the project objectives and would adversely impact on the future economy, opportunities for economic growth, amenity, environment and competitiveness of Sydney as a global city.

The base case option has been rejected as a viable strategic alternative because it would not address the identified project need or adequately satisfy the project objectives.

Improvements to the existing arterial road network

Roads and Maritime currently has an extensive program of new and upgraded road projects underway and planned across Sydney to address congestion and to improve travel times.

Information on these projects can be found on the Roads and Maritime website (www.rms.nsw.gov.au/projects/index.html) and in Sydney include:

- The Easing Sydney's Congestion Program, including the M4 Smart Motorway, the Parramatta Congestion Improvement Program, and the accelerated Pinch Point and Clearways Programs
- The Northern Beaches Hospital road upgrade project
- Intersection improvements on Mona Vale Road and Forest Way, Terrey Hills
- The WestConnex program of works, including the M4 Widening and M4 East, the New M5, the M4-M5 Link and Sydney Gateway
- The NorthConnex project
- Planning for the new M12 motorway and improved connectivity around the future Badgerys Creek airport
- Upgrades to The Northern Road, Bringelly Road, Narellan Road and Schofields Road
- Planning for the future F6 extension
- Planning for the potential future Outer Sydney Orbital.

These projects form part of a broader suite of transport initiatives being delivered and coordinated with other transport agencies, including Transport for NSW, Sydney Trains, Sydney Ferries and Sydney Buses. The broader suite of transport initiatives are detailed in the *NSW Long Term Transport Masterplan* (Transport for NSW, 2012).

The projects listed above all address identified needs in Sydney's existing arterial road network, but they would not provide necessary additional cross harbour capacity. None of these projects would relieve cross harbour congestion or address the need to upgrade the Warringah Freeway to improve separation of through-traffic and bypass functions.

Ways to increase road capacity across Sydney Harbour have been considered for many years (refer to Section 2.1.3). Options to provide additional capacity have included investigations into adding new lanes to the Sydney Harbour Bridge and developing new harbour crossing locations. Attempts to design modifications to the existing Sydney Harbour Bridge have not proved feasible due to engineering constraints limiting the additional load carrying capacity of the bridge and the existing congestion on approaches to the bridge. The significant heritage, visual and tourist values of the Sydney Harbour Bridge also limit the feasibility of major capacity increases.

Accordingly, substantial new improvements to the existing arterial road network have been rejected as a strategic alternative. It is not feasible to add additional lanes to the existing Sydney Harbour Bridge or Sydney Harbour Tunnel, and the impacts of substantial capacity increases to either connection are unlikely to be acceptable.

Improvements to public transport

The NSW Government, through Transport for NSW is currently planning and delivering a series of new and upgraded public transport connections consistent with the suite of transport projects outlined in the *NSW Long Term Transport Masterplan* (Transport for NSW, 2012).

Information on these projects can be found on the Transport for NSW website (www.transport.nsw.gov.au/projects/current-projects) and in Sydney include:

- Delivery of the Sydney Metro City & Southwest project to provide a new passenger rail connection across Sydney Harbour and connectivity to the north-west and south-west of Sydney
- Delivery of the CBD and South East Light Rail project, from Circular Quay to Randwick and Kingsford
- The Sydney's Ferry Fleet program, including additional ferries and increased ferry services
- The More Trains, More Services Program to boost passenger rail services and improve infrastructure over the next three years
- Upgrades to existing train stations as part of the Transport for NSW Transport Access Program (TAP), including at Arncliffe, Berala, Blacktown, Croydon, Edgecliff, Harris Park, Heathcote, Jannali, Leura, Narwee, Panania, Pendle Hill, Penrith, Toongabbie, Wentworth Falls and Wentworthville
- Delivery of the New Intercity Fleet to improve passenger rail services between Sydney and the Central Coast, Newcastle, the Blue Mountains and the South Coast
- Planning for Sydney Metro West to provide a new passenger rail connection between the Sydney CBD and Parramatta
- Upgrades to commuter car parking at stations across the Sydney passenger rail network
- Planning for a potential future extension of the South West Rail Link.

Some of these projects, including the Sydney Metro City & Southwest project and Sydney's Ferry Fleet Program, may contribute to relieving congestion on existing cross harbour connections. However, these projects would not be sufficient to fully resolve existing cross harbour congestion and capacity constraints, nor would they fully address the project objectives (refer to Table 2-3).

Given the complexity of journey patterns within the Sydney metropolitan area and the dispersed nature of origin and destination points for an individual journey, not all journeys can be catered for with public transport. The project would complement existing and future public transport projects, providing additional cross harbour capacity whilst catering for the diverse array of journeys and future population growth. It would also materially improve the bus network functionality, in particular the reliability and optionality for both long distance and inner North Shore services, and the functionality of Warringah Freeway and Sydney Harbour Bridge bus lanes.

Construction and operation of a new motorway (the project)

Construction and operation of an additional harbour crossing to the west of the Sydney Harbour Bridge has been discussed since the 1930s (refer to Section 2.1.3). Crossing options considered over the years have included new bridges and tunnels at several different crossing locations. Since the release of the *NSW Long Term Transport Master Plan* and *Rebuilding NSW State Infrastructure Strategy 2014*, investigations into alternative feasible harbour crossings have focussed on tunnel options linking WestConnex at Rozelle to around North Sydney.

A new motorway tunnel connection would:

- Increase the north-south harbour crossing road capacity
- Provide an alternative bypass of the CBD
- Improve resilience of the road network

- Reduce peak period congestion in arterial corridors
- Improve travel times between key centres for all vehicles (including buses).

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

Following identification of the preferred strategic alternative, different route and tunnel crossing options were considered. These options are discussed further in Section 2.3.2 and Section 2.3.3.

2.3.2 Corridor options

The two main options for providing a new harbour crossing are either a bridge or a tunnel. Because of the very high visual, tourist and heritage values of the Sydney Harbour Bridge and the surrounding Sydney Harbour setting, a new bridge across the harbour was discounted early in the options evaluation process. Using tunnels to cross the harbour would provide similar connectivity and design outcomes as a new bridge whilst avoiding many of a bridge's potential impacts on the visual, tourist and heritage context of the harbour and the Sydney Harbour Bridge. Tunnels also provide the opportunity to more effectively manage and control impacts from vehicle emissions and traffic noise, and to minimise potential surface disturbance in sensitive and developed areas.

Four main corridors were considered to connect the motorway networks on the northern and southern sides of Sydney Harbour, as shown in Figure 2-4. The corridor options were identified as the red option, the orange option, the brown option and the blue option.

The four main corridors were evaluated to identify the most technically, socially and environmentally acceptable tunnel corridor option with the most efficient transport connections. Key factors contributing to the identification and evaluation of these four main corridors were:

- Geology, geotechnical stability and suitability for tunnel construction
- Tunnel depth, tunnel geometry and ability to achieve acceptable road gradients
- Connectivity with the existing road network, particularly the motorway and arterial road networks to the north and south of Sydney Harbour
- Opportunities to minimise the need for property disturbance and acquisition
- Opportunities to avoid or minimise impacts on the natural, built and social environments.

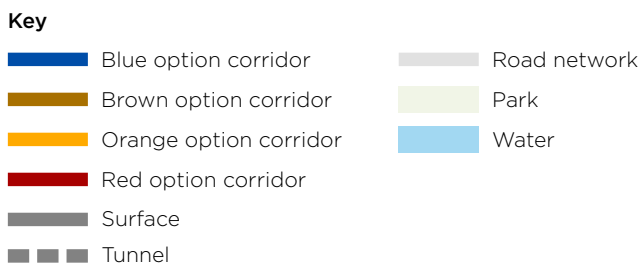
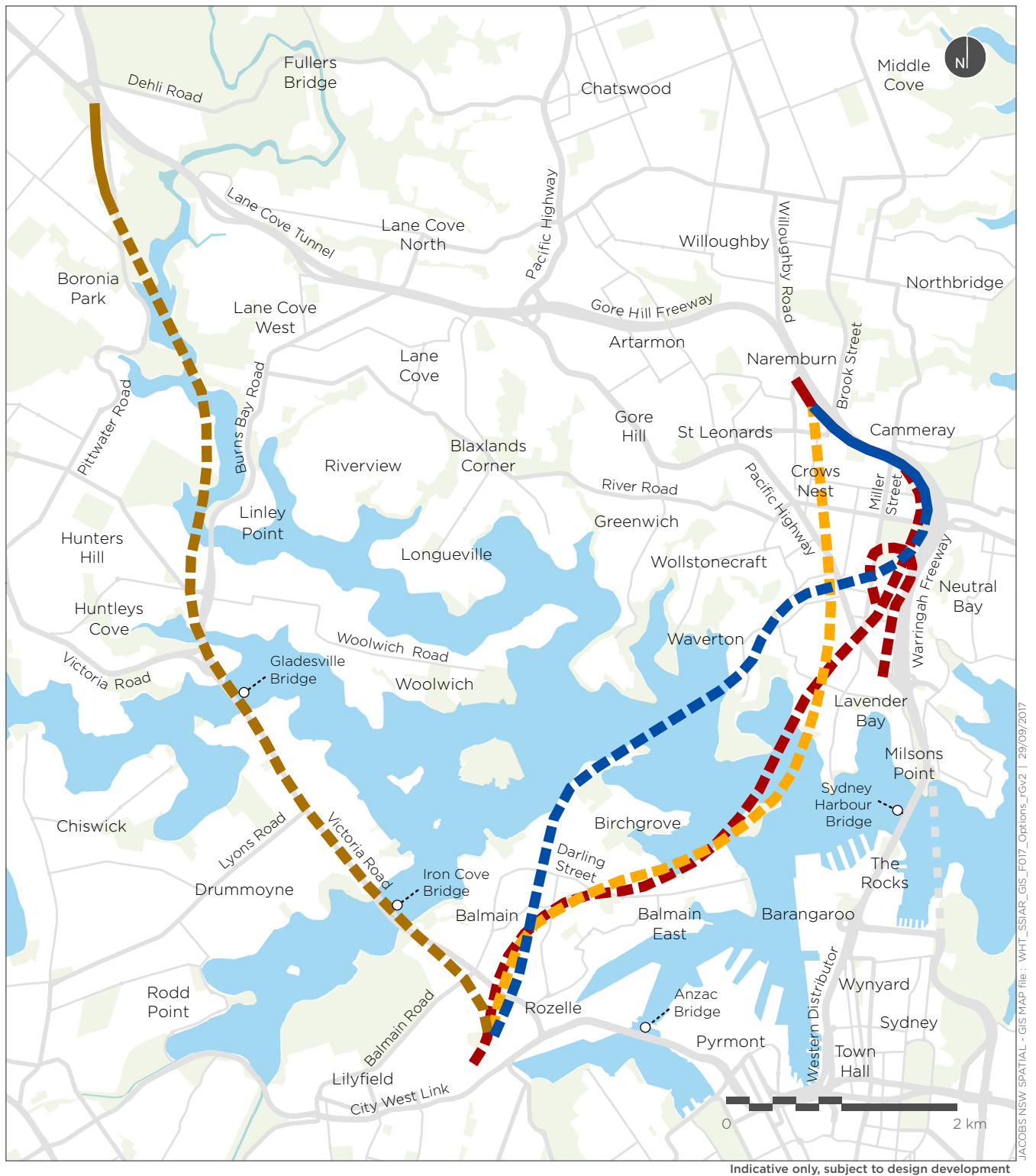


Figure 2-4 Western Harbour Tunnel and Warringah Freeway Upgrade main corridor options

Red corridor option

The red corridor option included tunnels crossing the harbour between Balmain, Goat Island and McMahon's Point. Although this corridor option provided necessary road network connectivity, it included several disadvantages when compared with other options, including:

- The need for steep gradients, with adverse outcomes for traffic performance and in-tunnel air quality
- Connectivity at North Sydney required long, circular access ramps with adverse outcomes for traffic performance
- Potential impacts to Goat Island (part of the Sydney Harbour National Park)
- Potentially greater impacts to the main shipping channel through Sydney Harbour, compared with other corridor options.

The red corridor option was rejected following consideration of these issues compared with other corridor options.

Orange corridor option

The orange corridor option was similar to the red corridor option across Sydney Harbour, with the key difference being connection to the Gore Hill Freeway near Artarmon rather than the Warringah Freeway at North Sydney. Compared with the red corridor option, the orange corridor option included substantially improved gradients and avoided the risk of increasing congestion through the existing constrained road corridor at Naremburn. However, disadvantages of this corridor option compared with options included:

- The need for a relatively long tunnel connection
- Reduced road network connectivity relative to other options, including limited connectivity to North Sydney and the Beaches Link and Gore Hill Freeway Connection project.

The orange corridor option was rejected following consideration of these issues compared with other corridor options.

Brown corridor option

The brown corridor option included a crossing of Sydney Harbour further to the west, broadly under Victoria Road and Gladesville Bridge. This corridor option connected to the Hills M2 Motorway/Lane Cove Tunnel corridor around East Ryde. Disadvantages of this corridor option compared with other options included:

- The need for a significantly longer tunnel connection than other options
- Significantly reduced road network connectivity relative to other options, including no close connectivity to North Sydney and the Beaches Link and Gore Hill Freeway Connection project
- Potential impacts on southern parts of the Lane Cove National Park and the Lane Cove River.

The brown corridor option was rejected following consideration of these issues compared with other corridor options.

Blue corridor option

The blue corridor option included a relatively shallow tunnel connection across Sydney Harbour from around Birchgrove to around Balls Head, based on local geology. This corridor option addressed many of the disadvantages of the other options, including good connectivity to North Sydney and the Beaches Link and Gore Hill Freeway Connection project and flatter tunnel gradients. The blue corridor option also avoided many of the sensitive areas potential affected by other options, including the Sydney Harbour National Park and Lane Cove National Park.

On the basis of its superior performance relative to other corridor options, the blue corridor option was identified as the preferred corridor to be carried forward for further route alignment design development (refer to Section 2.3.3).

2.3.3 Route options within the preferred corridor

Following identification of the blue corridor option as the preferred corridor for the Western Harbour Tunnel and Warringah Freeway Upgrade, further project development work has included:

- Community and stakeholder engagement to identify key issues to be taken into account in the design of the project (refer to Chapter 3)
- Environmental investigations along the corridor, including desktop and field investigations to identify key environmental issues
- More detailed design development taking into account community and stakeholder feedback and the outcomes of environmental investigations.

Project design development is currently underway with the aim of developing a reference design which will form the basis of an environmental impact statement for the project. The project design will continue to develop including:

- In response to ongoing community and stakeholder engagement
- To address impacts identified during the preparation of the environmental impact statement and issues that may be raised during the statutory approvals process for the project
- Innovation through procurement of the detailed design and construction contractor(s) for the project.

Key design aspects currently being considered for the project include:

- Construction methodology, including whether the tunnels would be constructed with roadheaders and/or tunnel boring machines
- The horizontal and vertical alignments of the project tunnels
- Design and configuration of the tunnel ventilation systems
- Locations of construction sites.

Construction methodology

Road tunnels are usually constructed using roadheaders, tunnel boring machines or a combination of the two.

Roadheaders are made up of rotating cutting heads mounted on a boom or similar structure. They can be used to cut away rock in a desired shape and tunnel cross sectional area. Tunnel boring machines are larger, and comprise a rotating circular cutting wheel that excavates rock to produce a circular tunnel cross sectional area. Examples of roadheaders and tunnel boring machines are shown in Figure 2-5. The indicative profiles of the Western Harbour Tunnel if roadheaders or tunnel boring machines are used are shown in Figure 2-6.



Figure 2-5 Examples of a tunnel boring machine (left) and a roadheader (right)

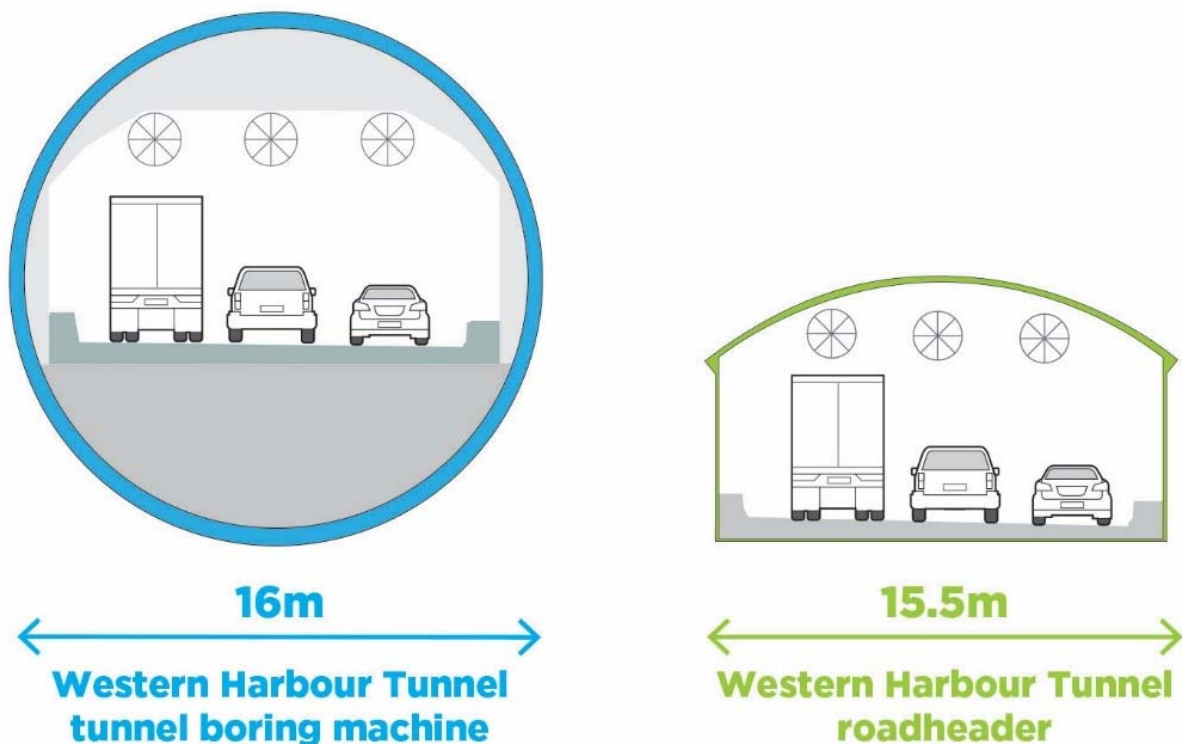


Figure 2-6 Comparison of tunnel profiles using a tunnel boring machine (left) and a roadheader (right)

Geology and geotechnical conditions are the key factors that determine whether roadheaders or tunnel boring machines are most appropriate for construction of tunnels. A decision to use either tunnel boring machines or roadheaders would therefore affect design aspects such as horizontal and vertical alignments (refer below). Other factors that would influence this decision include:

- Size and availability of surface access sites for tunnelling – tunnel boring machines usually require larger access sites than roadheaders
- The need for intermediate surface construction and access sites – depending on the length of tunnel, roadheaders may require intermediate surface construction and access sites. Tunnel boring machines can usually construct much longer tunnels without the need for intermediate surface access points
- Spoil generation and handling – because of their larger cross sectional area, tunnel boring machines usually produce more spoil than roadheaders
- Construction cost – tunnel boring machines are usually more expensive to operate than roadheaders.

Design options for the mined components of the project tunnels currently include construction with roadheaders, tunnel boring machines or a combination of the two. A preferred construction methodology would be identified and included in the environmental impact statement for the project.

Horizontal and vertical alignments

Within the preferred blue corridor option, design development for the project is currently considering different horizontal and vertical alignments for the project tunnels.

The horizontal and vertical alignments of the tunnels are constrained by the need to connect with WestConnex at Rozelle and the Warringah Freeway near North Sydney. However, between these points there is some flexibility in both the horizontal and vertical alignments of the tunnels. Different alignments are currently being considered, taking into account:

- Construction methodology, including the use of roadheaders or tunnel boring machines
- Local geological and geotechnical conditions
- Tunnel geometry, gradient and traffic performance
- The required length of mainline tunnels and ramps, noting that shorter tunnels are preferable in terms of cost and construction program.

The geology under Sydney Harbour is mostly rock at depth that is overlain by sediments. Depending on the vertical alignment of the tunnels, they may need to be constructed through rock, through sediment or a combination of these. Tunnelling through rock, and particularly Hawkesbury Sandstone, is preferred because it is a strong, stable material. However, Hawkesbury Sandstone and other rock materials can be deep under the harbour and there is a balance between the preference to tunnel through rock and the gradient of the tunnels. The gradient of the tunnels affects traffic performance, in-tunnel air quality and ventilation design.

Shallower tunnel options would encounter soft sediments and softer, more weathered rock, which may require strengthening and stabilisation. If required, stabilisation techniques such as grouting may be necessary for tunnel vertical alignments that pass through these areas.

An alternative to tunnelling through rock or sediment would be to place precast tunnels units on top, or within the top layers, of harbour rock and sediments. This alternative would involve excavation to create a trough through the rock and sediments, and installation of precast immersed tube tunnel (IMT) units within the trough.

Figure 2-7 shows the three main options for the vertical alignment of the Sydney Harbour tunnels:

- A deep tunnel, completely within rock (green)
- A shallower tunnel, with parts of the tunnel in softer, weathered rock or sediment (light blue)
- An immersed tube tunnel lying on top or within the top layers of softer, weathered rock and sediments (dark blue).

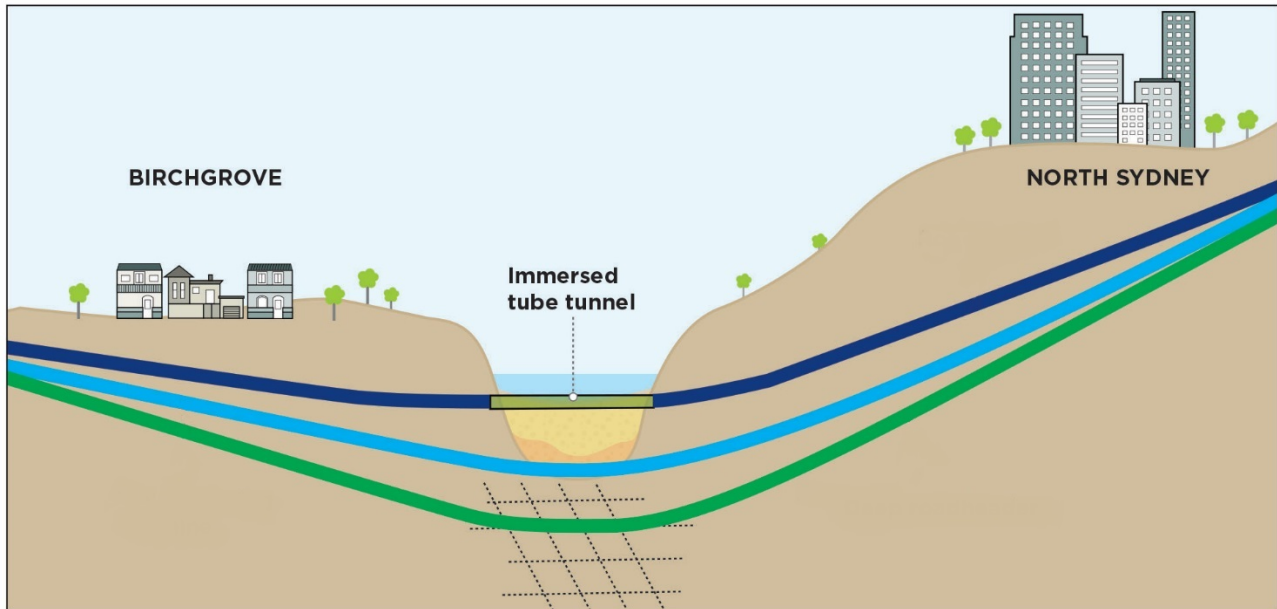


Figure 2-7 Main vertical alignment options for the harbour tunnels

If immersed tube tunnels are required, they would be constructed by placing a series of pre-cast tunnel segments, with backfilling around the tunnel using aggregate materials. Relatively small volumes of excess sediments excavated to form the immersed tube tunnel trough would require disposal, either on land if the materials are contaminated or offshore in a disposal area approved under the *Environment Protection (Sea Dumping) Act 1981*. This is the same construction methodology and sediment disposal approach adopted for construction of the existing Sydney Harbour Tunnel in the early 1990s (refer to Figure 2-8).



Figure 2-8 Construction of the Sydney Harbour Tunnel immersed tube tunnels in the early 1990s

Tunnel ventilation systems

The project tunnels would require ventilation systems to meet stringent in-tunnel air quality criteria for its safe operation and to effectively capture, manage and disperse vehicle emissions.

Consistent with most of the road tunnels around the world, the project tunnels would be longitudinally ventilated. Longitudinal ventilation relies mainly on the piston effect generated by vehicles travelling through the tunnels to move tunnel air forward, with additional mechanical ventilation provided by jet fans installed in the tunnel ceiling where required. Air would be drawn into each tunnel via the entry portal and would gather vehicle emissions as the air passes along the tunnel length.

Before the tunnel air reaches the exit portal, it would be directed through a ventilation facility using fans and effectively dispersed into the atmosphere. Release of tunnel air from the exit portals (also known as portal emissions) are not proposed as part of the project. Tunnel ventilation fans would be used to prevent portal emissions under normal operating conditions.

The tunnel ventilation systems, including the number and location of ventilation outlets, are currently being developed as part of the project design. The ventilation systems would be designed to achieve acceptable in-tunnel and ambient air quality. Ventilation facilities would be located to minimise impacts on the surface, including avoiding sensitive environments and minimising the need for acquisition and property impacts.

Construction sites

In addition to the surface disturbance areas required for the Warringah Freeway Upgrade and surface road works, a series of temporary construction compounds would be required along the project alignment. The construction compounds would be needed to support tunnelling and surface works. The number, sizes and locations of construction compounds would depend on whether

roadheaders or tunnel boring machines are used to construct the project, as well as the final horizontal and vertical alignments of the tunnels.

Construction compound sites may include activities such as construction laydown and staging areas, concrete batching and distribution, component casting works, worker facilities and amenities, and vehicle parking.

Environmental investigations and stakeholder feedback are currently being used to inform the identification of appropriate construction compound sites. Key factors being applied to identification of construction compound sites include:

- Locating the construction compound sites as close as possible to project construction areas
- Avoiding sensitive environmental and community locations where possible
- Maximising opportunities for direct access to arterial roads for construction traffic, and avoiding the need to use local residential streets if possible
- Minimising property disturbance and acquisition requirements, particularly in residential areas
- Minimising the extent and duration of construction impacts.

Construction compound sites will continue to be developed, and will be presented as part of the environmental impact statement. Because of the nature of the project and its location across Sydney Harbour, options to locate some construction compounds on water as well as on dry land will be considered.

BLANK PAGE

3 Consultation

3.1 Overview

Engagement with local communities and stakeholders began in March 2017, following the announcement of the Western Harbour Tunnel and Beaches Link program of works by the NSW Government. The key aim of engagement activities has been to gather community and stakeholder feedback to be taken into account in the design of the project and the subsequent environmental impact statement.

Engagement activities are ongoing, and will continue during the preparation and exhibition of the environmental impact statement.

Key stakeholders for the project include (but are not necessarily limited to):

- State agencies including the Department of Planning and Environment, NSW Environment Protection Authority, Ministry of Health, Department of Primary Industries, Office of Environment and Heritage, Port Authority NSW and Transport for NSW
- The Commonwealth Department of the Environment and Energy if referral or approval is required under the *Environment Protection and Biodiversity Conservation Act 1999*
- Local government, including the Inner West, North Sydney, Mosman, Willoughby, Lane Cove, City of Sydney and Northern Beaches Councils
- Road users, cyclists and pedestrians
- Aboriginal stakeholders
- Utility and service providers
- Local businesses and industry groups
- Directly affected residents and communities
- The broader community.

This chapter describes the consultation activities conducted to date, and activities proposed during preparation of the environmental impact statement.

3.2 Engagement objectives

The key communication objectives for the Western Harbour Tunnel and Beaches Link program of works include:

- Inform interested and affected communities and stakeholders about the design, development and potential impacts of the projects
- Seek feedback from communities and stakeholders on issues important to them, to be taken into account during design, development and environmental impact assessment of the projects
- Identify opportunities to avoid or minimise impacts on the natural, social and built environments including ideas from communities and stakeholders
- Establish clear, consistent and transparent lines of communication between the project team and communities and stakeholders
- Respond to community and stakeholder queries, concerns and requests for information
- Provide updates on field investigations, design development and progress of the environmental impact assessment process.

3.3 Community engagement activities to date

Community engagement activities began in March 2017. Since that time, a series of information and feedback activities have been conducted through several different media. These activities are summarised in Table 3-1.

Table 3-1 Engagement activities during concept design feedback period – 16 March to 31 July 2017*

Activity	Commencement	Detail
General project information and feedback channels		
Project website	April 2017	http://www.rms.nsw.gov.au/projects/sydney-north/western-harbour-tunnel-beaches-link/index.html
Project email address	March 2017	Around 700 emails sent to the project email account: motorwaydevelopment@rms.nsw.gov.au
Project 1800 number	March 2017	Around 1,000 telephone calls received via the project information line: 1800 789 297
Letterbox drops	April 2017	Over 330,000 project fact sheets and community feedback session information flyers delivered.
Online community engagement map	April 2017	Over 1,700 comments posted on specific topics by members of the community
Hosted events		
Community Feedback Session attended by project team and technical specialists	April 2017	Sixteen sessions attended by more than 2,100 people at the following locations: • The Mosman Club (twice) • McMahons Point Community Centre (twice) • Chatswood Club (twice) • Balmain Town Hall (twice) • Manly-Warringah Leagues Club (twice) • Northbridge Bowling Club (twice) • North Sydney Oval Function Centre (twice) • Seaforth Community Centre (once) • Fred Hutley Hall, North Sydney Council Chambers (once).

Activity	Commencement	Detail
Pop up information displays	June 2017	Twelve displays in major shopping centres attended by more than 700 people including: • Birkenhead Point Shopping Centre (twice) • Warringah Mall (four times) • Balgowlah Stockland (twice) • Chatswood Westfield (four times).
Direct engagement with individual stakeholders		
Meetings with residents and stakeholders	March	More than 25 meetings were attended by more than 1,000 people
Door knocks	March 2017	Over 1,500 residences
Notifications of field work		
Marine geotechnical notifications	April 2017	More than 170 notifications to properties in the vicinity of the proposed harbour crossings
Land based geotechnical notifications	May 2017	Over 5,500 notifications and more than 1,200 doorknocks
Noise monitoring installation notifications	May 2017	More than 590 notifications and more than 470 doorknocks
Air quality monitoring station installations	July 2017	More than 50 notifications and more than 40 doorknocks
Media		
Newspaper advertisements	April 2017	More than 89 half page advertisements, placed in the local media in the weeks preceding the community feedback sessions
Media releases	16 March 2017 and 6 April 2017	Media releases were issued by the NSW government to coincide with the preferred corridor and start of field investigation announcements.
Facebook	April 2017	Reach of over 169,000 people through two direct project related Facebook posts on the Roads and Maritime Facebook page, as well as a broadly targeted Facebook advertising campaign.

*Note: all feedback received from members of the community and stakeholders since 31 July has been included in the project data base and is being taken into consideration in the ongoing development of the proposal. Community and stakeholder engagement will be ongoing throughout the planning process.

3.4 Engagement with other stakeholders

As well as community engagement, meetings have been held with State and local government representatives, local precinct committees and interest groups to provide project information and receive feedback about issues or concerns. These meetings have included workshops and briefings with:

- Local councils, including: Inner West, City of Sydney, North Sydney, Willoughby, Lane Cove, Mosman and Northern Beaches
- State Government agencies, including: Transport for NSW, Sydney Coordination Office, Department of Planning and Environment, Office of Environment and Heritage, Environment Protection Authority, Infrastructure NSW, Department of Primary Industries, National Parks and Wildlife Service, Department of Premier and Cabinet, NSW Treasury, Port Authority of New South Wales, UrbanGrowth NSW, Greater Sydney Commission, Sydney Motorways Corporation, Transport Management Centre, and Sydney Trains
- Commonwealth Government agencies, including: Sydney Harbour Federation Trust and the Royal Australian Navy
- Utilities and service providers, including: Jemena, Ausgrid, Sydney Water Corporation, Vivo Energy, and the National Broadband Network
- Harbour transport and other stakeholders, including: HMAS Waterhen Commanding Officer and Ship's Commanders, Harbour City Ferries, Captain Cook Cruises, Fantasea Cruises and Mosman Rowers Club
- Major project teams, including: Northern Beaches Hospital, Sydney Metro and West Metro, WestConnex Stage 3 (M4-M5 Link) and B-Line
- The Lane Cove Tunnel concessionaire
- Community and recreation groups, including: Waverton Precinct Committee, Kirribilli Precinct Committee, Northbridge Progress Association, North Sydney Council community forum, Northern Beaches Council Sustainable Transport Forum, Seaforth residents group, Balgowlah residents group/s, Balmain-Birchgrove residents group, North Sydney-Cammeray community meeting, and various school representatives and parents and citizens committees along the project corridor.

3.5 Feedback received to date

Comments received from the community and stakeholders have been collated according to number of comments per key topic in Table 3-2.

Table 3-2 Number of comments for key topics

	Key topics raised	Number of comments
1	Location and operation of tunnel ventilation system	1068
2	Design - tunnel entry and exit portals, alignment, road connections	653
3	Transport mode, public transport alternatives	526
4	Potential property impacts	501
5	Construction impacts and locations	383
6	Request for more project information	327

	Key topics raised	Number of comments
7	Potential impact on local streets, rat runs, local road safety	312
8	Suggested design changes	275
9	Geotechnical testing	273
10	Satisfaction with engagement	151
11	Impacts on flora	145
12	Project cost and tolling	97
13	Support for project	89
14	Congestion	86
15	Dissatisfaction with engagement process	81
16	Impacts on fauna	81
17	Noise impacts	73
18	Cycling, cycleway facilities, active transport	61
19	Oppose project	59
20	Integration with other proposed infrastructure	21
21	Visual amenity	21
22	Environmental impact assessment and approval process	18
23	Aboriginal heritage	14
24	Impact on community amenity	8
25	Project timing	6

Key issues and feedback identified through engagement with the community and stakeholders to date is summarised in Table 3-3. Feedback has also been gathered on a spatial basis through an interactive feedback map at <http://www.rms.nsw.gov.au/projects/sydney-north/western-harbour-tunnel-beaches-link/consultation-map.html>. Feedback has been used to assist in the identification of key and other issues considered in this report.

Table 3-3 Key issues and feedback received to date

Category of issue/feedback	Details
Strategic need, justification and cost	General concerns raised were in relation to the development of a motorway rather than public transport initiatives. Alternatives including a heavy or metro rail line, a light rail connection and additional bus services were suggested. Some comments suggested that the tunnels should incorporate both road and rail transport. Broad comment was made that the proposal should form part of a wider, integrated transport plan at the Sydney-wide level, as well as at the local level (eg feedback on the need for North Sydney transport mode integration). A significant number of community representatives and stakeholders indicated support for the project but expressed concern over the uncertainty and/or timing of it proceeding. The cost of the project was raised by some stakeholders, including whether money spent on the project might be better used for public transport. Other stakeholders expressed support for the project but were concerned around tolling levels. Some stakeholders stated that they support the project but do not agree with 'private public partnership' delivery models.
Project design	Further information was sought by the community on design development and feedback provided on project design, including: • Tunnel depth, width and alignment, particularly depth of tunnels beneath residential properties • Locations for tunnel portals, on and off ramps, and ventilation outlets • Harbour crossing construction methodologies and potential impacts • Warringah Freeway and Gore Hill Freeway designs including ramp and portal locations. For those community members located broadly near potential portal locations, consistent feedback was that the portals should be located further away from residential areas. Some feedback was given supporting a tunnel but proposing significantly different alignments (eg tunnel beneath Mosman; Western Harbour Tunnel with direct connection to Lane Cove tunnel etc). Some community members sought information on the grade of the tunnels and expressed concern around steep grades and resultant increases in vehicle emissions.

Category of issue/feedback	Details
Property acquisition impacts, local amenity and property value	Questions were raised about the need for property acquisition and the acquisition process. General views expressed included that acquisition of private properties should be avoided. A number of residents close to the preferred route inquired about hardship acquisitions. Similar concern was expressed by some residents who may live close to potential construction compound sites and permanent infrastructure, but whose properties may not be acquired. Reassurance was sought that the project team would minimise impacts on properties near permanent works (eg through noise abatement structures, landscaping, noise treatments on properties). Broad concerns were raised about the potential for the project to adversely affect property values, particularly in locations near portals and ventilation facilities. Some concerns were also raised about the implications of tunnels on the integrity and resultant change to the value of properties on the surface. Information was requested and concerns expressed around the potential for subsurface property acquisitions. Common questions were around the level of compensation payable for such acquisitions, and the potential impacts on future development of properties with tunnels below.
Construction compound sites and spoil removal	Concerns were raised about the potential locations for construction compounds. Specific sites referred to in feedback included: • General sites on water or along the foreshore • Birchgrove Oval/Birchgrove Park, Birchgrove • Yurulbin Park, Birchgrove • Berrys Bay foreshore/Coal Loader, Waverton • Waverton Park, Waverton • St Leonards Park, North Sydney • ANZAC Park, Cammeray • Cammeray Golf Course, Cammeray • Hallstrom Park/Bicentennial Reserve, Willoughby • Flat Rock Baseball Diamond, Willoughby

Category of issue/feedback	Details
	• Artarmon Reserve, Artarmon • Tunks Park, Northbridge • Northbridge Oval/Northbridge Golf Club, Northbridge • Balgowlah Golf Club, Balgowlah • Balgowlah Oval, Balgowlah • Seaforth Oval, Seaforth • Burnt Bridge Creek, North Balgowlah/Seaforth • Garigal National Park, Seaforth • Manly War Memorial Park/Manly Dam, Allambie Heights. The key theme of the feedback was that there is limited open space in suburbs around the preferred route and loss of such open space should be minimised. Concerns were expressed around the potential for compound noise, vibration, dust and traffic impacts due to spoil removal. Information was sought on proposed plans to minimise spoil removal through local streets, and queried where spoil would be sent and how it would be disposed of. Strong support was expressed for spoil removal via water transport if feasible.
Environmental and technical field investigations	Further information was sought and feedback was provided on environmental field investigations, including terrestrial and marine geotechnical work. Questions were also raised around the location of geotechnical sites as they relate to a final tunnel alignment. Comments were collected from some community members concerned that geotechnical drilling would impact on property structures. This included concerns around potential noise and vibration from geotechnical work. Concerns were also expressed around field investigations and impacts on flora, fauna and indigenous heritage.
Environmental and heritage concerns	Broader environmental concerns were expressed around: • Impacts of waterway crossings on marine/estuarine ecology • Impacts on flora and fauna along and around Wakehurst Parkway • Impacts of tunnels on subsurface ground conditions, groundwater etc • Impacts of tunnel portals on environmental assets (eg Burnt Bridge Creek)

Category of issue/feedback	Details
	• General environmental impacts of motorways (ie emissions from cars and impacts on climate change). A number of concerns were expressed around heritage considerations including Aboriginal and non-Aboriginal heritage. Key areas where heritage concerns were raised included: • North Sydney heritage buildings • Balmain-Birchgrove heritage buildings • St Leonards Park, North Sydney • Birchgrove Oval, Birchgrove • Aboriginal heritage sites (eg along Wakehurst Parkway and the Clive Park shoreline in Northbridge) • Garigal National Park • Manly Dam • Manly-Warringah War Memorial Park.
Traffic and road user impacts, public transport and active transport	Concerns were raised about existing congestion and road safety, including whether the project would be effective in addressing these issues. Feedback connected with comments on the strategic need and justification for the project was provided, including whether a public transport initiative should be favoured. Some community members expressed support for the project overall but suggested local traffic impacts need to be mitigated, for instance: • Reducing rat runs on local streets by motorists attempting to access tunnel portals • Local traffic controls/traffic calming measures in residential areas to complement the motorway • Avoiding funnelling of traffic into the tunnels (ie no closure of local streets designed to generate motorway traffic). Consistent feedback was provided on the need to minimise construction traffic on local streets. A substantial number of questions were raised around spoil removal via trucks versus water transport. A significant number of questions were raised around whether the tunnels would be designed to accommodate buses, including double deck buses. Questions were also asked around the inclusion of

Category of issue/feedback	Details
	bus lanes or bus priority systems in the tunnels. Consistent questions were also raised about whether the tunnels could, or should, accommodate light of heavy rail infrastructure. Community members also sought information on whether active transport options could be incorporated in the project, with a cycleway along the Wakehurst Parkway commonly requested. Some members of the community and other stakeholders mentioned the need to duplicate Wakehurst Parkway further north, beyond the current scope of the project (ie north of the Warringah Road intersection, to Oxford Falls).
Air quality	Concerns were raised about air quality and potential human health risks, including the location of tunnel ventilation facilities. Specific sites referred to in feedback included: • Ventilation facilities at Rozelle, including those for WestConnex and for the project • Ventilation facilities in the Cammeray, Artarmon, Seaforth and Balgowlah areas • Concerns, in response to erroneous media coverage, around ventilation outlets in areas where no ventilation facilities are planned (eg Birchgrove, North Sydney, Northbridge). Specific concerns were raised by sporting groups around potential location of ventilation facilities near sports grounds and by members of the community in relation to the potential location of ventilation outlets in proximity to residential areas. Community members also raised concerns about the suitability of ventilation outlet locations given local topography in certain areas (eg Balgowlah). Concern raised by community members in Balmain-Birchgrove-Rozelle area around the potential for additional ventilation outlets at Rozelle (ie in addition to those proposed to be constructed as part of the Rozelle Interchange/M4-M5 Link). Consistent feedback was provided by community members that filtration systems should be considered/adopted as part of the tunnel ventilation systems. Community members sought more clarity on how tunnel ventilation systems currently work, with more detailed information requested on why filtration is not commonly used.

Category of issue/feedback	Details
Noise and vibration	Concerns were raised over the duration and intensity of construction noise, including on residential and other sensitive receivers. Specific concerns related to: • Impacts of tunnels directly beneath residential properties and impacts of tunnelling equipment • Impacts of surface works (eg construction of ramps and portals within close proximity to residential areas) • Impacts of work in harbour crossings on properties near the shoreline Community members requested more information on hours of work, and duration of work at individual sites. Concerns were also raised around impacts on the structural integrity of properties, with more information requested on property condition assessment surveys and compensation for affected properties. Detailed information was sought by community members on the likelihood of feeling vibration and hearing noise if the tunnelling equipment is directly below a residence. Information was sought on what mitigation measures could be put in place to reduce these impacts.
Engagement process	Some community members expressed a broad view that the level of consultation was appropriate and well implemented given the early concept design stage of the project. Other community members expressed a view that more detailed information on the alignment and infrastructure was required as part of the engagement process.

3.6 Future engagement activities

The general project information and feedback mechanisms summarised in Table 3-1 would continue to be available during design development and preparation of the environmental impact statement. These mechanisms would be complemented with direct community and stakeholder engagement activities focused on:

- Providing information and project updates at key stages during design development and preparation of the environmental impact statement
- Engagement with affected landowners and community groups about the project and key design decisions that may impact them
- Engagement and coordination with transport and other infrastructure providers, particularly around project interfaces and in relation to cumulative impacts
- Engagement with regulatory agencies during preparation of the environmental impact statement to ensure a complete and robust environmental impact statement.

Key phases of engagement activities would include:

- Around the making of the State significant infrastructure application to which this scoping report relates
- Around key design decision points
- Generally during the preparation of the environmental impact statement
- Around the time of public release of the environmental impact statement for comment
- In response to key issues raised in submissions made in response to the environmental impact statement, including direct engagement with community and stakeholders over specific issues of concern where relevant
- Ongoing during delivery of the project.

The environmental impact statement would include details of issues raised during engagement with the community and other stakeholders. It would also clearly identify where these issues have been responded to through the design development process and the environmental impact statement.

4 Project description

4.1 Overview and key elements

Roads and Maritime proposes to construct and operate the Western Harbour Tunnel and Warringah Freeway Upgrade (the project), which would comprise:

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

The project forms part of the larger Western Harbour Tunnel and Beaches Link program of works.

The design of the project is currently being developed, taking into account the outcomes of community and stakeholder engagement and environmental field investigations. The design development corridors being considered during design development for the Western Harbour Tunnel and Warringah Freeway Upgrade are shown in Figure 4-1. The project is being designed within these corridors.

Further details of the Western Harbour Tunnel and the Warringah Freeway Upgrade are provided in Section 4.2 and Section 4.3. Potential construction methodologies and construction program are discussed in Section 4.4.

4.2 Western Harbour Tunnel

Key elements of the Western Harbour Tunnel component of the project would include:

- Twin tolled motorway tunnels connecting WestConnex at Rozelle and the existing Warringah Freeway at North Sydney. Each tunnel would be around seven kilometres in length
- Works to connect the tunnels to WestConnex and to connect and integrate with the surface road network at Rozelle
- Works to connect the tunnels to the Warringah Freeway (including integration with the Warringah Freeway Upgrade) and to connect and integrate with the surface road network at North Sydney and Cammeray
- Ancillary operational facilities including a motorway control centre, ventilation and air supply facilities, groundwater and drainage management and treatment systems, signage, tolling, fire and life safety, lighting emergency evacuation and emergency smoke extraction infrastructure
- Surface drainage, utilities and service connections and modifications
- New and upgraded pedestrian and cyclist infrastructure around surface connections.

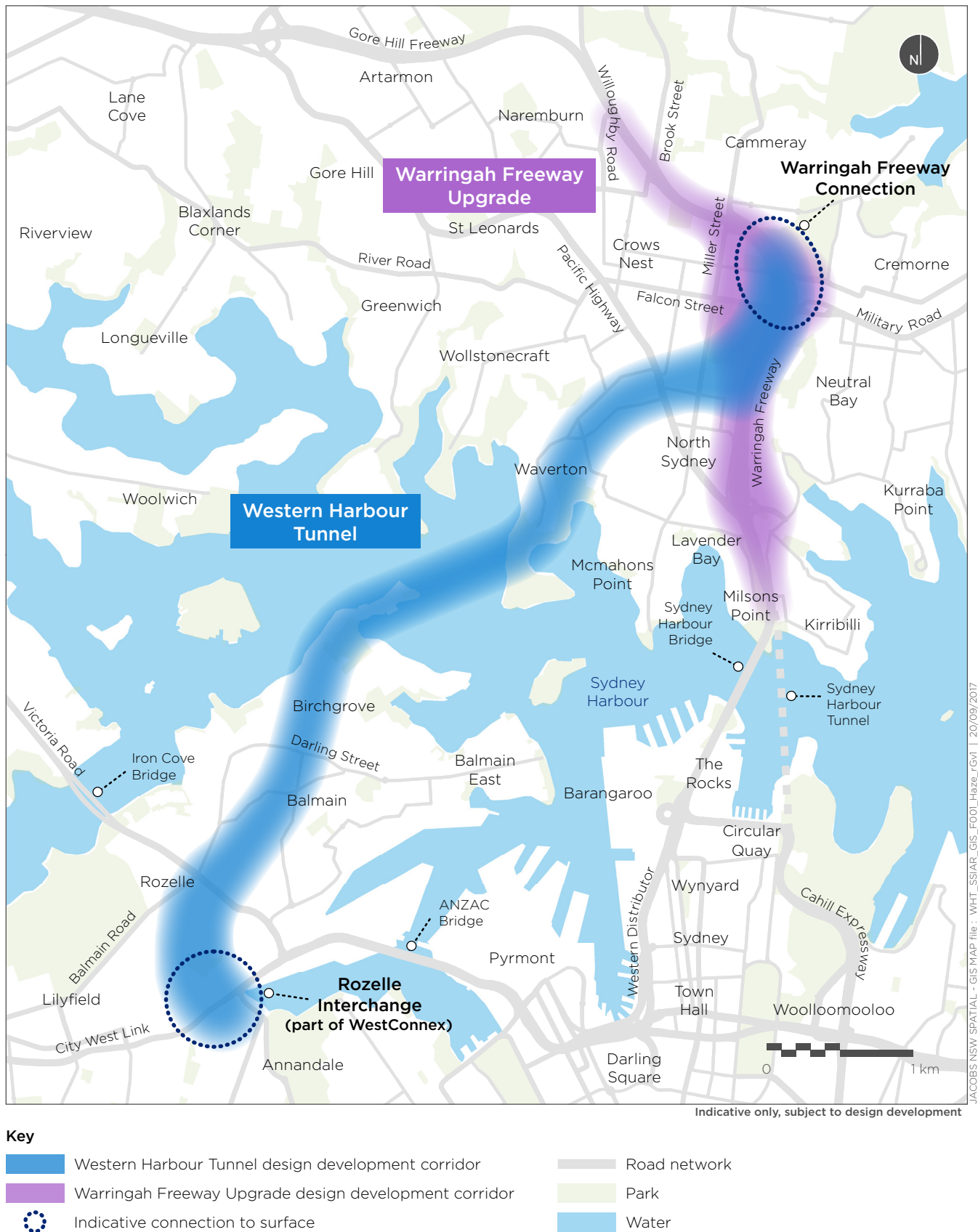


Figure 4-1 Western Harbour Tunnel and Warringah Freeway Upgrade design development corridors

4.2.1 Motorway tunnels

The twin mainline tunnels between the Rozelle interchange and the Warringah Freeway would be around seven kilometres in length. Tunnel ramps would be built to provide connections to and from surface roads.

Commencing at Rozelle interchange, the twin 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 around the Falcon Street overpass. North and south bound tunnels would be joined by cross passages at regular intervals to provide safe access or exit for passengers and emergency services in the event of a fire, or other emergency in the tunnels.

The mainline tunnels would be designed to accommodate service and freight vehicles, including over height vehicles. The tunnels would be provided with ventilation, lighting, signage and electronic visual surveillance and safety communication systems to allow communication with drivers. The posted speed limit within the motorway tunnels would be 80 km/h.

As discussed in Section 2.3.3, options under investigation for construction of the mainline tunnels include use of roadheaders, tunnel boring machines or a combination of the two. Depending on the depth of the tunnels, an immersed tube tunnel (IMT) component may be included as part of the project.

4.2.2 Connection to WestConnex

The project would connect with WestConnex at Rozelle. The interchange at Rozelle is being designed and delivered as part of the M4-M5 Link. The Rozelle Interchange would provide the following connectivity for the project road users:

- Mainline tunnel connection between the project and WestConnex. This would include free-flowing general traffic lanes to provide onward connectivity with the WestConnex M4 East and WestConnex New M5 corridors.
- A ramp connection between the project and the City West Link. This would include intersections to provide connectivity with The Crescent, ANZAC Bridge and Victoria Road.

The WestConnex M4-M5 Link project would include construction of stub tunnels from the Rozelle interchange along the alignment of the project mainline tunnels. The project would connect to these stub tunnels.

The WestConnex M4-M5 Link would also include construction of the ventilation facility for the southbound mainline tunnel of the project. This would only include construction of the structure, with fit out and operation of the facility forming part of the Western Harbour Tunnel and Warringah Freeway Upgrade project.

Subject to further design development, upgrades to the existing road network around the Rozelle interchange may be required to accommodate changes in traffic distribution resulting from the projects.

Roads and Maritime is working closely with the Sydney Motorway Corporation to ensure coordination of works at the interface between WestConnex and the project. This includes timing and staging of works, and options to minimise the total duration of construction disturbance. Details of a staging and coordination strategy would be provided in the environmental impact statement.

4.2.3 Connection to the Warringah Freeway and Beaches Link

The mainline tunnels would continue to around Cammeray where they would connect with the Warringah Freeway to provide a connection to the mainline tunnels for the Beaches Link project. If the two projects are constructed at the same time, the same roadheaders or tunnel boring machines could continue from construction of one project to the other without stopping. Otherwise, the Western Harbour Tunnel would construct infrastructure to connect to the Beaches Link and Gore Hill Freeway Connection project in the future.

On and off ramps would also be constructed to connect the mainline tunnels to the Warringah Freeway and the surface road network around North Sydney. Upgrades to surface roads in North Sydney near the on and off ramps would be required to integrate the project with the existing road network.

4.2.4 Ancillary operational facilities

Ancillary operational facilities for the Western Harbour Tunnel would comprise:

- Surface infrastructure, including:
 - A motorway control centre
 - An operational water treatment facility to manage and treat water from the tunnels, if required, prior to discharge
 - Ventilation facilities, including ventilation outlets and tunnel air intake infrastructure
 - Tolling infrastructure
 - Electricity supply infrastructure including project substations
 - Surface lighting and signage
 - Surface drainage works.
- In-tunnel infrastructure, including:
 - Emergency shoulders and breakdown bays
 - Tunnel cross passages for motorist egress and access for emergency services in the event of an incident in the tunnels
 - Firefighting suppression and firefighting systems
 - In-tunnel ventilation systems, including ventilation fans and connections with surface ventilation facilities
 - In-tunnel drainage, sumps and connections with the surface water treatment facility
 - In-tunnel lighting and signage
 - Tunnel monitoring systems
 - Electricity supply and communications infrastructure.

The locations and sizes of ancillary operational facilities are currently being developed taking into account technical and access requirements, existing land use, potential environmental impacts and amenity issues for the surrounding community. Ancillary operational facilities would be detailed and assessed in the environmental impact statement.

4.2.5 Pedestrian and cyclist infrastructure

Where the project affects existing pedestrian and cyclist infrastructure, new or upgraded facilities would be included in the project design to deliver an equivalent or better outcome than currently exists. Pedestrians and cyclists would not be permitted in the mainline tunnels.

4.3 Warringah Freeway Upgrade

Key elements of the Warringah Freeway Upgrade would include:

- Upgrade and reconfiguration of the Warringah Freeway from around Milsons Point to around Naremburn to connect and integrate with the Western Harbour Tunnel project and the Beaches Link and Gore Hill Freeway Connection project
- Dive structures to connect the Warringah Freeway to the Western Harbour Tunnel and Beaches Link
- New and adjusted bridge structures across the Warringah Freeway
- Upgraded and adjusted road ramp structures
- Upgrades to local surface roads in North Sydney and Cammeray to integrate the project with the existing road network
- Upgrades and amendments to bus infrastructure in response to bus lane upgrades and improvement works
- Tolling infrastructure and adjustments to existing tolling infrastructure
- New and upgraded pedestrian and cyclist infrastructure
- Other ancillary works.

4.3.1 Upgrade and reconfiguration of Warringah Freeway

Upgrade and reconfiguration works along the Warringah Freeway would extend from around Milsons Point to around Naremburn. These works would be required to connect and integrate with the Western Harbour Tunnel and the Beaches Link and Gore Hill Freeway Connection project.

Works would involve reconfiguration and adjustments to the existing traffic lanes along the Warringah Freeway to accommodate the additional traffic lanes from the Western Harbour Tunnel and the Beaches Link and Gore Hill Freeway Connection project. The existing bus layover on the Warringah Freeway would be relocated. The reconfiguration of existing traffic lanes would seek to simplify and improve traffic flow and wayfinding.

The upgrade would also require upgrades and modifications to local roads and intersections to accommodate changes in traffic conditions and integrate with the road network.

4.3.2 Dive structures

New dive structures would connect from the Warringah Freeway to the portals for the Western Harbour Tunnel mainline tunnels and the Beaches Link mainline tunnels. The dive structures would comprise a combination of troughs and cut and cover structures.

4.3.3 Bridge structures

The Warringah Freeway is crossed by several road and pedestrian bridges, which may require adjustment, replacement or relocation as part of the project. Bridges that may be affected by the project include:

- High Street bridge
- Mount Street bridge
- Ridge Street pedestrian bridge
- Falcon Street bridge
- Ernest Street bridge.

4.3.4 Ramps

Connections would be provided between the Warringah Freeway and North Sydney through road ramps. Subject to ongoing design development, connectivity may be provided with new, upgraded or modified ramp structures.

4.3.5 Local road upgrades

Upgrades to roads in North Sydney and Cammeray near the Warringah Freeway Upgrade would be required to connect and integrate with the project with the existing road network.

4.3.6 Bus infrastructure

Upgrade and reconfiguration of the Warringah Freeway would require and enable changes and enhancements to bus infrastructure. This would include relocation of the existing Cammeray bus layover between Miller Street and Falcon Street and improvements to the existing bus priority lane on Warringah Freeway.

4.3.7 Pedestrian and cyclist infrastructure

Where the project affects existing pedestrian and cyclist infrastructure, new or upgraded facilities would be included in the project design to deliver an equivalent or better outcome than currently exists. Opportunities to improve pedestrian and cyclist safety and connectivity across the Warringah Freeway are also being actively considered as part of the project.

4.3.8 Other ancillary works

Other ancillary works that are likely to be required as part of the Warringah Freeway Upgrade:

- New and modified retaining walls along Warringah Freeway to cater for the new traffic flow arrangements
- Noise mitigation works such as noise barriers
- Modifications to existing embankments and cuttings
- Adjustments to drainage systems
- New and upgraded lighting and signage
- Utility protection or relocation
- Tolling infrastructure and adjustments to existing tolling infrastructure.

4.4 Construction

The Western Harbour Tunnel and Warringah Freeway Upgrade components of the project may be delivered as separate but coordinated construction packages. A more detailed staging plan and construction coordination measures would be presented in the environmental impact statement.

4.4.1 Timing

The project is expected to take around five to six years to build. A more detailed construction program, including anticipated staging of construction activities, would be included in the environmental impact statement.

4.4.2 Methodology

Construction methodologies are currently being considered as part of the design development for the project. This includes whether mined tunnels would be constructed with roadheaders or tunnel boring machines or both, and the approach to upgrade and reconfiguration of the Warringah Freeway.

Indicative construction activities and methodologies would be comparable to other recent motorway tunnel projects and would include:

- Establishment of construction compounds including demolition, fencing, installation of site facilities, relocation and protection of utilities, installation of acoustic sheds, and construction of temporary buildings and wharves
- Construction of mainline tunnels, interchange caverns, intersections and roadside infrastructure
- Management and haulage of spoil during tunnelling and excavation activities by truck and/or barge
- Demolition, modification and construction of bridges and other civil engineering structures, such as portals, retaining walls, pedestrian paths and bridges, cycleways, culverts, noise barriers, fencing, tolling gantries, lighting and signage
- Modifications to surface roads including lane upgrades and modifications, changes to signalisation and intersection works
- Subject to harbour crossing methods, management of temporary marine based activities, including land and water access and construction sites
- Construction and delivery of pre-cast elements if the project includes an immersed tube tunnel component
- Environmental management and pollution control measures for the project
- Tunnel fitout and utilities connections.

As discussed in Section 2.3.3, deeper parts of the project tunnels would be constructed with roadheaders or tunnel boring machines, or a combination of the two. Troughs and cut and cover construction methods would be required at shallower sections, such as near the tunnel portals. Other excavation activities likely to be carried out include the creation of cross passages and caverns or shafts for other support infrastructure, as well as infrastructure for a connection to Beaches Link.

Early works required for site preparation such as minor road works, land acquisition, fencing, demolition, site clearance, utilities installation and adjustments, management of contamination and site set up would generally be conducted separately to the main project works and would be subject to separate approvals (if required).

4.4.3 Construction hours

Where feasible and reasonable, construction activities would be carried out during standard construction hours. Two key components of the project that may require works outside standard construction hours include:

- Tunnelling, tunnel spoil handling and transport
- Works affecting or adjacent to live traffic lanes on the Warringah Freeway.

Continuous works can reduce the construction program by up to two thirds relative to standard construction hours based on availability of construction times alone. In most cases, tunnelling would be carried out at significant depths below the surface and would not lead to surface impacts.

Tunnelling would generate significant volumes of tunnel spoil. To avoid and minimise surface disturbance in a highly developed urban corridor, construction compound sites would cover the smallest area necessary to support construction activities. Because of this, there would be limited space available for storage of tunnelling spoil on construction compound sites. Handling and transport of spoil may therefore need to be conducted up to 24 hours per day, seven days per week at some sites to handle material produced from continuous tunnelling activities. This could be for a period of up to two years at tunnelling compound sites depending on final construction planning.

The Warringah Freeway carries significant volumes of traffic for most of the day. Most works for the Warringah Freeway Upgrade would be carried out during the evening and night time periods to ensure the safety of construction workers and to avoid major disruptions to traffic. A more detailed construction program and staging plan would be developed and presented in the environmental impact statement aimed at minimising traffic disruptions caused by temporary lane closures and minimising impacts on surrounding communities.

Other construction activities that may be required outside of standard construction work hours include:

- Transport of large plant, equipment, prefabricated structures or materials
- Marine based work where necessary due to tide, wind, harbour traffic or barge stability control issues
- Utility installations or relocations to minimise utility downtime or to prevent adverse impacts to the relevant utility, road network or other sensitive service or site
- Works required to be conducted out of standard hours for emergency or safety reasons
- Works that can be constructed without impacting sensitive receivers, or where (following consultation with affected receivers) works are conducted to reduce the total duration of impacts from the proposed activity.

4.4.4 Construction sites and compounds

Surface disturbance during construction of the project would include:

- Construction sites within the footprint of the project
- Construction compounds, including a series of locations along the project corridor used to support construction. Construction compounds would include tunnel declines and shaft, staging and laydown areas, concrete batching and casting, spoil and materials handling activities, worker facilities and vehicle parking.

Construction compound locations would be identified where feasible and reasonable to minimise surface impacts. As discussed in Section 2.3.3, construction compounds would be identified with the aim of:

- Locating the construction compound sites as close as possible to project construction areas
- Avoiding sensitive environmental and community locations where possible
- Maximising opportunities for direct access to arterial roads for construction traffic, and avoiding the need to use local residential streets if possible
- Minimising property disturbance and acquisition requirements, particularly in residential areas.

Tunnel construction using roadheaders usually requires a greater number of construction compound sites. Tunnelling with tunnel boring machines usually requires fewer but larger construction compound sites. For construction on waterways, as may be required for installation of an immersed tube tunnel, construction compound sites may be required on water or in close proximity to the shore.

As result of the project's interface with WestConnex at the Rozelle Interchange, there may be opportunities to use common construction sites to minimise cumulative impacts. This potential opportunity is currently being investigated in consultation with Sydney Motorway Corporation. If feasible, details of shared construction sites including staging and management would be presented in the environmental impact statement.

BLANK PAGE

5 Key assessment issues

5.1 Overview

Key assessment issues are those that are likely to require preparation of detailed assessments because of the severity or extent of potential impacts, or because of community and stakeholder interest in the issue. Key assessment issues are distinguished from other important assessment issues (refer to Chapter 5.7) which may not require detailed assessments.

Based on environmental investigations that have been carried out to date, and feedback received from the community and other stakeholders, key assessment issues for the project have been identified as:

- Traffic and transport, including road safety
- Air quality, including in-tunnel and ambient air quality
- Noise and vibration
- Human health risks
- Non-Aboriginal heritage
- Cumulative impacts.

These key assessment issues are discussed in the following sections. Other assessment issues are outlined in Chapter 5.7.

5.2 Transport and traffic

This section identifies the potential traffic and transport impact of the project on the local and regional road network during construction and operation including public transport, pedestrians and cyclists. This section also considers potential impacts on port freight and logistics within Sydney Harbour in addition to harbour-based public transport.

5.2.1 Overview

Road network and performance

Figure 5-1 shows the major transport infrastructure within and around the design development corridor.

The main existing motorway connection across Sydney Harbour is the M1 Motorway, which links the M5 East Motorway in the south to the Hills M2 Motorway in north. The M1 Motorway comprises General Holmes Drive/Southern Cross Drive, the Eastern Distributor, the Sydney Harbour Tunnel, the Warringah Freeway and the Gore Hill Freeway. The M1 Motorway crossing of Sydney Harbour is complemented by the Sydney Harbour Bridge, which provides connectivity through the Western Distributor to the west, including Victoria Road, the City West Link and Parramatta Road. Additional cross harbour connectivity is provided by the Gladesville Bridge to the west, between Drummoyne and Huntleys Point.

Sydney Harbour Bridge (including the Bradfield Highway and Cahill Expressway) is one of the busiest roads in NSW, carrying around 169,000 vehicles per day. Sydney Harbour Tunnel is the eighth busiest road in NSW, carrying 92,000 vehicles a day (Roads and Maritime, 2014a). Most traffic accessing the Sydney Harbour Bridge or the Sydney Harbour Tunnel from the north passes along the Warringah Freeway. Infrastructure Australia has listed the Sydney Harbour Bridge, Warringah Freeway and Eastern Distributor as one of Australia's 30 most congested road

corridors, generating a congestion cost of \$1.2 million by lane kilometre in 2011 (Infrastructure Australia, 2015).

Congestion along existing harbour crossings and the roads leading up to them currently adversely affects the efficiency and safety of the motorway and arterial road network. Periods of heavy traffic on the Sydney Harbour Bridge, Sydney Harbour Tunnel and along the Warringah Freeway have spread beyond traditional peak hours, leading to longer travel times for motorists and a higher incidence of traffic incidents compared with free flowing traffic conditions. This congestion has also resulted in increasing pressure on ANZAC Bridge to operate as a feeder to the north-south connection across Sydney Harbour, instead of its primary east-west function.

In the south, the Western Harbour Tunnel would connect to the Rozelle Interchange being delivered as part of the WestConnex M4-M5 Link project. Traffic travelling to and from the Western Harbour Tunnel would be distributed through the interchange into WestConnex or surface connections such as the ANZAC Bridge, Victoria Road and the City West Link. Key intersections in this area include:

- Victoria Road/The Crescent
- City West Link/The Crescent
- The Crescent/Johnston Street
- Victoria Road/Darling Street/Balmain Road.

In the north, the Western Harbour Tunnel would connect to the Warringah Freeway, which would be reconfigured through the Warringah Freeway Upgrade. Key intersections in this area include:

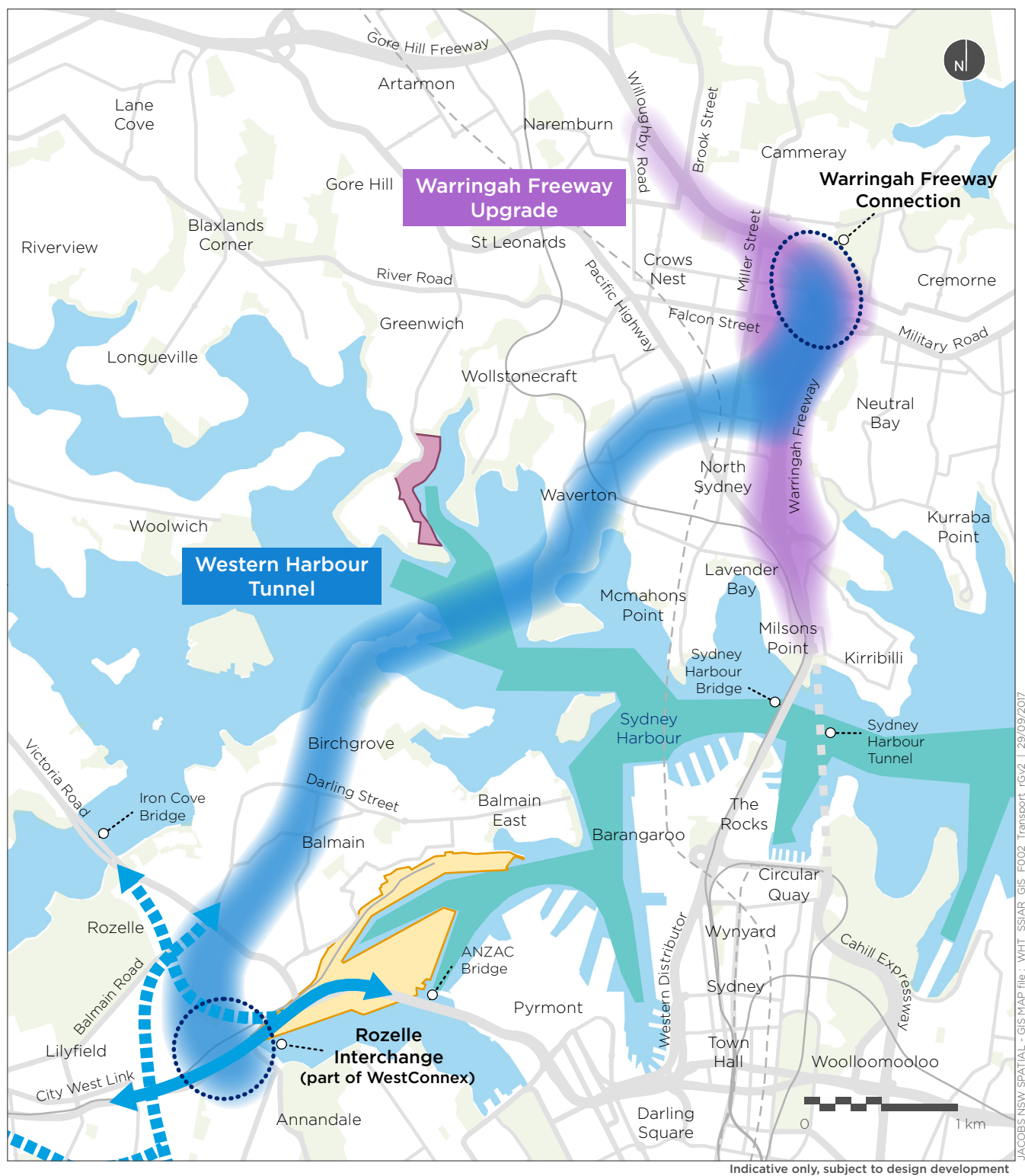
- Falcon Street/Miller Street
- Pacific Highway/Walker Street
- Pacific Highway/Miller Street
- Berry Street/Walker Street
- Berry Street/Miller Street
- Clarke Road/High Street
- Falcon Street/Warringah Freeway interchange.

Commercial shipping operations

Sydney Harbour is a leading destination for cruise shipping and the only port in Australia with two dedicated cruise facilities. Along with cruise shipping, the port handles a wide range of freight including dry bulk, bulk liquids and general cargo through berths at Glebe Island and White Bay. Additional private facilities are located at Gore Bay (Port Authority of NSW, 2016).

The main areas for port freight and logistics within Sydney Harbour are located within the Sydney Harbour port precinct which is focused around Glebe Island and White Bay. The port precinct provides deep water berths, accommodating dry bulk imports, the cruise industry and around 600 common user berth movements during 2014/2015. Common user berth movements typically include refuelling activities; servicing marine construction; emergency and planned maintenance; and facilitating major harbour events and functions (Port Authority of NSW, 2016). The fuel terminal at Greenwich is an important importation facility supplying fuel to the Sydney and NSW markets.

Figure 5-1 shows the Sydney Harbour port precinct and main shipping channels through the harbour. Harbour-based recreational and sporting activities are outlined further in Section 6.6.



- Key**
- Western Harbour Tunnel design development corridor
 - Warringah Freeway Upgrade design development corridor
 - Indicative connection to surface
 - WestConnex M4-M5 Link (indicative)
 - Shipping channel
 - White Bay and Glebe Island port precinct
 - Fuel terminal at Greenwich

- Road network
- Existing rail
- Approved rail
- Park
- Water

Figure 5-1 Major transport infrastructure around the design development corridor

Public transport

Rail

The T1 North Shore Line connects the Sydney CBD to northern Sydney via the Sydney Harbour Bridge and major stations at North Sydney, St Leonards, Chatswood and Hornsby. This railway line forms a key transport corridor connecting major and specialised centres both within Sydney's northern suburbs and south of Sydney Harbour.

Sydney Metro Northwest is currently under construction between Cudgegong Road and Chatswood and is anticipated to open to customers in the first half of 2019. Construction of the next stage of the Sydney Metro, from Chatswood to Sydenham is anticipated to commence in 2018. The Sydney Metro City and South West project will include the new Victoria Cross Station beneath Miller Street, between McLaren Street and south of Berry Street, North Sydney. The Victoria Cross Station will include changes to surface transport infrastructure, including:

- New bike parking near the corner of Miller Street and Berry Street
- New kiss and ride bays on Berry Street
- Retention of existing bus stops close to the station on Miller Street
- Wayfinding signage and Sydney Metro information within the North Sydney CBD
- Enhancement of pedestrian infrastructure around the station. Options for optimal integration of transport infrastructure with the wider North Sydney CBD are being investigated further by Transport for NSW in consultation with Sydney Metro, Roads and Maritime and North Sydney Council.

The Sydney Metro West project, connecting the Sydney CBD to Parramatta, is currently in the early stages of consultation with the community and stakeholders. One of the key areas being targeted for connectivity via the Sydney Metro West project is the Bays Precinct. Subject to further design development, consultation and planning, there is potential to locate a metro station in the Bays Precinct. WestConnex, the Rozelle Interchange and the Western Harbour Tunnel would connect near the north western boundary of the Bays Precinct.

Buses

The bus network within Sydney is extensive and caters for a large proportion of travel. The bus network comprises over 600 routes and is focused on the Sydney CBD. Over 40 per cent of routes pass through Sydney CBD and about 39 per cent of buses travelling to the Sydney CBD during the morning peak originate from the north of Sydney Harbour. These buses use the Warringah Freeway and the Sydney Harbour Bridge.

A bus lane is currently provided on the Warringah Freeway southbound, from Cammeray connecting through to the Sydney Harbour Bridge and across into the Sydney CBD. A bus layover is also located on Warringah Freeway (southbound) within the road reserve. This existing bus infrastructure is likely to require reconfiguration as part of the Warringah Freeway Upgrade and there are opportunities to significantly improve the existing bus lane, including removal of lane weaves and other suboptimal design issues.

The Victoria Road corridor is another major bus route providing access from around Parramatta and Ryde into the Sydney CBD. This bus route connects via the Iron Cove Bridge, along The Crescent at White Bay, over the ANZAC Bridge and through the Western Distributor.

Ferry

Ferries within Sydney Harbour serve both commuters and tourists/leisure customers. Most ferry services connect to the Sydney CBD at Circular Quay. Ferry routes relevant to the project include:

- The F4 Darling Harbour service, connecting Circular Quay to Pyrmont Bay and Darling Harbour via Milsons Point and McMahon's Point
- The F3 Parramatta River service, connecting Circular Quay to Parramatta via Milsons Point, McMahon's Point, Barangaroo and a series of stops along Sydney Harbour and the Parramatta River. Key ferry stops around the Western Harbour Tunnel crossing point include Balmain East, Balmain and Birchgrove.

Active transport

There is a relatively well defined cycle network across the lower North Shore which aims to avoid the most heavily trafficked roads with marked and unmarked on-road cycle routes and off-road paths.

A network of separated, dedicated cycleways currently exists in the area around the potential future WestConnex Rozelle Interchange. This includes connections along the Victoria Road corridor, The Crescent and over the ANZAC Bridge. Dedicated cycling lanes are also provided along Lilyfield Road. Some of this cycling infrastructure would be relocated or upgraded as part of the WestConnex M4-M5 Link project.

Around the Western Harbour Tunnel crossing of Sydney Harbour, separated dedicated cycleways are provided in Birchgrove Park in Birchgrove and through Carradah Park and Waverton Park in Waverton.

Existing cycling infrastructure along the Warringah Freeway corridor is currently fragmented, with key components including:

- The Sydney Harbour Bridge crossing, which is accessed from Alfred Street South in Milsons Point (in the north) and Kent Street (in the south)
- Separated dedicated cycleways or dedicated cycling lanes around Alfred Street and Middlemiss Street, Milsons Point, and High Street, Kirribilli
- Separated dedicated cycleways or dedicated cycling lanes along Ridge Street and through St Leonards Park, North Sydney, with connectivity over the Warringah Freeway to Alfred Street North and Winter Avenue, Neutral Bay
- Separated dedicated cycleways or dedicated cycling lanes along Ernest Street and through Cammeray Golf Course, Cammeray

Pedestrians are generally catered for locally through footpaths and dedicated road crossings. The areas surrounding the project generally have a high volume of pedestrians, especially within the North Sydney, Crows Nest and Sydney CBD areas. There are a number of dedicated pedestrian links, in particular:

- A footpath along the east side of Sydney Harbour Bridge
- Ridge Street and Falcon Street pedestrian bridges
- Links through St Leonards Park.

5.2.2 Summary of potential issues

Key potential traffic and transport assessment issues for the project include:

- During construction:
 - Generation of construction traffic
 - Changes to the surface road network and access arrangements
 - If an immersed tube tunnel design is pursued, potential interactions with commercial shipping operations and ferry services.
- During operation:
 - Changes in the distribution of traffic across the road network, with potential changes in traffic performance and road safety.

Construction

Construction of the project would require the use of heavy vehicles to deliver construction plant, equipment and materials as well as for the removal of waste, including general construction waste, office waste and spoil from tunnelling activities. If an immersed tube tunnel design is progressed, sediment volumes generated during the construction of the tunnels would likely be removed by barge rather than by road.

Heavy vehicle movements during the tunnelling stage may occur from some sites on an up to 24-hour basis. Construction of the Warringah Freeway Upgrade component would require detailed construction staging and extensive out-of-hours works to minimise substantial traffic impacts and to protect worker safety in a live road environment.

Surface construction works, including ancillary works, portal works and tie-ins to the surrounding road network, as well as the establishment of construction sites and compounds would result in changes or modifications to:

- Existing property access
- Existing pedestrian and cyclist access and movements
- Speed limits on the motorway and surrounding roads.

Accordingly, the project would affect the surrounding road network during construction as a result of:

- Changes in intersection and/or traffic performance on the surrounding road network due to heavy vehicle movements associated with construction and spoil removal, narrowing of lanes, speed restrictions and/or temporary road closures. Some of these impacts would be reduced if an immersed tube tunnel is progressed and sediment volumes removed from harbour construction sites using barges rather than road transport
- Potential impacts to road users, including buses, pedestrians and cyclists during construction due to temporary road arrangements or the close proximity of construction activities to normal traffic
- Temporary disruptions and delays to traffic and public transport services, including buses as a result of speed restrictions and/or potential temporary road closures
- Temporary changes to property access, including provision of alternative access arrangements
- Cumulative impacts with WestConnex and Sydney Metro construction works.

Construction of the Western Harbour Tunnel component of the project may affect commercial shipping operations and ferry services, particularly if an immersed tube tunnel design is pursued. Activities that may affect commercial shipping operations and ferry services include:

- Establishment and use of cofferdam sites within the harbour
- Movement of plant and equipment on water to the cofferdam sites
- Removal of sediment volumes from cofferdam sites by barge
- Establishment of shore sites to support construction activities on the harbour.

Temporary exclusion zones and speed limits may be required around harbour and shore construction sites, resulting in temporary disruptions and/or delays to recreational boating.

Operation

The project would provide a western motorway bypass of the Sydney CBD. The project would deliver important transport benefits, including:

- Faster, safer and more reliable journeys on the Sydney Harbour Bridge and Sydney Harbour Tunnel, resulting in significant reductions in cross-harbour trip times for buses and other vehicles
- Reduced congestion on the ANZAC Bridge and Western Distributor, improving traffic flow and journey times for buses, freight and other vehicles accessing the Sydney CBD and enhancing road safety
- Increased resilience of Sydney's busiest transport corridor, making the inner city road network and connections to the Global Economic Corridor less vulnerable to incidents and disruptions
- The project would extend the benefits of WestConnex, connecting with the M4-M5 Link to form a western bypass of the CBD
- Improved facilities for pedestrians and cyclists.

The integration of the project into the existing road network would result in a redistribution of traffic. Subject to more detailed traffic modelling, this redistribution of traffic is likely to lead to reduced traffic volumes on some routes including the Sydney Harbour Bridge. Other routes, particularly those around access points to the project, may experience an increase in traffic volumes.

During operation the project would have no impact on commercial shipping operations, ferry services or recreational boating.

5.2.3 Proposed further assessments

A detailed construction and operational traffic and transport assessment would be prepared as part of the environmental impact statement. The assessment would be prepared in accordance with *Guide to Traffic Generating Developments Version 2.2* (Roads and Traffic Authority, 2002).

The construction traffic and transport assessment would include (as a minimum):

- Potential traffic and transport impacts on the road network, including consideration of public transport impacts, as well as pedestrian and cyclist access throughout construction of the project
- Potential cumulative impacts with other major transport and infrastructure projects in the vicinity of the project
- Potential construction traffic impacts including spoil haulage, route identification, details of the construction fleet, the nature of existing traffic, and the need to close, divert or otherwise reconfigure elements of the road network associated with construction of the project
- Potential impacts on commercial shipping operations and ferry services as result of marine based construction (if required)
- Mitigation and management measures to ensure that impacts are maintained within acceptable limits.

The operational traffic and transport assessment would include (as a minimum):

- Assessment of existing local and regional traffic volumes and traffic patterns against forecast volumes and potential changes to traffic patterns associated with the project
- Traffic modelling including for the opening year, being the year of completion of the project, and 10 years from the anticipated opening date
- Direct and indirect operational traffic impacts on the local and regional road network, including consideration of freight and public transport users, and implications for pedestrians and cyclists
- A road safety analysis
- Mitigation and management measures to ensure that impacts are maintained within acceptable limits.

5.3 Air quality

This section identifies the potential impact of the project on local and in-tunnel air quality during construction and operation.

5.3.1 Overview

The NSW Government established an Advisory Committee on Tunnel Air Quality to provide guidance and recommendations on the scientific and engineering issues for road tunnel ventilation design and operation based on NSW, national and international experience. The Advisory Committee has published several technical papers since being established in 2013. These technical papers have been used to provide an overview of the existing air quality in Sydney and the policy framework relevant to a project such as this. Recommendations from the Advisory Committee would be considered further during project design development and preparation of the environmental impact statement.

Ambient air quality in Sydney is monitored by a network of 15 monitoring stations operated by the Office of Environment and Heritage. These stations are located to record air quality data representative of that experienced by the general population within the Sydney region. The data is recorded continuously and available to the public online in near real-time. Data from the Office of Environment and Heritage monitoring stations is typically supplemented with additional monitoring carried out for individual projects. The Western Harbour Tunnel and Beaches Link program of works has installed project-specific air quality monitoring stations, and will also draw on data collected for other projects.

The *NSW State of the Environment 2015* states air quality in NSW has improved significantly since the 1980s due to initiatives that have reduced urban air pollution from industry, businesses, homes and motor vehicles (EPA, 2015). However, motor vehicle emissions remain a major source of urban air pollution, with exposure to air pollution linked to a range of health outcomes (refer to Section 5.5). The main pollutants in motor vehicle emissions include carbon monoxide (CO), oxides of nitrogen (NO_x), volatile organic compounds (VOCs), particulate matter (PM, including PM₁₀, PM_{2.5} and ultra fine fractions) and sulfur dioxide (SO₂). Oxides of nitrogen and volatile organic compounds react in the atmosphere to form photochemical smog.

Air quality in Sydney is good by national and international standards. Carbon monoxide, nitrogen dioxide and sulfur dioxide concentrations are consistently well below the national standards. However, ozone and particulate matter concentrations occasionally exceed the national standards in the Sydney region, with no apparent downward trend in the concentrations of these pollutants (Advisory Committee on Tunnel Air Quality, 2014).

Ozone is a major component of photochemical smog and forms in the lower atmosphere during warm and sunny conditions. Peak ozone levels in Sydney are therefore typically observed between

November and March (Advisory Committee on Tunnel Air Quality, 2014). While all parts of Sydney can experience ozone concentrations above the national standards, the west and south-west regions are most often exposed (EPA, 2015).

While motor vehicles are contributors to particulate matter, there are many other sources from both natural processes (eg bushfires or dust storms) and human activities. Particulate matter concentrations in Sydney have exceeded national air quality standards on up to 18 days a year from 2012 to 2014 (EPA, 2015).

5.3.2 Summary of potential issues

Key potential air quality assessment issues for the project include:

- During construction:
 - Generation of dust and emissions from construction plant and equipment
 - If an immersed tube tunnel design is pursued, potential odour emissions from the handling of sediments.
- During operation:
 - In-tunnel air quality
 - Changes in ambient air quality as a result of changes in surface traffic distribution and emissions from ventilation facilities (including potential cumulative impacts associated with the Beaches Link and Gore Hill Freeway Connection project).

Construction

The construction of the project has the potential for the following air quality related impacts:

- Temporary increases in emissions of gases and particulate matter associated construction vehicles, plant and machinery. This would include temporary ventilation systems within the tunnel during construction
- Temporary increases in dust which may occur as a result of earthworks, vegetation clearance, use of the ancillary concrete batching plant, heavy vehicle movements, general construction and stockpiling activities
- Temporary generation of odour during handling and disposal of sediments, if an immersed tube tunnel design is pursued.

The potential impacts of increased dust and emissions would depend on the scale and intensity of the construction activity, quantities of the material handled, weather and the proximity of sensitive receivers. Any impacts would be temporary and relatively short-lived.

Operation

During operation of the project, potential air quality impacts would be associated with motor vehicle emissions (specifically, products of combustion as well as non-exhaust emissions such as dust generated from the road surface). Air quality is relevant to the in-tunnel atmosphere, emissions from surface roads and the operation of ventilation facilities.

In-tunnel air quality

Ensuring stringent in-tunnel air quality outcomes are achieved is a fundamental design objective for the project. The project's tunnel ventilation systems are being designed to ensure that established in-tunnel air quality criteria are met under all normal operating conditions. In February 2016, the Advisory Committee on Tunnel Air Quality released an in-tunnel air quality (nitrogen dioxide) policy for all new road tunnels over one kilometre in length. The policy acknowledges the past reductions in CO emissions per vehicle due to improved vehicle technology have been more significant than reductions of NO₂ and sets a tunnel average criterion for NO₂ concentrations.

The NO₂ criterion of 0.5 parts per million (ppm) compares favourably to international in-tunnel NO₂ design guidelines which range between 0.4 ppm and 1.0 ppm. The tunnel ventilation system would be designed and operated to meet the NO₂ in-tunnel air quality criterion as well as visibility requirements.

Ambient air quality

Potential local air quality impacts from the project would arise from changes in the distribution of surface traffic (including both increases and decreases in traffic volumes) and the operation of tunnel ventilation facilities. Air quality impact assessments that have been previously prepared for NorthConnex and the WestConnex projects have shown that most air quality impacts from motorway tunnel projects come from changes in surface traffic, rather than from operation of ventilation facilities.

Surface road related air quality impacts may be experienced where existing surface roads are subject to significant changes in traffic flows or volumes and could result in a potential increase or decrease in near roadside air pollutant concentrations. For example, the reduction in traffic congestion along surface roads has the potential to deliver air quality improvements to areas along key arterial roads. These local effects would be the subject of further investigation as described below in Section 5.3.3.

The project would require ventilation facilities for the tunnels. Ventilation facilities aim to effectively disperse tunnel emissions to ensure that established ambient air quality criteria are not exceeded. Ventilation facilities would be located to also minimise impacts on the surface, including avoiding sensitive environments and minimising the need for acquisition and property impacts.

Air quality impacts from ventilation facilities would be subject to detailed investigations and assessment as described below in Section 5.3.3 and would build on recent experiences on other major road tunnel projects and recommendations from the Advisory Committee on Tunnel Air Quality. The assessment would be based on the location and design characteristics of the facilities, emissions to air, buildings and land use, prevailing weather and topographical effects to determine any changes in air pollutant concentrations at sensitive receivers.

5.3.3 Proposed further assessments

A detailed air quality impact assessment would be prepared as part of the environmental impact statement. This assessment would identify the potential impacts of both construction and operation of the project. The assessment would be prepared in accordance with *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2016).

Specifically, the assessment would include (as a minimum):

- Qualitative assessment of proposed surface works and worksites with consideration of mitigation and management measures to reduce and minimise the emission of dust, odour and other pollutants during construction
- Quantitative prediction and assessment of the operational air quality impacts of the project, with consideration of local dispersion conditions, existing background levels of pollutants, managed air emissions, and changes in vehicle emissions on surface roads
- The use of background monitoring data from existing air quality monitoring stations, in addition to data collected from project-specific air quality monitoring stations
- Cumulative local and regional air quality impact assessment
- Cumulative assessment of the impact associated with in-tunnel air quality when travelling through multiple tunnels resulting in exposure for longer periods of time

- Mitigation and management measures to ensure that impacts are maintained within acceptable limits.

5.4 Noise and vibration

This section identifies the potential noise and vibration impacts of the project on the acoustic amenity of local communities and the structural integrity of buildings and other structures during construction and operation.

5.4.1 Overview

The project would be located in a highly developed urban/suburban setting, with areas of medium to high density residential, commercial and light and heavy industrial land development. The design development corridor is also characterised by a series of recreational, health and educational developments. The majority of the project would be located at significant depth below the ground, which would inherently reduce the potential for noise and vibration impacts on surface development during construction and operation.

Around the southern end of the project, the existing noise environment is influenced by noise from arterial roads including the ANZAC Bridge, The Crescent and Victoria Road. Ongoing operations within the Sydney Harbour port precinct at Glebe Island and White Bay are also significant contributors to the noise environment.

Around Sydney Harbour near the Western Harbour Tunnel crossing location, the noise environment is characteristic of residential and recreational areas. The harbour foreshore in this area comprises a series of residential areas, many with receivers at moderate to high elevations above the harbour, and a series of foreshore parks and open spaces. Sources of noise comprise local roads, recreational marine activities and commercial shipping activities, such as tanker movements to and from the fuel terminal at Greenwich.

The environment around the connection of the Western Harbour Tunnel with the Warringah Freeway is dominated by traffic noise from the freeway, and surrounding arterial roads. Rail noise along the surface component of the T1 North Shore rail line also influences the local noise environment. North Sydney, Milsons Point and Kirribilli include a series of elevated commercial and residential receiver locations. The northern parts of North Sydney, Cammeray and Crows Nest are less densely developed, and include recreational and open space areas such as St Leonards Park and the Cammeray Golf Course. There is a relatively high density of schools along the project corridor.

5.4.2 Summary of potential issues

Key potential noise and vibration assessment issues for the project include:

- During construction:
 - Noise and vibration generated by surface works, including construction traffic noise
 - Vibration and ground-borne noise generated by tunnelling activities, particularly in areas where the tunnels would be constructed close to the surface
 - If an immersed tube tunnel design is pursued, noise generated by construction activities on the harbour, including the movement of barges and other vessels.
- During operation:
 - Changes in traffic noise as a result of changes in surface traffic distribution
 - Noise generated by fixed operational facilities, including ventilation facilities, water treatment infrastructure, substations and the motorway control centre.

Construction

During construction, the project would result in localised noise and vibration impacts, particularly where surface works would occur for interchanges, tunnel portals, marine based construction and ancillary works. Tunnelling could also generate vibration and ground-borne noise impacts on sensitive receivers located close above the project alignment or in the vicinity of work sites.

Construction works during the evening and night time periods would be required, with the potential for tunnelling and associated above ground support activities (including spoil haulage via road and barge) to occur 24 hours per day, seven days per week. The majority of surface works at the interchanges would be conducted during the evening and night time periods for safety and operational reasons, particularly for the Warringah Freeway Upgrade component of the project.

The construction of the project could result in the following potential airborne noise and vibration issues:

- Airborne noise impacts from surface works including at interchanges and connections at Rozelle, North Sydney and the Warringah Freeway
- Airborne noise impacts from construction ventilation systems, worksites, cofferdams (if required) and any open cut sections of the project
- Construction road traffic noise from the use of heavy vehicles
- Construction maritime traffic noise from the potential use of barges and support vessels
- Cumulative impacts including those associated with construction of the Beaches Link and Gore Hill Freeway Connection project.

Potential ground borne noise and vibration issues include:

- Ground-borne noise impacts from tunnelling and piling
- Potential vibration impacts on buildings near to surface works, or buildings near to, or above, the tunnel alignment
- Potential vibration impacts on buildings generated by blasting and rock breaking activities, which may be required depending on the geological conditions encountered during construction
- Potential impacts to heritage items and vibration sensitive developments (such as some health facilities) due to vibration and settlement associated with tunnelling or surface works.

Operation

The project would result in a significant reduction in surface traffic, with these vehicles redistributed to the project tunnels. As a result, it is anticipated that the project would result in a reduction in surface traffic noise and an improvement in acoustic amenity along those surface roads experiencing reduced traffic volumes.

The main operational noise impacts from the project would arise from traffic using new or upgraded surface road infrastructure or where traffic volumes on surface roads would change as a result of the project. This would include the potential for traffic noise break out from the tunnel portals.

Other sources of operational noise emissions may include ventilation infrastructure, the motorway control centre and other surface ancillary infrastructure.

The project is not anticipated to be an ongoing source of significant vibration during operation.

5.4.3 Proposed further assessments

A detailed construction and operational noise and vibration impact assessment would be carried out as part of the environmental impact statement. The assessment would identify and assess

noise and vibration impacts on surrounding sensitive receivers and land uses, and the potential impacts on the structural integrity of buildings and items, such as heritage items.

The following guidelines would be considered as relevant during the preparation of the noise and vibration assessment:

- *Interim Construction Noise Guideline* (DECC, 2009)
- *Assessing Vibration: a technical guideline* (DEC, 2006a)
- *Construction Noise and Vibration Guideline* (RMS 2016a)
- *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZECC, 1990)
- *British Standard BS7385-2:1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration*
- *German Standard DIN 4150-3: 1999-2 Structural Vibration – Part 3: Effects of vibration on structures*
- *NSW Road Noise Policy* (DECCW, 2011)
- *NSW Industrial Noise Policy* (EPA, 2000)
- *Noise Mitigation Guideline* (RMS, 2015a)
- *Noise Criteria Guideline* (RMS, 2015b)
- *Noise Model Validation Guideline* (RMS 2016b).

The noise and vibration assessment would include (as a minimum):

- Identification of potentially affected noise and vibration sensitive receivers
- Development of project-specific construction noise management levels and construction vibration goals
- Assessment of out of hours work required during construction
- Assessment of airborne and ground-borne noise and vibration impacts from the construction of the project on identified residential and other sensitive receivers including the duration of impact and the potential use of blasting as part of the tunnelling methodology (if required)
- Assessment of road traffic noise from the use of heavy vehicles and equipment during the construction of the project
- Assessment of maritime traffic noise from the use of barges and support vessels during the construction of the project, if works on the harbour are required
- Assessment of noise impacts from the operation of the project on identified residential and other sensitive receivers at the year of opening and 10 years after opening
- Cumulative assessment of potential construction noise and vibration impacts due to other developments in the vicinity, such as WestConnex
- Mitigation and management measures to ensure that impacts are maintained within acceptable limits.

5.5 Human health risks

This section describes the human health considerations relevant to the project. This includes the potential health impacts and benefits of the project and the possible risks of the project to the health of local communities and individuals.

5.5.1 Overview

The existing health of the community around the design development corridor is influenced by a range of factors including age, socio-economic status, employment, education, individual lifestyle factors, genetic predisposition and access to health and social care.

Population profile

The socio-economic statistics for the local government areas in the design development corridor indicate that the design development corridor has a low level of disadvantage compared to other regions in NSW. The design development corridor has a relatively small Aboriginal population, relatively low proportion of people from non-English speaking background, lower unemployment rates, median weekly household income levels in excess of the Greater Sydney average and a lower proportion of social housing rentals (Australian Bureau of Statistic, 2016).

Existing health of population

The project would be located within the Northern Sydney and Sydney Local Health Districts. The Northern Sydney Local Health District includes the area north of the Sydney Harbour to the Hawkesbury River and the Sydney Local Health District extends west to Bankstown and Punchbowl. Selected health statistics for these health districts from HealthStats NSW (NSW Ministry of Health 2016), indicate that the districts have the highest life expectancy of the 15 NSW health districts (with the South Eastern Sydney health district). Obesity, alcohol consumption, smoking rates, and levels of physical activity are relevant lifestyle factors that affect health. Of the 15 health districts in NSW, Northern Sydney and Sydney have a lower than average percentage of the population that are overweight or obese, lower or similar to the average rate of alcohol consumption at levels posing a long-term risk to health and lower than average percentage of smokers aged 16 years and over. The districts have a higher than average percentage of the population with adequate physical activity and a lower than average incidence of respiratory disease deaths.

Sensitive receivers

The project would pass through or under areas of medium to high density residential, commercial and light and heavy industrial land uses. There are also a number of sensitive receivers in the design development corridor that are likely to be more sensitive to changes in the environment and potential health impacts. This includes children, the elderly or those with existing health conditions. Sensitive receiver locations include schools, childcare facilities, hospitals and aged care facilities.

Environmental factors

A range of environmental factors influence human health including air quality, noise and vibration, soil and water quality, and environmental hazards. Existing air quality, noise and vibration, soil and water quality in the design development corridor is described in Section 5.3, Section 5.4 and Section 6.4 respectively.

Hazards and risks

Hazards and risks associated with the project have the potential to affect the surrounding environment and human health. Existing hazards in the design development corridor that are relevant to the project include road traffic hazards associated with the existing road corridors and environmental hazards such as extreme weather events. Extreme weather events that have the potential to affect human health include extreme heat days, bushfires, storms and flooding. The intensity and frequency of these events is expected to increase as a result of climate change.

5.5.2 Summary of potential issues

The health and safety impacts from the project may be direct or indirect and short or long term. Direct impacts arise from the exposure to pollutants including air, water, soil and noise, or as a result of safety incidents during construction or operation. Indirect impacts may arise from the project's influence on the determinants of health such as access, amenity or economic impacts.

The project would result in changes to air quality and the noise environment, which would include increases in some areas and decreases in others. Because of this, some areas are likely to experience a reduction in health risks and others will experience slight increases in health risks.

The human health risk assessments for NorthConnex and the WestConnex projects have shown that motorway tunnels typically result in an overall reduction in health risks by removing traffic noise and air emissions sources from surface roads.

Changes in the urban environment also have the potential to result in impacts to health, primarily due to increased levels of stress and anxiety associated with rapid changes in the community.

Construction

Potential health and safety impacts associated with construction of the project may include:

- Direct effects on the health and safety of the population, for example:
 - Exposure to increased noise levels from worksites, surface work and construction vehicles
 - Increases in dust which may occur as a result of earthworks, vegetation clearance, use of the concrete batching plant, general construction and stockpiling activities
 - Increases in air emissions from construction traffic and machinery at surface sites
 - Environmental and human health risks associated with the accidental release of hazardous materials due to improper handling or storage, or in the event of a traffic or vessel accident resulting in the release of hazardous material
 - Exposure to contaminants arising from disturbance of contaminated sediments during dredging in Sydney Harbour, if required
 - Potential impacts to water quality including recreational areas immediately adjacent to construction sites in Sydney Harbour
 - Temporary loss of recreational areas as a result of establishing and operating worksites
 - Work health and safety hazards to construction workers, road users or the general public that may arise due to a traffic incident, tunnel collapse, flooding or inundation during construction, or extreme weather during harbour-based work
 - Changed traffic and pedestrian access resulting in unsafe conditions or potentially affecting emergency services access
 - Rupture or interference with underground services during construction resulting in injury to workers or the public.
- Indirect beneficial and adverse health effects arising from changes to access to workplaces, recreational areas (open space) and amenities.

Operation

Operation of the project has the potential to result in the following health and safety outcomes:

- Improved connectivity between major health facilities, including the Royal North Shore Hospital, Royal Prince Alfred Hospital and the Northern Beaches Hospital (with the Beaches Link and Gore Hill Freeway Connection project)
- Beneficial or adverse health effects from decreases or increases in noise exposure during operation
- Beneficial or adverse health effects from decreases or increases in air pollutants during operation
- Changes in access and amenity from changes to the local road network due to increased traffic volumes and/or road closures or access restrictions
- Environmental and human health risks associated with traffic incidents.

There may also be indirect beneficial and adverse health impacts arising from changed access to workplaces, recreational areas or amenities.

5.5.3 Proposed further assessments

A health risk assessment would be carried out as part of the environmental impact statement in accordance with the following guidelines:

- *Environmental Health Risk Assessment, Guidelines for assessing human health risks from environmental hazards* (enHealth, 2012)
- *Health Impact Assessment: A practical guide* (NSW Health, 2007).

Specifically, the assessment would include (as a minimum):

- A description of the existing health of the population in and around the design development corridor
- Assessment of changes in health risks as a consequence of the project, including in relation to air quality, noise and social changes
- Environmental hazards and associated health risks and their distribution in and around the design development corridor
- Indirect health effects arising from changes to social infrastructure or access
- Measures to minimise negative health impacts and maximise health benefits.

5.6 Non-Aboriginal heritage

This section identifies the potential impact of the project on Non-Aboriginal heritage values of the design development corridor during construction and operation.

5.6.1 Overview

Early history

Initial European settlement in Sydney was concentrated on the southern side of Sydney Harbour around Sydney Cove. The exploration of the upper waterways of Sydney Harbour commenced shortly after the arrival of the colonists at Sydney Cove.

Birchgrove, in the southern section of design development corridor, was originally part of Private George Whitfield's 30 acre grant of 1796, before being passed through multiple hands and subdivided into residential lots. While the sale of the smaller lots was slow, the western end of the harbour attracted industries dependant on water, such as shipbuilding and repair, transport of raw materials, as well as being the site for a power cable tunnel to the north of the harbour in the early 20th century (Inner West Council, 2016).

The waterways of Port Jackson and Parramatta River were intensively utilised as a conduit for communication and movement of goods and people from the start of European occupation. These waterways were the route for vessel traffic between Sydney Town and Parramatta long before an effective road linked the two centres.

At the tip of Yurulbin Point and around Snails Bay, foreshore allotments were taken up by maritime related industries such as lightering, chandleries, and in the case of Yurulbin Point, shipbuilding and repair. This resulted in the construction of short timber jetties, slipways, seawalls and *ad hoc* low level land reclamation.

In 1788, Lieutenant Henry Ball and two marines were the first Europeans to explore the hinterland of Sydney's North Shore. Splitting off from an expedition exploring the creeks that fed into Middle Harbour, Ball and the two marines returned to Sydney Cove overland and took two days to return via what is now Balls Head.

Berrys Bay, on the eastern side of the Waverton Peninsula has been used for port and maritime industry since the 1820s, when Edward Wollstonecraft and Alexander Berry constructed two convict-built sandstone wharves to allow produce from their Shoalhaven property to be unloaded.

This area continued through a number of uses following its lease to the P&O Company, including boatyards, a distillery and a military depot for the NSW Torpedo Corps. Early in the 20th century, the Anglo-Persian Oil Company established their business on the western side of peninsula at the former Coal Loader site, installing the first oil tank in 1923 (Godden Mackay Logan, 2000).

The European history of the northern section of the design development corridor dates back to 1828 when the government surveyor, Sir Thomas Mitchell, produced a plan for a potential township just a few kilometres north of Milsons Point. The proposed township was accepted and by 1838 a basic design had been produced which included the present east-west layout of McLaren, Berry and Mount Streets, the north-south layout of Miller and Walker Streets and the 40 acre site of St Leonards Park (originally known as 'The Reserve'). The township of St Leonards was officially gazetted in 1838.

During the first half of the 20th Century the motor car became an essential means of transport for people of every walk of life and social standing. Throughout the later half of the 20th Century, millions of dollars were spent upgrading existing roads and adding a system of freeways and motorways to help ease the growing congestion of traffic. Initial plans for the Warringah Freeway showed a crossing into the Manly Warringah area via Castlecrag, then later Castle Cove. The first stage of the road was opened in June 1968 taking traffic off the Harbour Bridge to the suburbs of the North Shore without having to negotiate local traffic in North Sydney.

The original north termination point of the freeway was Chandos Street, Cammeray, with a small extension being added to Willoughby road in 1978. The Chandos Street ramps were moved to Brook Street at this time. Three years after the Warringah Freeway was completed as far as Willoughby, the freeway was extended as far as Lane Cove, the new section being called the Gore Hill freeway.

It was not until 1992 when the Gore Hill Freeway was added to connect the Warringah Freeway to the Pacific Highway at Lane Cove, that the road officially became part of Australia's Highway 1.

Registered heritage sites and conservation areas

Database searches have been carried out to identify registered heritage sites and conservation areas within and surrounding the design development corridor.

Figure 5-2 shows the heritage items within the vicinity of the design development corridor. No heritage items listed on the World or Commonwealth Heritage Lists are within 100 metres of the design development corridor.

There are seven heritage items listed on the State Heritage register within the design development corridor:

- Tarella (SHR 00270)
- Raywell (SHR 00093)
- Sydney Harbour Railway Electricity Tunnel (SHR 01231)
- North Sydney Sewer Vent (SHR 01641)
- St Leonards Park (SHR 01941)
- Milsons Point Railway Station Group (SHR 01194)
- Sydney Harbour Bridge, approaches and viaducts (SHR 00781).

The former coal loader at Balls Head has also been nominated for listing on the State Heritage Register.

No registered maritime heritage sites including shipwrecks are located within about 100 metres of the design development corridor. However, investigations carried out by Roads and Maritime and by Cosmos Archaeology in 2017 identified two wrecks on either side of the former coal loader wharf. The investigations indicated that the wrecks are unlikely to be older than 75 years and therefore not protected by the *Heritage Act 1977* as a historic shipwreck.

Notwithstanding, there are 82 registered vessels that are listed as wrecked in Sydney Harbour that have not been located. Shipwrecks are known to be present within Berry's Bay and there are likely to be shipwrecks in the deeper channels around Balls Head foreshore. The majority of shipwrecks in these areas would likely be relatively recent, however the remains of smaller undocumented vessels from the 19th century may be present (Cosmos Archaeology, 2017).

Several other listed heritage items are also located with the design development corridor above potential alignments of the project's mainline tunnels and ramps. Although it is unlikely that vibration or settlement impacts would affect the surface for most of the project alignment due to the significant tunnel depth, the potential for impacts on surface heritage items would be considered as part of the environmental impact statement.

Archaeological and cultural potential

There is potential for additional heritage sites and objects to occur across the landscape. Archaeological potential is assessed through the identification of underlying geology and proximity of resources, past land uses and the evaluation of the impact that subsequent activities have had on the land and the likelihood that evidence of the past has survived. Areas associated with the project which may have archaeological potential include:

- Areas of early industrial uses, eg Glebe Island may have evidence of early maritime and industrial uses
- Areas of early residential subdivisions, eg St Leonards may have evidence of early European occupation, including rubbish dumps, building foundations, wells and cesspits.

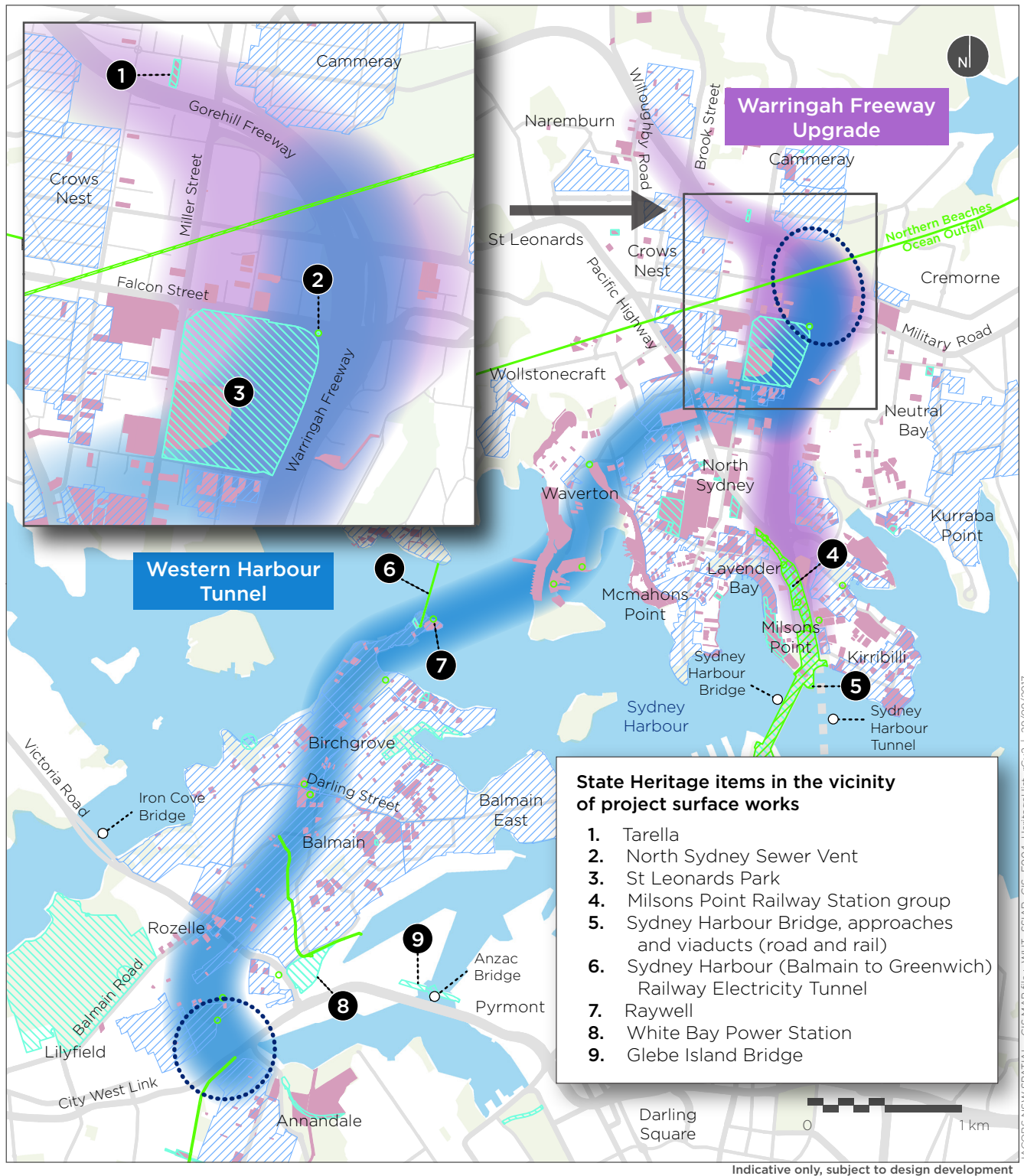


Figure 5-2 Heritage items within about 100 metres of the design development corridor

5.6.2 Summary of potential issues

Construction

There is the potential for direct and indirect impacts to non-Aboriginal heritage items, conservation areas and maritime archaeology to occur during the construction of the project, including to State heritage items. Potential construction impacts could include:

- Physical impact on the item or within the curtilage of the item. This could include permanent impacts such as the partial or complete demolition of the item to facilitate future operational surface infrastructure and ancillary facilities, or could include temporary impacts to the curtilage of a heritage listed item due to temporary use of the site for a worksite or other temporary facilities
- Structural damage to a heritage item due to vibration and settlement associated with tunnelling or surface works
- Temporary impacts on views to or from heritage items and within heritage conservation areas.

Operation

Potential impacts on non-Aboriginal heritage during operation may be associated with:

- The establishment of new project infrastructure that detracts from the values of a heritage item and or changes the visual outlook from a heritage item
- Physical impacts on the item or within the curtilage of the item as a result of architectural treatment to buildings for operational noise attenuation.

5.6.3 Proposed further assessments

A non-Aboriginal heritage assessment would be prepared as part of the environmental impact statement. The assessment would be prepared in accordance with the following guidelines:

- *The Burra Charter* (Australia ICOMOS, 2013)
- *Assessing Heritage Significance* (NSW Heritage Office, 2001)
- *Statements of Heritage Impact* (NSW Heritage Office, 1996)
- *Criteria for the assessment of excavation directors* (NSW Heritage Council, 2011)
- *Assessing significance for historical archaeological sites and relics* (NSW Heritage Branch, 2009).

The non-Aboriginal heritage assessment would include (as a minimum):

- Identification of items and areas of heritage significance (including wrecks and submerged heritage) that would be materially affected by the project during its construction and operation, by field survey and research, including any buildings, works, relics, gardens, landscapes, views, trees or places of heritage significance
- Assessment of the potential impacts on the values, settings and integrity of heritage areas and items and archaeological resources located near the project, including items both above and below ground and submerged, where such potential exists, the likely significance of those impacts.

The assessment would outline the proposed mitigation and management measures (including measures to avoid significant impacts and an evaluation of the effectiveness of the mitigation measures) in accordance with relevant guidelines.

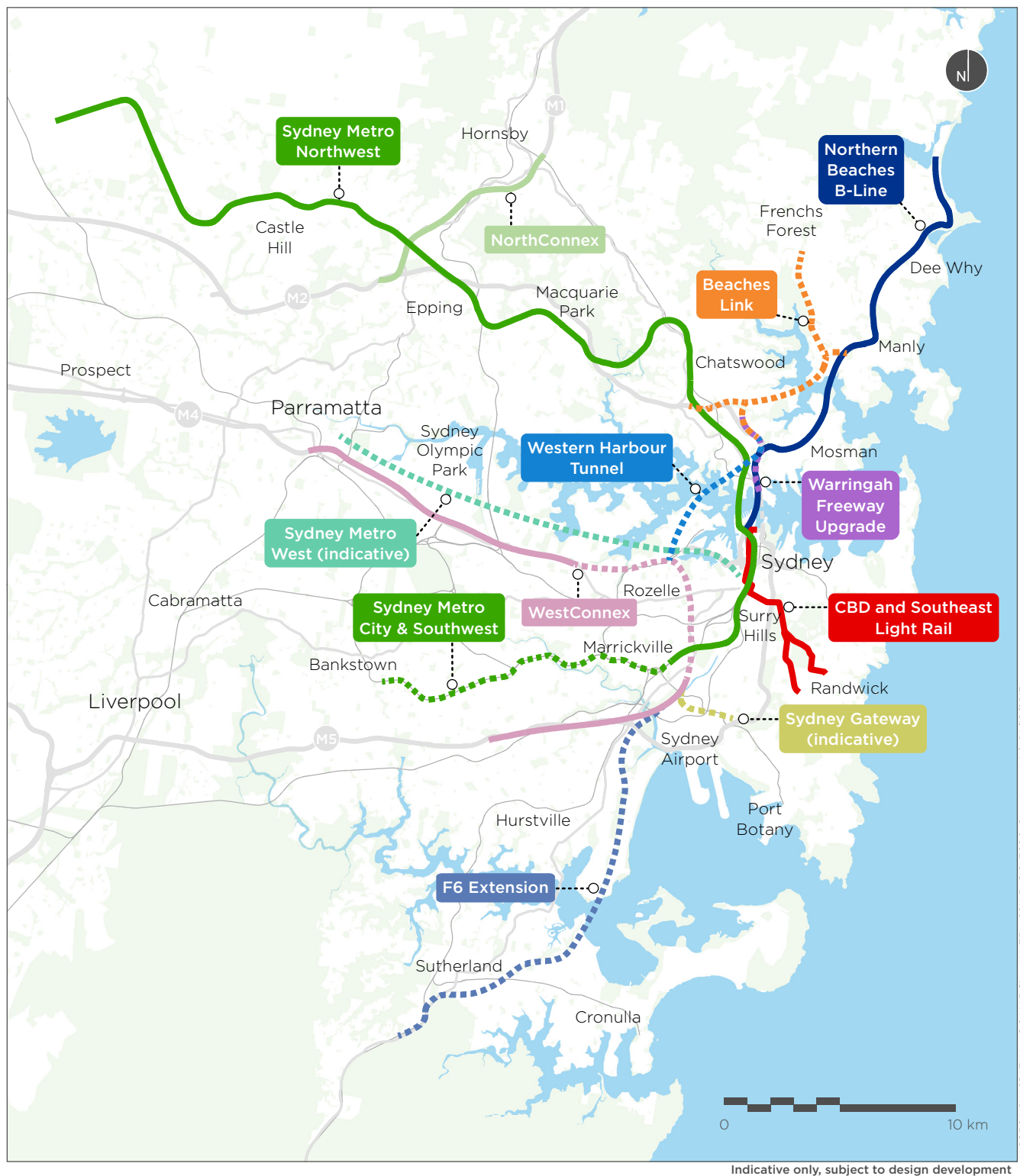
5.7 Cumulative impacts

This section provides an overview of the potential cumulative impacts that may arise during construction and operation of the project as a result of other major infrastructure projects occurring in proximity to and in similar timeframes to the project.

5.7.1 Overview

Cumulative impacts may arise for each of the key assessment issues and other assessment issues identified in this scoping report.

A desktop review has been carried out to identify other projects within the Sydney region that may interact spatially and/or temporally with the project, resulting in cumulative impacts. Relevant projects and construction programs are shown in Figure 5-3 and summarised in Table 5-1.



Key

— Western Harbour Tunnel	— WestConnex	— Road network
— Warringah Freeway Upgrade	— NorthConnex	— Rail
— Beaches Link	— F6 Extension	 Park
— Sydney Metro	— Indicative Sydney Gateway	 Water
— Indicative Sydney Metro West	— Northern Beaches B-Line	
— CBD and Southeast Light Rail	— Approved	
	- - - - - Proposed	

Figure 5-3 Sydney region projects with potential for cumulative impacts with the Western Harbour Tunnel and Warringah Freeway Upgrade

Table 5-1 Sydney region projects with potential for cumulative impacts

Project	Construction timing	Description
WestConnex M4 East	2016-2019	The project will extend the M4 through two new 5.5km tunnels from Homebush to Haberfield. The project does not overlap spatially with the Western Harbour Tunnel and Warringah Freeway Upgrade project. However, as a large tunnelling project in the Sydney area, there may be cumulative traffic impacts as a result of surface works and changes to access.
WestConnex M4-M5 Link	2019-2023	The project includes new twin 9.2km motorway tunnels between the M4 East at Haberfield and the New M5 at St Peters. The project includes tunnel stubs in the vicinity of the Rozelle Interchange to allow for a potential future connection to the Western Harbour Tunnel.
WestConnex New M5	2016-2020	The New M5 will provide twin underground motorway tunnels, nine kilometres long, from Kingsgrove to a new St Peters Interchange. The project does not overlap spatially with the Western Harbour Tunnel and Warringah Freeway Upgrade project. However, as a large tunnelling project in the Sydney area, there may be cumulative traffic impacts as a result of surface works and changes to access.
Sydney Gateway	Operational by 2023	Sydney Gateway will consist of a new road link between the WestConnex St Peters Interchange and Sydney Airport, with connections to Port Botany. The project does not overlap spatially with the Western Harbour Tunnel and Warringah Freeway Upgrade project. However, as a large road project in the Sydney area, there may be cumulative traffic impacts as a result of surface works and changes to access.
F6 Extension	Proposed project	Roads and Maritime has been conducting a study into developing a link between the M1Princes Motorway and the Sydney Motorway Network.
Sydney Metro City & Southwest	2017-2024	Sydney Metro is a new metro railway between Bella Vista and Bankstown through the Sydney CBD. This includes new tunnels and stations. Sydney Metro City & Southwest tunnel alignment between Chatswood and Sydenham passes over the Western Harbour Tunnel and Warringah Freeway Upgrade project alignment in North Sydney. The construction of Sydney Metro City & Southwest may result in cumulative traffic, air quality and noise impacts in the North Sydney area.
Bays Precinct in Sydney Harbour	2015-2022 onward	The Bays Precinct Urban Transformation Program includes proposed development in White Bay, Rozelle Bay and Blackwattle Bay integrating port, maritime, employment, housing, public space and recreation uses. Glebe Island adjacent to White Bay will be used as a spoil handling area for the Western Harbour Tunnel and Warringah Freeway Upgrade project, prior to the commencement of works for the Bays Precinct in 2022.

Project	Construction timing	Description
CBD and Southeast Light Rail	Operational by early 2019	The project involves a new light rail line extending from Circular Quay along George Street to Central Station, through Surry Hills to Moore Park, then to Kensington and Kingsford via ANZAC Parade and Randwick via Alison Road and High Street. The project includes a maintenance depot in the Rozelle Rail Yards.
NorthConnex and Hornsby Quarry	2015-2019	NorthConnex is a nine kilometre tunnel that will link the M1 Pacific Motorway at Wahroonga to the Hills M2 Motorway at West Pennant Hills. A substantial proportion of tunnel spoil from the NorthConnex project will be placed at Hornsby Quarry. The NorthConnex project is about 15km northwest of the Western Harbour Tunnel and Warringah Freeway Upgrade project.
Northern Beaches B-Line 2016-2017	Operational in late 2017	The B-Line program includes new bus lanes, bus bays, lane widening and commuter carparks to deliver transport improvements for the Northern Beaches. The Western Harbour Tunnel and Warringah Freeway Upgrade project would support the operation of the B-Line program.
Barangaroo	Current to 2024	The Barangaroo precinct is a 22-hectare development site at the western edge of the Sydney Harbour. The precinct is a mixed use development including parkland, commercial office buildings and residential apartments. The project does not overlap spatially with the Western Harbour Tunnel and Warringah Freeway Upgrade project however as a major infrastructure project occurring in the Sydney region, cumulative impacts such as air quality, noise and traffic from construction may be relevant considerations.
Beaches Link and Gore Hill Freeway Connection	TBA	The Beaches Link and Gore Hill Freeway Connection project includes new tolled motorway tunnels linking Warringah Freeway and Burnt Bridge Creek Deviation, with connections to Gore Hill Freeway at Artarmon and Wakehurst Parkway at Seaforth. The Western Harbour Tunnel and Beaches Link program of works are part of an overall motorway program, connecting at the Warringah Freeway.
Sydney Metro West	Proposed project	A proposed underground metro railway would link the Parramatta and Sydney CBDs, with potential stations at Parramatta, Sydney Olympic Park, Bays Precinct and Sydney CBD. The potential alignment for the project would be in close proximity to the Western Harbour Tunnel and WestConnex M4-M5 Link near Rozelle.

5.7.2 Summary of potential issues

Potential cumulative impacts may occur at the local scale due to projects elements occurring at the same location, or there could be regional impacts or benefits arising from projects in the same region. The projects identified in Table 5-1 occur within the greater Sydney metropolitan area and some will include construction works within or adjacent to the project.

Construction

Potential cumulative impacts arising from the project in combination with other major infrastructure projects include the following:

- Temporary traffic disruption and access changes as a result of major construction projects throughout Sydney
- Air quality and human health impacts from dust generation during construction where projects occur in close proximity and similar timeframes
- Noise and vibration impacts where construction is to occur in a similar location and timeframe, for example at Rozelle where WestConnex and the project construction occur in the same area
- Property acquisition and changes to land use
- Socio-economic impacts from temporary use of recreational areas and open space for construction of major projects
- Socio-economic benefits arising from employment opportunities and economic growth generated by the construction of major infrastructure projects in the Sydney area
- Construction of the project will generate greenhouse gases which will be cumulative to the greenhouse gases generated by other major and minor infrastructure projects in the Sydney area.

Operation

Operation of the project simultaneously with other large road infrastructure projects and residential developments identified in Table 5-1 has the potential to generate cumulative impacts. Such cumulative impacts would be localised and would be largely related to amenity impacts on local residents, the local community and users of recreational areas within and in the vicinity of the project corridor. This may potentially include impacts to local traffic conditions, noise and vibration, air quality and human health, social and economic impacts as well as impacts to visual amenity. Cumulative groundwater impacts may also occur and would need to be investigated further as part of the environmental impact statement.

5.7.3 Proposed further assessments

Further assessment of cumulative impacts would be carried out as part of the environmental impact statement. This would include (as a minimum):

- Review of current or planned projects in the vicinity of the project for which construction may occur over a similar period
- Specialist studies for the project environmental impact statement will consider the potential for cumulative impacts arising from the project in combination with the impacts of other projects
- Identification of mitigation measures where needed for cumulative impacts.

BLANK PAGE

6 Other assessment issues

6.1 Overview

This section discusses other important issues that would be assessed as part of the environmental impact statement, in addition to the key issues identified in Chapter 5.

6.2 Biodiversity

This section identifies the potential impact of the project on terrestrial and marine biodiversity during construction and operation. Marine biodiversity would be relevant if works on the harbour, including installation of an immersed tube tunnel are pursued.

6.2.1 Overview

A desktop environmental assessment including database searches has been conducted to identify terrestrial and marine biodiversity values in the design development corridor. Preliminary field surveys have been carried out to supplement desktop information and inform ongoing design development.

The focus of the marine ecology studies to date has been on nearshore intertidal and subtidal areas at sites in Sydney Harbour. Impacts to these areas would be highly dependent on the preferred harbour crossing option and construction method. Potential impacts on marine biodiversity would be relevant if an immersed tube tunnel design is pursued.

Terrestrial environment

Landscape features

The design development corridor occurs within the Sydney Metropolitan area which is one of the most disturbed areas within the Sydney Basin bioregion; having been altered due to urban growth and development. The majority of the design development corridor occurs within cleared land which has been subject to vegetation clearing or weed invasion. There are some areas of remnant, regrowth and planted vegetation that occur within the design development corridor.

Vegetation communities

Based on vegetation mapping and preliminary field surveys two native vegetation community (plant community types (PCT)) and two highly disturbed vegetation types with little or no native vegetation were identified within the design development corridor. This vegetation is shown in Figure 6-1a and Figure 6-1b, and summarised in Table 6-1.

There are no threatened ecological communities listed under the *Biodiversity Conservation Act 2016* (NSW) (BC Act) or the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) within the design development corridor.

Table 6-1 Plant community types within the design development corridor

PCT No.	BVT No.	Description	Threatened ecological community
1778	ME65	Coastal Sandstone Foreshores Forest	No
920	ME024	Estuarine Mangrove Forest	No
N/A	N/A	Miscellaneous ecosystems – highly disturbed with no or limited native vegetation (Urban Exotic/Native)	No
N/A	N/A	Miscellaneous ecosystems – highly disturbed with no or limited native vegetation (Weeds and Exotics)	No

Threatened flora species

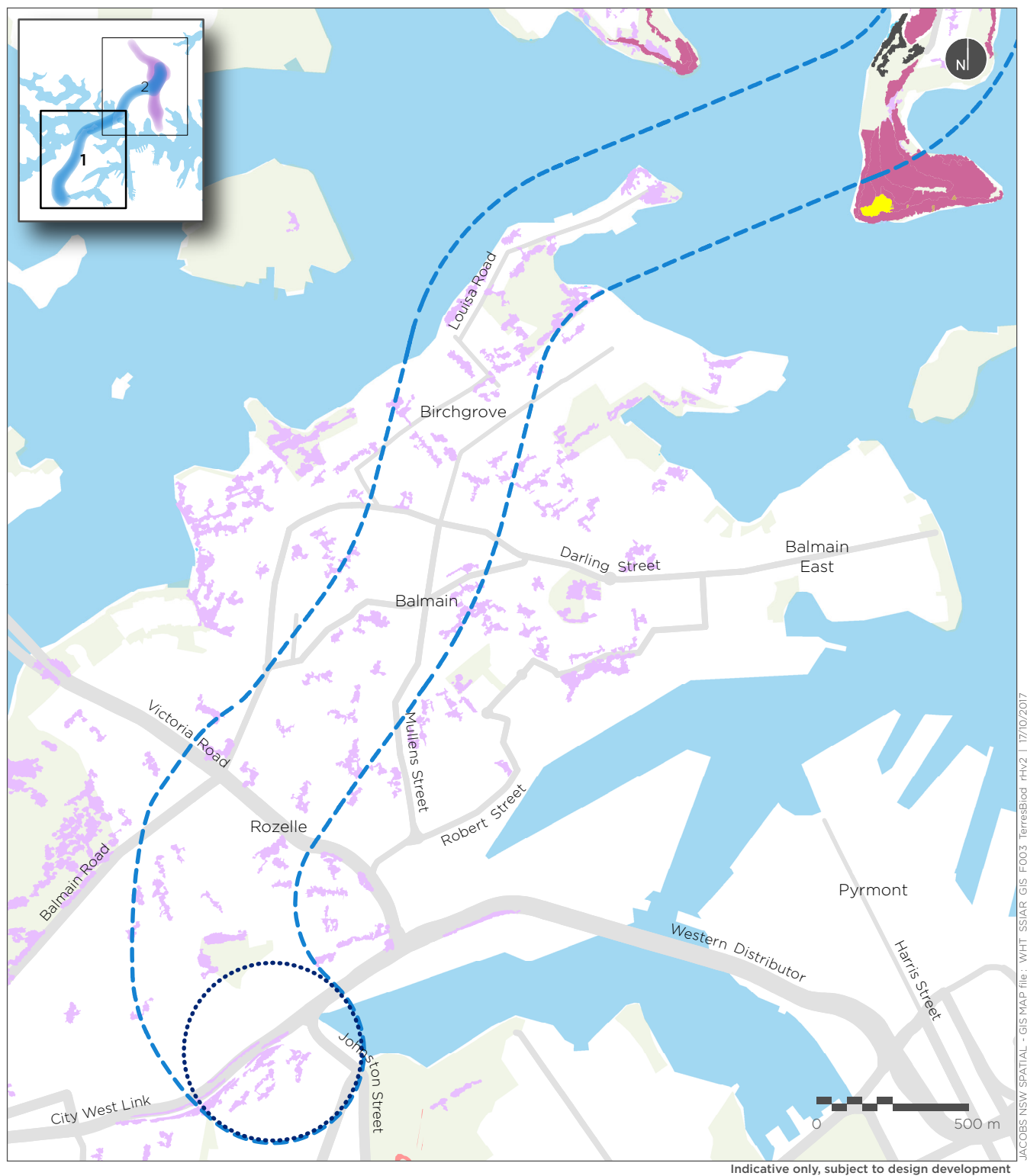
The results of database searches have identified several threatened flora species listed under the BC Act and the EPBC Act as having the potential to occur or likely to occur in the design development corridor. However, the developed urban nature of the design development corridor and very limited native vegetation reduces the potential for threatened flora species to be present. BioNet Atlas records for the design development corridor indicate that the following threatened flora species have been sighted in the design development corridor and immediate surrounds:

- Black-eyed Susan (*Tetratheca juncea*) – listed as vulnerable under the BC Act and EPBC Act. Records in the locality of the design development corridor are dated from the 1800s and the species is now considered to be extinct in the Sydney area (DoEE 2017)
- Glandular Pink-bell (*Tetratheca glandulosa*) – listed as vulnerable under the BC Act. Records in the locality of the design development corridor are dated from the 1800s to early 1900s, with the closest recent (1995) record of this species located in the Lane Cove National Park
- Sunshine Wattle (*Acacia terminalis* subsp. *terminalis*) – listed as endangered under the BC Act and EPBC Act. This species has been recorded in areas of native vegetation adjoining Sydney Harbour, including at Balls Head.

No threatened flora species have been recorded within the design development corridor during the preliminary field surveys conducted to date.

Fauna habitat

Terrestrial fauna habitat within the design development corridor is limited due to the urban and developed environment with little native vegetation. Urban landscape trees within the design development corridor and small patches of native vegetation at Yurulbin Park and Balls Head are likely to provide habitat for common urban fauna species.



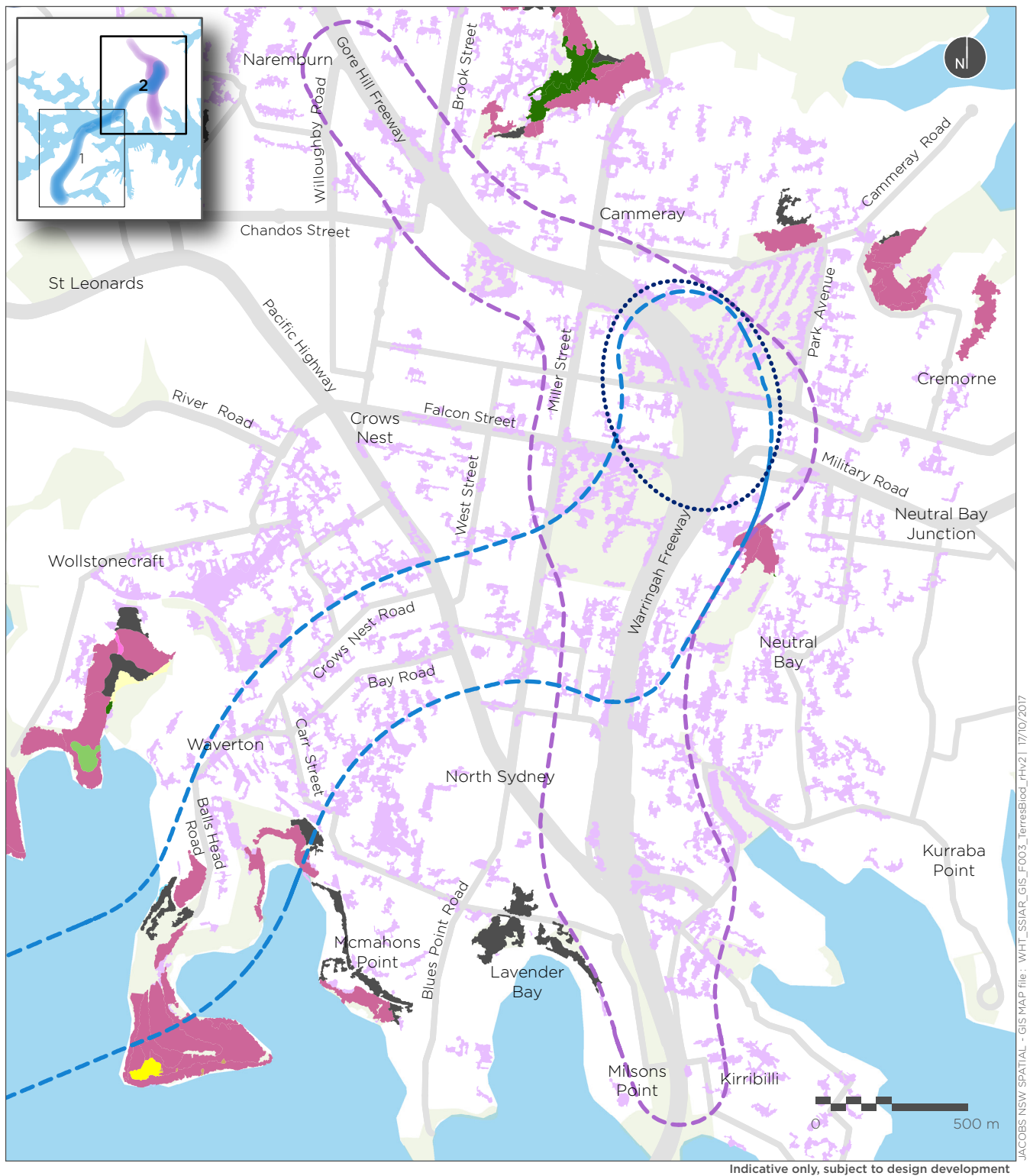
Key

- Western Harbour Tunnel design development corridor
- Indicative connection to surface
- Road network
- Park
- Water

Plant community types within 500m of the design development corridor (OEH: SydneyMetroArea v3 2016)

- 1126: Estuarine Saltmarsh
- 1234: Estuarine Swamp Oak Forest
- 1778: Coastal Sandstone Foreshores Forest
- 1822: Coastal Headland Banksia Heath
- 920: Estuarine Mangrove Forest
- Rock
- Urban Exotic/Native
- Weeds and Exotics

Figure 6-1a Terrestrial biodiversity features within and nearby the harbour crossing between Birchgrove and Waverton



Key

- Western Harbour Tunnel design development corridor
- Warringah Freeway Upgrade design development corridor
- Indicative connection to surface
- Road network
- Park
- Water

Plant community types within 500m of the design development corridor (OEH: SydneyMetroArea v3 2016)

- | | |
|---|---|
| 1234: Estuarine Swamp Oak Forest | 920: Estuarine Mangrove Forest |
| 1778: Coastal Sandstone Foreshores Forest | Plantation (native and/or exotic) |
| 1822: Coastal Headland Banksia Heath | Rock |
| 1828: Coastal Sandstone Gallery Rainforest | Urban Exotic/Native |
| 1841: Coastal Enriched Sandstone Moist Forest | Weeds and Exotics |
| 1847: Sydney Foreshores Shale Forest | |

Figure 6-1b Terrestrial biodiversity features within and nearby the harbour crossing between Birchgrove and Waverton

Threatened fauna species

Results of the threatened species database searches have identified several threatened fauna species listed under the BC Act and the EPBC Act as having the potential to occur or likely to occur within the design development corridor and surrounds, including birds, frogs and mammals. However, the developed urban nature of the corridor and very limited native vegetation reduces the potential for threatened fauna species to be present. Bionet Atlas records for the design development corridor indicate that the following threatened fauna species have been sighted in the design development corridor and surrounds:

- Curlew Sandpiper (*Calidris ferruginea*) – listed as critically endangered under the EPBC Act and endangered under the BC Act
- Grey-headed Flying Fox (*Pteropus poliocephalus*) – listed as vulnerable under the EPBC Act and BC Act
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) – listed as vulnerable under the BC Act
- Powerful Owl (*Ninox strenua*) – listed as vulnerable under the BC Act.

Three species listed as migratory species under the EPBC Act have been identified as having a moderate or higher likelihood of occurrence within the design development corridor and surrounds, based on the habitat recorded:

- Common Sandpiper (*Actitis hypoleucos*)
- White-Throated Needle Tail (*Hirundapus caudacutus*)
- Eastern Osprey (*Pandion cristatus* syn. *P. haliaetus*).

However the habitat present is unlikely to be 'important habitat' for any migratory species as defined under the EPBC Act Significant Impact Guidelines.

Freshwater aquatic and riparian habitats

Freshwater waterways within or near the design development corridor include Willoughby Creek and Whites Creek. Willoughby Creek is located within the northern section of the Warringah Freeway Upgrade and Whites Creek is located south of the Rozelle Interchange. Due to the heavily urbanised surrounding environment, aquatic habitats and riparian areas are likely to have poor to moderate water quality which limits the occurrence of native fish and environmentally sensitive amphibian species within these environments. Riparian vegetation may contain habitat for commonly occurring amphibians, reptiles and mammals that are well suited to disturbed environments.

Marine environment

Marine habitat features

The shoreline of Sydney Harbour has been extensively modified since European settlement with over 50 per cent replaced by seawalls, boat ramps, and other man-made structures. In addition, the position and shape of the shoreline has been altered through reclamation works and localised infilling (GHD, 2015). The intertidal and subtidal habitats in the design development corridor within Sydney Harbour are directly affected by stormwater and urban run-off from adjacent land.

Nearshore sub tidal habitats of Sydney Harbour include rocky boulder reefs, flat rock platforms and soft bottoms (including seagrass meadows and bare sediment). Intertidal habitats of Sydney Harbour relevant to the design development corridor include rocky shores and artificial structures, and soft bottoms (including sandy beaches). Marine habitat features are shown in Figure 6-2.

Within the design development corridor in Sydney Harbour and Parramatta River, reef habitat complexity is moderate to high. Areas of moderate reef complexity occur around Balls Head Bay and Longnose Point, with areas of high complexity around Berry Island and parts of Goat Island.

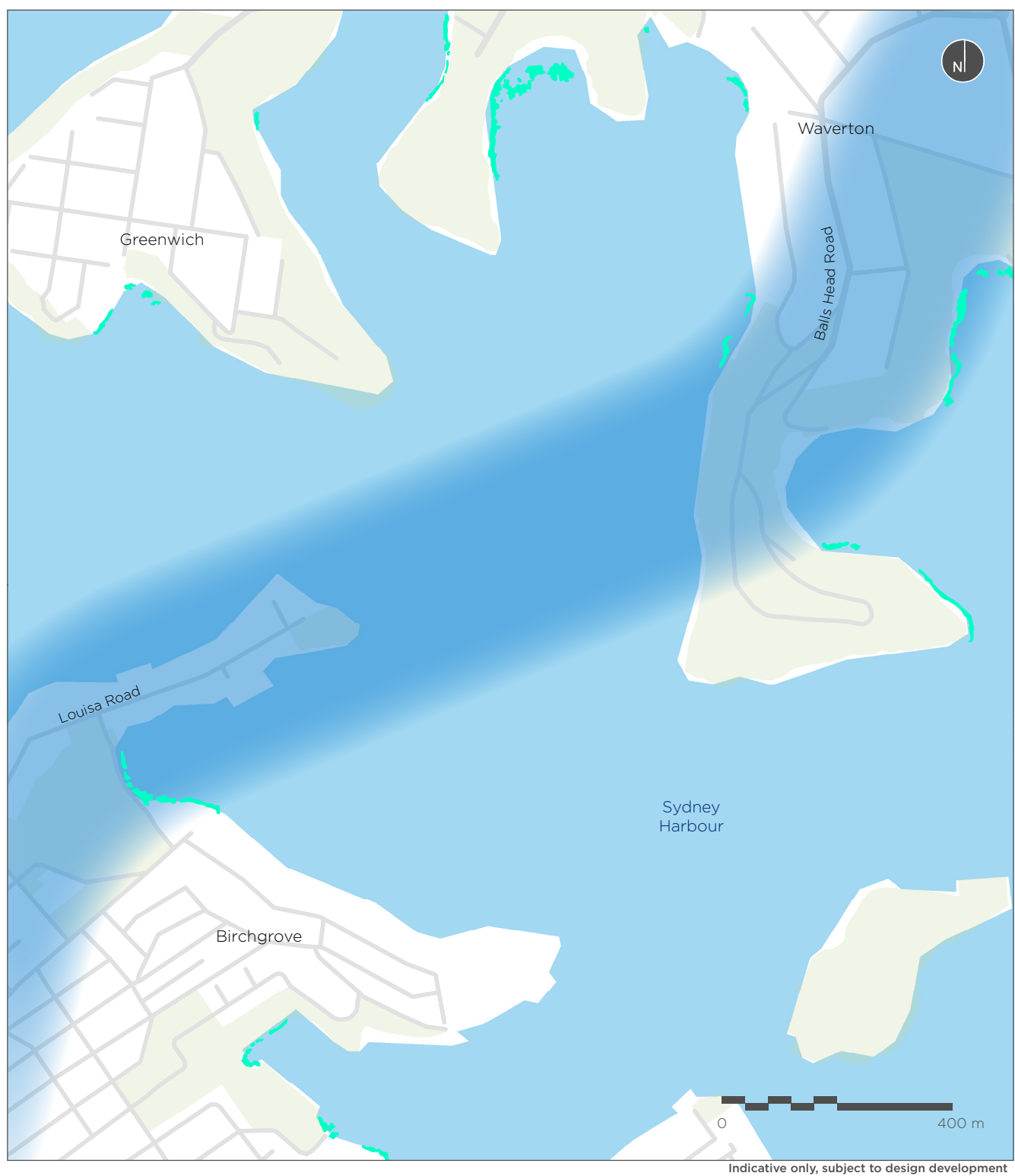
According to *NSW DPI Policy and Guidelines for Fish Habitat Conservation and Management* (Department of Primary Industries, 2013), fish habitats in the design development corridor are likely to be classified as 'Type 1 highly sensitive key fish habitat' (Berrys Bay at Waverton) or 'Type 2 moderately sensitive key fish habitat' (Longnose Point at Birchgrove and Balls Head at Waverton). The waterway class for the locations in the design development corridor is classified as 'Class 1 major fish habitat'.

Listed species, populations and communities

Database searches have identified several species listed under the BC Act, the *Fisheries Management Act 1994* (FM Act) and/or the EPBC Act, as potentially occurring within the marine habitats of the design development corridor, including:

- Cetaceans (mainly dolphins)
- Several species of marine turtles, fish, sharks, shore birds and sea birds
- Syngnathiformes (including species of seahorses, pipefishes, seadragons, pipehorses, ghostpipefish and seamoths) accounting for 25 of the species potentially occurring within the design development corridor. These species are often found in association with seagrass beds or rocky reefs. No critical habitat for these species is mapped within the design development corridor
- Black Cod (*Epinephelus daemeli*), listed as vulnerable under the EPBC Act. This species resides on rocky reefs and has the potential to occur within the design development corridor.

Based on vegetation mapping, seagrass meadows (PCT 1913) have been identified within and adjacent to the design development corridor, as shown in Figure 6-2. Preliminary field investigations have indicated that species present may include Eelgrass or Ribbonweed (*Zostera capricorni*). Other seagrass species in Sydney Harbour, outside the design development corridor include Paddleweed (*Halophila ovalis*) and Strapweed (*Posidonia australis*).



Key

- Western Harbour Tunnel design development corridor
- 1913: Seagrass Meadows (OE: SydneyMetroArea v3 2016)

- Road network
- Park
- Water

Figure 6-2 Marine biodiversity features within and nearby the harbour crossing between Birchgrove and Waverton

6.2.2 Summary of potential issues

Terrestrial biodiversity

The project is unlikely to have a significant impact on terrestrial biodiversity due to the majority of works occurring underground, and the highly disturbed surface environment. Potential impacts may result from:

- Vegetation clearance associated with surface works for road widening, tunnel portal construction and worksites
- Loss of urban street trees and other planted vegetation adjacent to existing roads and in public areas
- Mortality of fauna during both the construction and operation of the project
- Introduction and/or spread of noxious weeds and other invasive species
- Impacts to groundwater levels during construction and operation and associated impacts to groundwater dependent ecosystems
- Mobilisation of sediments into urban drainage lines and potential pollution from materials used in the process of construction and operation, resulting in downstream impacts to aquatic species and communities.

Marine biodiversity

If works on Sydney Harbour, including installation of an immersed tube tunnel, are pursued as part of the project there is potential to impact marine biodiversity, including EPBC Act, BC Act and FM Act listed threatened species, populations and communities. Potential impacts may result from:

- Removal of marine vegetation resulting in habitat loss and loss of connectivity for marine fauna species
- Changes to marine habitats during construction and operation of the project
- Creation of a turbidity plume during dredging and support vessel movements in shallow water resulting in impacts on water quality (with resulting impacts to marine biota) and deposition of sediments in marine habitats
- Mortality of sessile fauna during construction of cofferdams and dredging activities
- Ship strike and entrainment of marine fauna in construction equipment
- Disturbance and removal of benthic fauna during construction
- Introduction of pest species
- Impacts on water quality associated with marine oil spills or disturbance of contaminated sediments.

6.2.3 Proposed further assessment

Terrestrial biodiversity assessments

A detailed terrestrial biodiversity assessment would be prepared as part of the environmental impact statement for the project. The assessment would be carried out in accordance with the requirements of the *Biodiversity Conservation Act 2016* and the *Biodiversity Assessment Method (BAM)*. The *Environment Protection and Biodiversity Conservation Act 1999 Significant Impact Guidelines* (Department of the Environment, 2013) would also be applied to the assessment of impacts on threatened species and ecological communities listed under the EPBC Act.

The terrestrial biodiversity assessment would include (as a minimum):

- Identification of listed flora and fauna species, habitat, populations and ecological communities (including groundwater dependent ecosystems) that may be affected by the project

- Assessment of the direct and indirect impacts of the project on terrestrial flora and fauna species, populations, ecological communities and their habitats, and groundwater dependent ecosystems
- Assessment of the significance of the impacts of the project on listed species, ecological communities and populations listed under the EPBC Act, the BC Act and FM Act and groundwater dependent ecosystems that occur or are considered likely to occur
- Identification of mitigation and offset measures, determined in accordance with the Biodiversity Assessment Method and the EPBC Act Environmental Offsets Policy, if necessary.

Marine biodiversity assessments

A detailed marine biodiversity assessment would be prepared as part of the environmental impact statement for the project following the *Policy and Guidelines for Fish Habitat Conservation and Management* (Department of Primary Industries, 2013) and the *Fisheries NSW policy and guidelines for fish habitat conservation and management (Update 2013)*. The *Environment Protection and Biodiversity Conservation Act 1999 Significant Impact Guidelines* (Department of the Environment, 2013) would also be applied to the assessment of impacts on threatened species and ecological communities listed under the EPBC Act.

The marine biodiversity assessment would (as a minimum):

- Identification of listed marine flora and fauna species, habitat, populations and ecological communities that occur or are considered likely to occur
- Assessment of the potential direct and indirect impacts of the project on marine flora and fauna species, populations, ecological communities and their habitats, and groundwater dependent ecosystems
- Assessment of the significance of the potential impacts of the project on species, ecological communities and populations listed under the EPBC Act, the BC Act and FM Act that occur or are considered likely to occur in the design development corridor
- Identification of mitigation and offset measures determined in accordance with the *Fisheries NSW policy and guidelines for fish habitat conservation and management (Update 2013)*.

6.3 Aboriginal cultural heritage

This section identifies the potential impacts of the project on the Aboriginal cultural heritage values of the design development corridor during construction and operation.

6.3.1 Overview

History

Occupation within NSW has been continuous since at least 45,000 years ago (OEH, 2017) and is represented by abundant archaeological evidence. Within the Sydney area, evidence has been dated back to around 30,000 years at Parramatta. Over this time period, Sydney Harbour has changed significantly. Sydney Harbour estuary is a drowned river valley, which occurred some 17,000 years ago. As such, the design development corridor either side of the harbour crossing would have been the middle-upper slopes of the ancient river valley and the climate and vegetation would have been significantly different than the current landscape. Aboriginal occupation may have occurred along the areas adjacent to the river, utilising food, water and raw materials available in the deep valley.

The underlying geology of the design development corridor consists of Hawkesbury Sandstone and Ashfield Shale. Evidence of Aboriginal use of Hawkesbury Sandstone in the Sydney area includes occupation deposits in natural shelter formations created by weathering processes in

exposed sandstone, grinding grooves where edge-ground stone axes were manufactured or maintained, and rock engravings or pigment motifs that were applied to exposed sandstone.

The design development corridor is located across a landscape of varying subsistence resources. Archaeological and historical records indicate that marine and estuarine resources formed an important part of the subsistence activities of the Aboriginal people that inhabited the Sydney Harbour area. Historically, people living in the Sydney Harbour area relied on catching fish and a variety of other marine animals for subsistence. Shellfish not only formed an important subsistence resource, but were also utilised as fish-hooks, shafted onto spears, used for repairing spears, and for cutting (Attenbrow, 2010).

There is considerable information on the heritage of Waverton Peninsula, including Balls Head, which is located in the central section of the design development corridor. The *Waverton Peninsula Industrial Sites Conservation Management Plan* (Godden Mackay Logan, 2000) documented a number Aboriginal heritage sites associated with the sandstone formations in the vicinity of Waverton Peninsula. The sites include open rock engravings, open and sheltered occupation sites, a sheltered stencil art site and burial site. The most well-known of the sites is the rock engraving (Site ID 45-6-0026) adjacent the former Coal Loader which includes numerous motifs including a whale and several human figures.

Registered Aboriginal heritage sites

Searches of the NSW Office of Environment and Heritage's Aboriginal Heritage Information System (AHIMS) and preliminary field surveys have been carried out to identify registered Aboriginal heritage sites within and surrounding the design development corridor. The results of the AHIMS database search are shown in Figure 6-3.

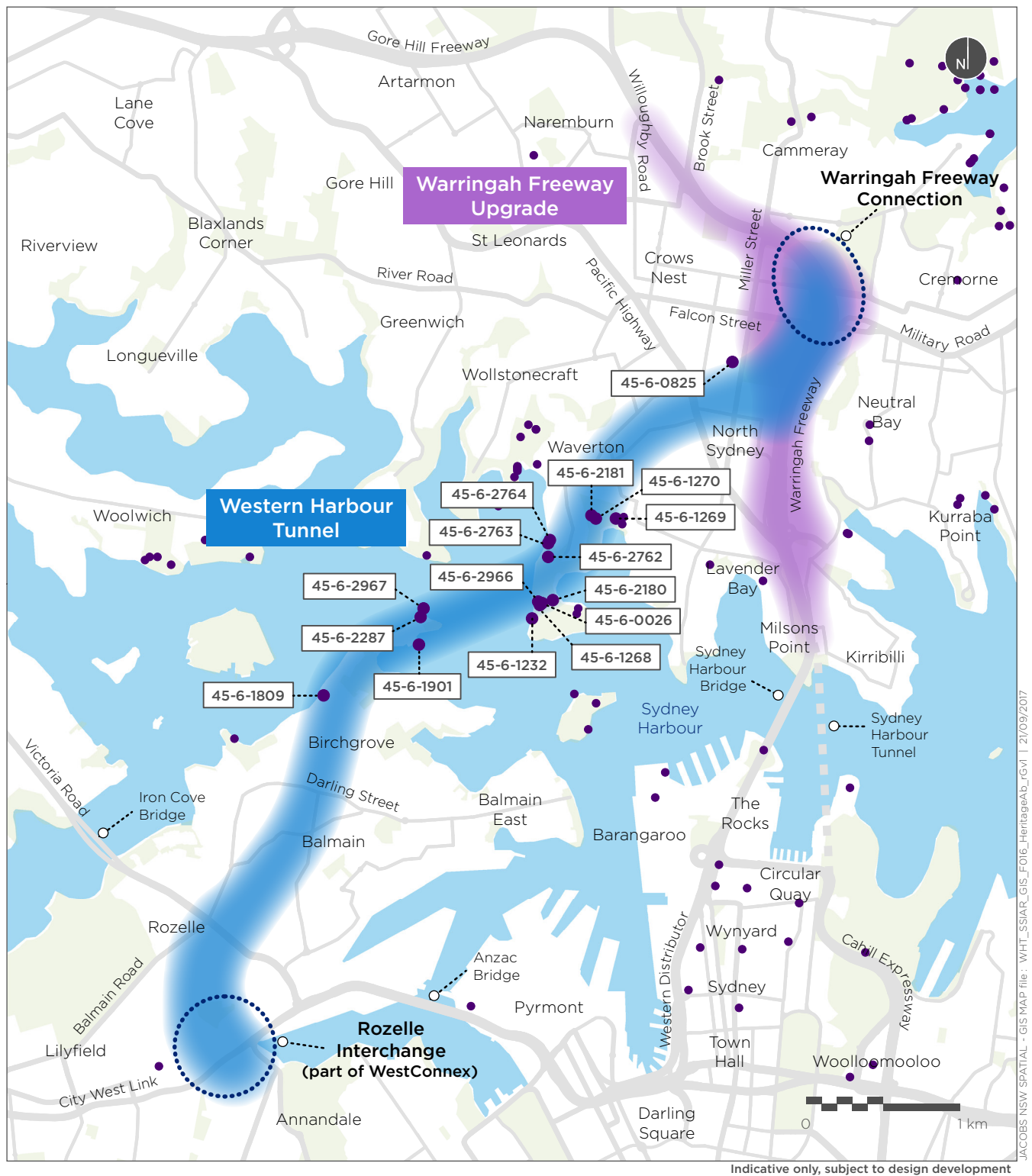
The majority of registered sites within and around the design development corridor are shell, artefact, art and potential archaeological deposits.

Archaeological and cultural potential

There is potential for additional heritage sites and objects to occur across the landscape. Archaeological potential is assessed through the identification of underlying geology and proximity of resources, past land uses and the evaluation of the impact that subsequent activities have had on the land and the likelihood that evidence of the past has survived. Areas associated with the project which may have archaeological potential include:

- Areas with outcropping or underlying sandstone bedrock (eg Waverton Peninsula and Yurulbin Park) may have the potential for engravings, grinding grooves or shelter formations with occupation deposits and/or art
- Foreshore areas (eg Waverton Peninsula and Yurulbin Park) may have the potential for shell middens and open campsites in addition to evidence of early maritime and residential uses
- Areas where old growth trees occur may have the potential for Aboriginal scarring on tree trunks.

Despite the impacts to the Aboriginal community following European colonisation, Aboriginal community connections to the area and culture in the central Sydney area are strong and ongoing. In addition to the registered archaeological sites and areas of Aboriginal archaeological potential identified above, cultural features may also be present. Cultural features could have spiritual, natural resource usage, historical, social, educational or other type of significance and may not necessarily be associated with sites or objects or be observable features.



- Key**
- Western Harbour Tunnel design development corridor
 - Warringah Freeway Upgrade design development corridor
 - Indicative connection to surface
 - AHIMS sites

- Road network
- Park
- Water

Figure 6-3 Registered Aboriginal heritage items within the vicinity of the design development corridor

6.3.2 Summary of potential issues

Construction

The project has the potential to impact on areas of Aboriginal cultural heritage significance through:

- Direct disturbance of surface areas of Aboriginal heritage or cultural significance
- Indirect disturbance through ground settlement or vibration impacts during construction, particularly tunnelling works.

Operation

Operational impacts on Aboriginal cultural heritage are not anticipated as widespread ground disturbance/excavation would be restricted to the construction phase.

6.3.3 Proposed further assessments

A detailed Aboriginal cultural heritage assessment would be prepared as part of the environmental impact statement. The assessment would be prepared in accordance with the following guidelines:

- *Guide to investigating, assessing and reporting on Aboriginal Cultural Heritage in NSW* (OEH, 2011)
- *Aboriginal Cultural Heritage Consultation requirements for proponents* (DECCW, 2010a)
- *Code of practice for archaeological investigation of Aboriginal objects in NSW* (DECCW, 2010b)
- *Procedure for Aboriginal Cultural Heritage Consultation and Investigation* (Roads and Maritime 2011).

The Aboriginal cultural heritage assessment would include (as a minimum):

- Identification of the potential for the project to disturb Aboriginal heritage (sites, objects, remains, values, features or places)
- Assessment of the significance of the heritage to the Aboriginal community in consultation with relevant stakeholders
- Assessment of the extent and significance of impact as a result of construction and/or operation of the project
- Identification of requirements for in situ conservation of items and/or areas (as appropriate), the need for further archaeological testing and/or detailed archaeological excavations
- Mitigation and management measures (including measures to avoid significant impacts and an evaluation of the effectiveness of the mitigation measures) in accordance with relevant guidelines.

6.4 Soil and water quality

This section identified potential impacts of the project on soils and sediments (terrestrial and marine), water quality and coastal processes within Sydney Harbour such as wave climate, sediment transport patterns, tides and currents.

6.4.1 Overview

The Sydney Harbour estuary is a drowned river valley, characterised by steep sided banks carved into Sydney sandstone between 25 and 29 million years ago. Around 17,000 years ago, the sea level rose, flooding the river valley and forming a flood tide delta. By 8,000 years ago, sea level stood at five metres below present and the sea reached its present position about 6,000 years ago. The Sydney Harbour estuary is about 30 kilometres in length, ranging in width from around 60

metres near the headwaters to about three kilometres approaching the estuary mouth (Hedge et al., 2013).

Geology

The project would be located within the Sydney Basin. The bedrock geology along the alignment is comprised primarily of Hawkesbury Sandstone, with an outcrop of overlying Ashfield Shale at higher elevations in the North Sydney area. Quaternary alluvial and estuarine sediments within the design development corridor are associated with current and ancient watercourses.

The design development corridor crossing of Sydney Harbour crossing contains areas underlain by estuarine, marine and alluvial sediments overlying Hawkesbury Sandstone. Depths to rock over this part of the corridor are expected to be over 44 metres below sea level. The surface sediments typically consist of 'muddy' silt interbedded with fine to medium silty sand.

Soils

The *Soil Landscapes of Sydney 1:100,000 Sheet Series 9130* (Chapman and Murphy, 1989) indicates that the design development corridor passes through a variety of soil landscapes as described in Table 6-2.

Acid sulfate soils are not expected in most areas within the design development corridor based on the *Australian Soils Resource Information System* (ASRIS, 2011) and acid sulfate soil risk mapping published by the Office of Environment and Heritage (2013). The key exception is Sydney Harbour where there is a high probability of occurrence of acid sulfate soil material in bottom sediments.

Artificial fill deposits are likely to be common in developed areas and are mapped as present in the area around the Rozelle Interchange and at Birchgrove Park.

Table 6-2 Soils landscapes of the design development corridor

Name	Soil characteristics
Gymea	Shallow to moderately deep (0.3–1 metres), on undulating to rolling rises and low hills on Hawkesbury Sandstone. Limitations of this soil landscape include localised steep slopes, high soil erosion hazards, shallow highly permeable soil and very low soil fertility.
Blacktown	Strongly acidic and hard setting, and have low fertility, high aluminium toxicity, localised salinity and sodicity, low wet strength, low permeability, and low available water holding capacity.
Disturbed terrain	Cap of sandy loam over compacted clay or waste materials and may be strongly acidic to strongly alkaline. Some limitations include low fertility, low wet strength, low availability water capability, high permeability, localised toxicity/acidity and/or alkalinity.
Hawkesbury	Shallow (<0.05 metres) discontinuous lithosols/siliceous sands associated with rock outcrops, with earthy sands and some yellow podzolic soils on the inside of benches and along rock joints and fractures. Limitations are described as extreme soil erosion hazard, mass movement hazard and steep slopes with some impermeable and plastic subsoil.

Terrestrial contamination

Online searches of the NSW EPA register of contaminated sites, list of notified sites and the public register for environment protection licences has identified several known or potentially

contaminated sites including service stations, former power stations, industries, marinas and shipyards.

Other areas of potential environmental concern may occur in or adjacent to the design development corridor associated with the land uses listed in Table 6-3. Potential contaminants, including petroleum hydrocarbons, volatile organics, dioxins, pesticides and metals, represent potential exposure risks during the intrusive works and the handling of material collected during the works through dermal contact, ingestion, inhalation of vapours or particulate matter and environmental damage.

Table 6-3 Areas of potential environmental concern

Areas of potential environmental concern	Contaminants of concern
Service stations, auto workshops	Total recoverable hydrocarbons (TRH), benzene, toluene, ethylbenzene and xylene (BTEX), Polycyclic aromatic hydrocarbon (PAH), metals
Boat repairs, marinas	TRH, BTEXN, volatile organic compounds (VOC), chlorinated solvents, tributyltin (TBT)
Electrical substations	TRH, polychlorinated biphenyl (PCB)
Drycleaners	Chlorinated hydrocarbons
Rail corridors	TRH, BTEX, PAH, pesticides, asbestos
Roads, road reserves	TRH, BTEX, PAH, metals
Parks, reserves, playing fields, golf courses	Pesticides, herbicides
Sydney Harbour	PAH, TBT, dioxins, metals
Historic fill materials	TRH, BTEX, PAH, metals, asbestos

Marine contamination

If the project includes marine works, including potentially installation of an immersed tube tunnel, contaminated sediments may be encountered. This includes the upper layers of sediment in Sydney Harbour which have historically been impacted by industrialisation and urbanisation of the catchment.

The contamination status of Sydney Harbour has been characterised in previous studies and indicates extensive metal contamination present in the sediment coupled with non-metallic contaminants such as organohalide pesticides and polycyclic aromatic hydrocarbons (PAHs). Contamination levels tend to increase with distance upstream of Sydney Heads. The deeper parts of the central Sydney Harbour, including between Birchgrove and Balls Head, experience tidal flushing and low sedimentation which would reduce the accumulation of contaminants. However, bays such as Berrys Bay feature lower energy circulation and higher sedimentation rates and therefore, there would be increased potential for contaminated sediments in such areas.

Based on the historical and recent land use, potential contaminants of concern in sediments include:

- Total recoverable hydrocarbons (TRH)
- Polycyclic aromatic hydrocarbons
- Organochlorine pesticides
- Heavy metals
- Tributyltin (TBT)
- Polychlorinated biphenyls (PCBs)
- Dioxins (polychlorinated dibenzo-p-dioxins), dioxin-like substances, furans (polychlorinated dibenzofurans) and furan-like substances
- Other organic compounds.

Water quality

Freshwater creeks and ephemeral drainage channels within the design development corridor are limited due to urbanisation and development that has occurred. Freshwater creeks within and/or near the design development corridor include Willoughby Creek and Whites Creek. Willoughby Creek is located within the northern section of the Warringah Freeway upgrade and Whites Creek is located south of the Rozelle Interchange.

The Willoughby Creek catchment is a mix of residential and commercial land use and has been significantly altered as a result of past development. The Whites Creek catchment is a mix of residential in the upper reaches with industrial in the lower reaches. Whites Creek has also been significantly altered and consists of a predominately brick and concrete channel (Sydney Water, 2014).

Water quality of both creeks is expected to be influenced by 'point source' water pollution such as stormwater drainage outlets and diffuse water pollution such as urban runoff that does not enter stormwater drains. Water quality is anticipated to be generally poor, typical of a heavily urbanised environment.

There are several water quality monitoring sites within Sydney Harbour. The closest monitoring site to the design development corridor is at the Greenwich Baths (about 600 metres to the west). According to the State of the Beaches 2015-2016 report (Beachwatch, 2016), the water quality at Greenwich Baths is good. A good rating indicates that microbial water quality is suitable for swimming most of the time but the water may be susceptible to pollution from several potential sources of faecal contamination, including discharge from Lane Cove River. Microbial water quality has generally improved since 2000–2001 owing to licensing of discharges from the sewerage system and improved management of stormwater.

6.4.2 Summary of potential issues

Construction

Construction of the project has the potential for the following soil, water quality and contamination related impacts:

- Impacts to soils due to spills or leaks of fuels, oils or hazardous substances from construction work, plant and equipment and/or from vehicle incidents (hydrocarbons and heavy metals)
- Disturbance of contaminated soils, especially if surface work is carried out within land known to be contaminated, or on land which has been identified as potentially contaminated based on current and historic activities. Disturbance of contaminated soils has the potential to result in offsite pollution and ecological or human health impacts
- Disturbance of contaminated sediments in the upper layers of sediment in Sydney Harbour which have historically been impacted by industrialisation and urbanisation of their catchment. There is a risk of mobilisation of these sediments which may result in offsite pollution and impacts to marine fauna and water quality

- Exposure of soils during construction resulting in direct erosion impacts. This may lead to dirty water runoff and sedimentation in local watercourses or adjacent land
- Dirty water runoff and sedimentation of local watercourses including Willoughby Creek, as well as downstream waterbodies including Middle Harbour and Sydney Harbour
- Exposure of potential or actual acid sulfate soils, particularly in the sediments of Sydney Harbour, resulting in the production of sulfuric acid, which may become bioavailable in the environment and affect local aquatic ecosystems and water quality
- If immersed tube tunnel construction and marine based worksites are required, there is potential for the creation of turbidity in the water column resulting in impacts on water quality and deposition of sediments in marine habitat. Depending on the results of contamination investigations, there may be additional water quality impacts associated with resuspension of contaminated sediments.

Operation

During operation of the project potential for impacts relating to soil, water quality and contamination would be limited as there will not be ongoing ground disturbance. Impacts may include:

- Impacts to water quality of receiving watercourses due to the discharge of treated groundwater and other waste waters (such as tunnel wash or deluge system water). This could have an impact on the water quality of the receiving waterway, depending on the discharge volumes, treatment and the point of discharge
- Impacts to water quality of receiving watercourses due to increased runoff from roads. This would typically contain oils and greases, petrochemicals and heavy metals as a result of vehicle leaks, operational wear, road wear and atmospheric deposition. Increased flows could also lead to increased potential for scouring of soils and watercourses
- Spills or leaks of fuels and/or oils from vehicle accidents, or from operational plant and equipment.

6.4.3 Proposed further assessments

The environmental impact statement would include an assessment of potential soil, water quality and contamination impacts during construction and operation of the project. The assessment would be guided by the *NSW Water Quality and River Flow Objectives* and would consider the following guidelines:

- *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (DEC, 2006b)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ, 2000)
- Other relevant catchment/water quality management objectives.

The assessment of potential water quality impacts would include (as a minimum):

- Identification of waterways that may be impacted by the construction and operation of the project, including assessment of the sensitivity of the receiving environments
- Assessment of the potential impacts to water quality including any resuspension of contaminated sediments during marine based activities
- Assessment of the risk of erosion and sedimentation in accordance with Roads and Maritime's *Erosion and Sedimentation Management Procedure* (Roads and Maritime, 2008)
- Assessment of changes to coastal processes in Sydney Harbour, including tidal flow and velocity and wave climate impacts and effects on sediment transport patterns
- Assessment of potential impacts involving acid sulfate soils in accordance with the *Acid Sulfate Soils Assessment Guidelines* (Department of Planning, 2008)
- Assessment of potential impacts involving contaminated land in accordance with *Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land* (Department of

Urban Affairs and Planning & Environment Protection Authority, 1998) and *Guidelines for Consultants Reporting on Contaminated Sites* (Office of Environment and Heritage, 2000)

- Assessment of soil properties including the extent and severity of salinity and how it may affect groundwater resources and hydrology
- Assessment of the impact on soil and land resources including soil erosion and sediment transport
- Identification of appropriate mitigation and management measures to safeguard the environment during construction and operation.

6.5 Groundwater

This section describes the groundwater resources within the design development corridor and potential impacts of the project.

6.5.1 Overview

Groundwater system

The design development corridor overlies four water bearing geological units, as summarised in Table 6-4.

The groundwater system is expected to consist of a deep groundwater system (where groundwater flows through the underlying rock layers) and a more localised surface groundwater system (where groundwater flows through overlying residual soils and fill).

Recharge of the deep groundwater system is expected to be via either direct recharge (at locations where the bedrock is exposed) or via downward percolation through the residual soil or fill (at locations where bedrock is not exposed). The surface groundwater system is likely to be recharged by rainfall and percolation from irrigation of residential gardens and open spaces, as well as incidental runoff from impervious surfaces such as roads and footpaths.

Table 6-4 Water bearing geological units

Geological units	Occurrence	Characteristics
Artificial fill	Along harbour foreshores and Rozelle	Water bearing unit supporting perched water systems but with very high variability and unpredictability
Ashfield Shale	North Sydney, Crows Nest, Cammeray	Behaves as an aquitard, very low permeability unit, high salinity
Mittagong Formation	North Sydney, Crows Nest, Cammeray	Transitional layer between Ashfield Shale and Hawkesbury Sandstone, thin, characteristics of Hawkesbury Sandstone
Hawkesbury Sandstone	Entire alignment	Semi-confined water bearing zone with highly variable hydraulic conductivity, good water quality

Groundwater levels

Groundwater monitoring bores have been installed along the design development corridor to inform the assessment of potential groundwater impacts from the project.

Groundwater monitoring has been carried out along the alignment of the Sydney Metro City and Southwest project since 2015 (Jacobs, 2015). This monitoring indicates that in the area between Chatswood and the Sydney CBD:

- In the residual soil, groundwater levels are around 2.5 metres below ground level
- In the Ashfield Shale groundwater levels are around 9.2 metres below ground level
- In the Mittagong Formation groundwater levels are around 12.9 metres below ground level
- In the Hawkesbury Sandstone, groundwater levels are around 12 to 22 metres below ground level.

Seasonal groundwater level variations are expected to occur as a response to rainfall. These fluctuations may affect the rate of groundwater inflow. Variations of groundwater levels are around 10 metres within the Hawkesbury Sandstone (GHD, 2006).

Groundwater users

The 'PINNEENA' database has been searched for registered bores within 2.5 kilometres of the design development corridor. Sixty five registered groundwater bores were identified and 90 of these are active groundwater users (stock, domestic, recreation and irrigation). The remainder are either installed for monitoring purposes (90), cancelled/lapsed (19) or have an unknown use (six). Around 27 bores are located within one kilometre of design development corridor. The majority of these bores are for monitoring purposes with three being registered for domestic purposes.

Groundwater dependent ecosystems

There are no mapped groundwater dependent ecosystems that rely on the surface expression of the regional groundwater within two kilometres of the design development corridor.

Groundwater quality

The groundwater quality in Hawkesbury Sandstone has been described for a number of major infrastructure projects across Sydney. Generally, groundwater quality has been found to have a high iron concentration, high salinity and slight acidity. High levels of iron can pose a high level risk to human health as well as having a negative impact on the environment. High salinity levels can result in degradation in soil quality and inhibit plant growth.

Dissolved metals such as manganese may also be present as well as other contaminants associated with petrol stations or landfill leachates and leaky sewer pipes.

Groundwater quality within Ashfield Shale is reported to be of poorer quality than in Hawkesbury Sandstone and may be corrosive to construction materials, such as concrete. In areas where Hawkesbury Sandstone underlies Ashfield Shale, the groundwater quality may have a higher salinity due to leakage from the unit above.

The Rozelle area has been subject to historical filling which may contain hazardous materials. Based on the proximity to Sydney Harbour, groundwater levels around Rozelle Bay would be expected to be around one or two metres below ground level. Groundwater in this area would therefore discharge directly into Sydney Harbour. There is potential that the fill, if hazardous, may have resulted in the contamination of the groundwater in the vicinity of Rozelle.

6.5.2 Summary of potential issues

Construction

Groundwater is likely to be encountered during construction as tunnelling activities move through the water bearing geological units. Potential impacts may result from:

- Groundwater drawdown as a result of construction works may impact water levels and potentially water quality in surface water bodies. Groundwater drawdown is likely to be restricted to a relatively narrow zone along the tunnel alignment. Bores and other groundwater users within this zone may be impacted
- Discharge of treated groundwater during construction. The rates and magnitude of groundwater infiltration are anticipated to be similar to other recent tunnelling projects carried out in the Sydney Basin, including the Eastern Distributor, Cross City Tunnel, NorthConnex and M5 East Motorway tunnels.

Operation

Depending on the final design, the tunnel component of the project may either be drained, undrained or a combination of both. Where the final design is for a drained tunnel (ie a tunnel that allows ongoing groundwater inflow), local groundwater in the vicinity of the tunnel may be drawn down to the tunnel invert level. This may affect existing groundwater bores and may also result localised ground settlement, consolidation or subsidence.

6.5.3 Proposed further assessments

Geotechnical and groundwater investigations have commenced to inform design development and the environmental impact statement. These investigations would identify the ground conditions for tunnelling across the project corridor, including further understanding specific geological structures, potential groundwater inflows and likely propagation of groundwater drawdown.

The groundwater assessment would include (as a minimum):

- A review of historical data on groundwater levels and quality, and data collected for the project
- Estimates of groundwater inflow
- Quantitative modelling of the extent of groundwater drawdown (for transient and steady state conditions) that would occur including assessment of potential settlement issues
- Consideration of the *NSW Aquifer Interference Policy* (Office of Water, 2012a)
- Characterisation of the water quality of groundwater inflows along the tunnel to inform treatment requirements for potential discharge to surface water
- Assessment of potential mobilisation of saline groundwater, contaminated groundwater and exposure of acid sulfate soils, and the associated impacts
- Impacts to existing groundwater users, surface water features and groundwater dependent ecosystems in accordance with the *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (Office of Water, 2012b)
- Estimation of groundwater discharge volumes into local watercourses during construction and operation, and the associated impacts on water quality
- Identification of management measures during construction and operation.

6.6 Socio-economics, land use and property

This section describes the potential socio-economic, land use and property impacts of the project during construction and operation.

6.6.1 Overview

The project would be located within the Inner West and North Sydney local government areas. Land uses in the design development corridor is largely residential but also includes areas of industrial, commercial, and retail development as well as open space and some recreational areas.

Community profile

The design development corridor has a relatively low level of disadvantage compared to other regions in NSW. Professionals, managers and clerical and administrative workers make up the top three occupation categories in the design development corridor, with the main industries of employment being in the areas of professional, scientific and technical services, finance and insurance services, and health care and social assistance.

Critical social infrastructure

The design development corridor accommodates a wide range of community services and facilities that cater for the needs of the community, including: education facilities; health, medical and emergency services; sport, recreation and leisure facilities; and community and cultural facilities. These include both land based and harbour based facilities.

Figure 6-4 shows the locations of the major parks and recreational areas within or near the design development corridor.

Business and industry

The project is located within the Global Economic Corridor, which extends from Sydney Airport in the south through to Macquarie Park in the North and Sydney Olympic Park in the west. The Global Economic Corridor is considered one of Australia's most important economic clusters accounting for around 41 per cent (or \$195 billion) of NSW's gross regional product (NSW Government, 2014a).

A key objective of the project, amongst other things, is to support employment growth and productivity in key employment centres by improving connectivity.

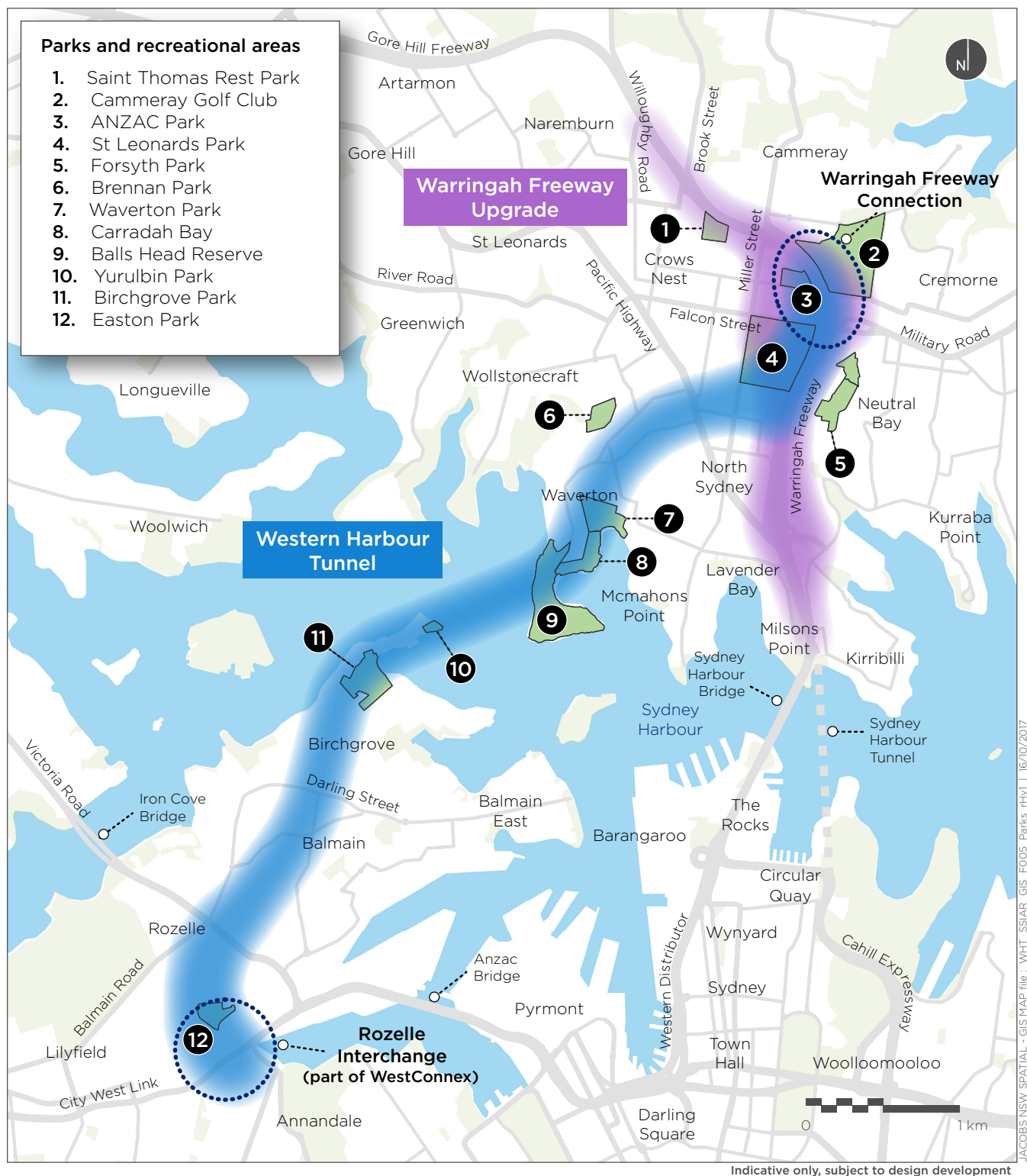


Figure 6-4 Major parks and recreational areas near the design development corridor

6.6.2 Summary of potential issues

Both positive and negative socio-economic, land use and property impacts are likely to occur during the construction and operation phases of the project.

Construction

Construction of the project has the potential for the following temporary social and economic impacts:

- Disruption to access to private properties, businesses and community facilities
- Temporary loss of community open space and recreation areas or restricted access as a result of worksites
- Temporary impact to amenity for residents and road users as a result of construction work
- Temporary exclusion zones and speed limits within Sydney Harbour may impact recreational fishers in addition to rowing, sailing and other recreational water activities.

As well as these socio-economic, land use and property impacts during construction, the project also has the potential to generate socio-economic benefits during construction as a result of additional jobs created for the construction workforce and increased business turnover for some businesses in proximity to construction worksites, particularly food and beverage outlets.

Operation

Permanent or long term socio-economic, land use and property impacts of the project would include:

- Impacts associated with property acquisition, including uncertainty for owners about the property acquisition process and potential need to relocate
- Reduced or modified access to private properties, businesses and community facilities
- Community concerns and perceptions about changes to air quality and potential health impacts for communities near tunnel portals
- Impacts to community value and sense of place as a result of loss of vegetation, impacts to heritage and potential loss of Aboriginal heritage
- Potential fragmentation of land and altered accessibility for residents and other users of these areas
- Changes in traffic flows, including movement of traffic onto adjacent local streets close to interchange locations.

Long term socio-economic benefits directly attributable to the proposal would potentially include (but may not be limited to):

- Improved journey times for private vehicles, business trips and public transport
- Improved travel options for those who travel as part of work, increasing productivity for business and employees, based on a more efficient route for through traffic traveling between the north and south
- Reduced costs for vehicle owners, as a result of reduced fuel consumption per journey
- Improved patronage to local businesses located on arterial and local roads as a result of less congestion
- Connectivity improvements to active transport routes
- Reduced congestion and traffic on local roads.

6.6.3 Proposed further assessments

A detailed socio-economic assessment would be carried out as part of the environmental impact statement. The assessment would be prepared in accordance with *Environmental Planning and Impact Assessment Practice Note: Socio-economic Assessment* (Roads and Maritime, 2013a).

The socio-economic assessment would include (as a minimum):

- A description of the social and economic profile for the communities and businesses surrounding the project
- Assessment of the potential positive and negative impacts of the project on the social and economic values of the area during construction and operation
- Assessment of direct and indirect impacts on property and land use
- Identification of any community facilities that may be affected during construction or operation of the project
- Identification of appropriate mitigation and management measures.

The socio-economic assessment would be informed by the results of other specialist studies including noise and vibration, air quality and traffic and transport which will be key potential socio-economic impacts.

6.7 Urban design and visual amenity

This section describes the urban design and visual amenity considerations relevant to the project.

6.7.1 Overview

Urban design

An urban design strategy would be prepared for the project including overarching principles to ensure the project is integrated into the surrounding landscape.

The overarching principles for the strategy would be to:

- Provide an integrated urban design approach to join WestConnex and the Warringah Freeway
- Develop a theme that references geography, place and heritage
- Provide a driver experience that enhances the journey, encourages awareness, increases orientation and enhances safety.

The urban design strategy would include specific principles related to urban design, landscape, water sensitive urban design and facilities design.

The urban design strategy would be developed in accordance with *Beyond the Pavement: Urban Design Policy Procedures and Design Principles* (Roads and Maritime, 2014b). Specific initiatives would be developed for the project to improve urban and landscape design at key locations consistent with the overall urban design strategy described above.

Visual amenity

The project would be largely tunnelled, meaning that impacts on surrounding areas would be limited to connections and interface works, motorway facilities, works to local roads, landscaping and amenity improvements, and temporary work sites.

South of Sydney Harbour, the topography of the design development corridor gains elevation from Lilyfield Road to a high point at Darling Street in Balmain before descending through Birchgrove to Yurulbin Park. The park has informal stands of mature trees, rock outcroppings and some retaining

walls across its hilly topography, contributing to its character of a small headland. Tree cover currently provides screening to the adjacent residential properties.

North of Sydney Harbour the topography rises through the residential areas of Balls Head and Waverton to the Pacific Highway. The northern shore of Sydney Harbour in the design development corridor comprises the developed shoreline of the Balls Head Coal Loader and natural vegetated areas of Balls Head Reserve. East of the project corridor is Berrys Bay, the foreshore area of which features a number of currently disused waterfront structures. A walkway runs along the edge of the site adjacent to the existing residential area.

6.7.2 Summary of potential issues

Construction

The project would change the urban design and visual amenity of the surrounding landscape though the introduction of new infrastructure and landscaping aspects. Potential landscape and visual amenity impacts during construction would include:

- Visual impacts from active construction areas and the introduction of worksites
- Temporary impacts to views to or from heritage places
- Vegetation clearing within the project footprint
- Construction traffic management measures such as road barriers and construction lighting
- Fencing, temporary noise barriers and acoustic sheds during construction
- Light spill from worksites during out-of-hours construction.

Operation

Landscape and visual amenity impacts would be limited to surface infrastructure during operation. The internal design of the project tunnels would be developed with the aim of providing a pleasant visual experience for motorists.

Potential positive and negative visual and landscape impacts during operation would include:

- Visual impacts to existing receivers from new infrastructure such as tunnel portals, ventilation facilities, noise barriers and surface roads
- Light spill onto surrounding properties
- Removal existing trees within the project footprint and prior to project landscaping establishment
- Changed views for motorists on new infrastructure and the visual interaction between tunnels and surface roads
- Changed views to and from public land and heritage places.
- Improved visual and landscape outcomes through the design features of the project.

6.7.3 Proposed further assessments

An urban design and visual impact assessment would be carried out as part of the environmental impact statement. The assessment would consider the following guidelines:

- AS4282-1997 Control of the obtrusive effects of outdoor lighting
- *Beyond the Pavement: Urban Design Policy Procedures and Design Principles* (Roads and Maritime, 2014b)
- *Bridge Aesthetics: Design guidelines to improve the appearance of bridges in NSW* (RMS, 2012)
- *NSW Sustainable Design Guidelines Version 3.0* (Transport for NSW, 2013d)
- *Crime preventions and the assessment of development applications* (DUAC, 2001)

- *Crime Prevention through Environmental Design* (Queensland Government, 2007)
- *Disability (Access to Premises – Buildings) Standards 2010*
- *Technical guideline for Urban Green Cover in NSW* (OEH, 2015)
- *Healthy Urban Development Checklist* (NSW Health, 2009)
- *Environmental Impact Assessment Practice Note – Guidelines for Landscape Character and Visual Impact Assessment* (Roads and Maritime, 2013b).

The urban design and visual impact assessment would include (as a minimum):

- Description of the visual character of the project corridor
- Identification of the visual character and urban design of the project and its components
- Assessment of the compatibility of the project with its visual and landscape context
- Consideration of hard and soft urban design elements of the project in the context of the existing and desired future character of the area
- Assessment of the visual impacts of the project (including lighting) during construction and operation
- Identification of measures to avoid, minimise and/or mitigate potential visual and landscape impacts.

6.8 Spoil and waste management

This section describes the potential waste streams and potential impacts during construction and operation of the project.

6.8.1 Overview

The largest waste stream generated by the project would be spoil associated with tunnelling activities. Around 1.6 million cubic metres of spoil could be generated if the project tunnels are constructed with roadheaders and around 2.2 million cubic metres if tunnel boring machines are used. This waste stream would be unavoidable, and would be minimised through beneficial reuse as part of the project where possible. Depending on the construction methodology selected for the project, the spoil waste stream would include soil, rock and potentially sediments.

The spoil waste stream generated by the project that can't be beneficially reused would be managed as follows:

- Contaminated materials, sediments and wastes would be directed to an appropriately licensed waste facility
- 'Clean' spoil (virgin excavated natural materials) would be preferentially reused where viable opportunities for beneficial reuse are identified during the project's construction program. Otherwise, these materials would also be directed to an appropriately licensed waste facility
- If water based works, such as installation of an immersed tube tunnel, are pursued, marine sediments would be directed for unconfined sea disposal in accordance with a permit under the *Environment Protection (Sea Dumping) Act 1981*. An appropriate impact assessment and application for a sea disposal permit would be prepared in this case.

Other waste streams generated during construction of the project would include:

- Demolition wastes from existing structures that require removal
- Other excavated wastes, such as sediment and rock, from dredging
- Vegetation waste from the removal of trees, shrubs and ground covers that are unable to mulched and reused within the project
- Packaging materials such as crates, pallets, cartons, plastics and wrapping materials

- Surplus construction material and general site reinstatement such as fencing, sediment, concrete, steel, formwork and sand bags
- Worksite waste such as liquid wastes from cleaning, repairing and maintenance, waste from spillages, fuel or oil waste, effluent from site amenities and general office wastes
- Waste water from worksites and construction processes.

Waste streams generated during operation of the project would include:

- Wastes from operational maintenance and repair activities required over the life of the project. The type and volume of wastes generated would be dependent on the nature of the activity, but would predominantly consist of green waste, oil, road materials, as well as contaminated waste resulting from potential fuel spills and leaks
- Waste water from the tunnel deluge systems, which would form part of the fire and life safety systems
- Litter generated by road users.

6.8.2 Summary of potential issues

Impacts associated with waste generation and management would be mainly associated with the construction of the project. These may include:

- Traffic, air quality, noise and greenhouse gas impacts associated with the transport of significant waste volumes by road, rail or barge
- Potential for environmental impacts from waste handling, storage and disposal
- Contamination of soil or water from disposal of contaminated material
- Social amenity impacts such as visual impacts and odour associated with waste storage and disposal.

6.8.3 Proposed further assessments

A waste assessment would be prepared as part of the environmental impact statement. This would include (as a minimum):

- Opportunities for waste minimisation and reuse through design or construction planning
- A review of the likely waste streams and volumes from construction and operation of the project
- Preparation of a spoil management strategy identifying how spoil generated from tunnelling and possible dredging activities (subject to construction methods) would be managed during construction including likely volumes, likely nature and classification of excavated material, opportunities for recycling, potential disposal sites, stockpile management, and method(s) and transport routes. This spoil management strategy would consider the cumulative effects of spoil haulage and disposal activities associated with other Sydney based tunnel projects
- Procedures for assessing, handling, stockpiling and disposing of potentially contaminated materials and wastewater, in accordance with the NSW Environment Protection Authority's *Waste Classification Guidelines* (EPA, 2014)
- Disposal and recycling options for each type of waste (other than spoil), including contingencies for unexpected waste volumes
- Identification of potential environmental or social impacts from the excavation, handling, storage on site and transport of waste particularly in relation to sediment/leachate control, noise and dust.

6.9 Flooding, hydrology and hydrodynamics

This section provides a description of the flooding and drainage environment and catchments and coastal processes in the design development corridor and the potential impact from construction and operation of the project.

6.9.1 Overview

Flooding and hydrology

The design development corridor is located in the Sydney Harbour and Parramatta River catchment which consists of a number of smaller distinct sub-catchments. As a result of surface work interaction at Warringah Freeway and Rozelle, two sub-catchments are relevant to the project and have a history of flooding as described below. Additionally, localised flooding could occur at any section of the project and connecting roads if the capacity of the drainage system is not sufficient to accommodate surface flows.

Willoughby Creek catchment

The Willoughby Creek catchment drains in a north-easterly direction, extending from the Pacific Highway in North Sydney and has a total catchment area of about 1.5 square kilometres at Grafton Street. Warringah Freeway runs north-south through the middle reaches of the catchment, which predominantly comprises medium density residential development with areas of higher density residential and commercial development also present within its upper reaches. Areas of open space, such as St Leonards Park and ANZAC Park, influence flood storage characteristics. A series of drainage systems comprising pipe and box culvert sections control runoff from the catchment upstream of the Warringah Freeway and converge at ANZAC Park where they discharge under the Warringah Freeway.

During a 1-in-100 year flood event, floodwaters collect in ANZAC Park pond against the existing noise barrier that runs along the western side of the Warringah Freeway. Floodwaters collect to a maximum depth of about three metres.

Whites Creek catchment

The Whites Creek catchment drains an area of 262 hectares lying to the south of Rozelle Bay and is located between Balmain Road, Leichhardt and Johnston Street, Annandale. From the outlet in Rozelle Bay, the creek proceeds in a meandering course in a southerly direction crossing Brennan, Piper, Booth, Styles and Albion Streets before terminating at Parramatta Road (Sydney Water, 2014).

The Leichhardt Flood Study (Cardno, 2015) describes flooding in the Whites Creek catchment as occurring along both the creek itself and a number of overland flow tributaries that connect with the creek. The Whites Creek culvert tends to flow full in a 1-in-5 year flood event. While the flow path tends to follow Whites Creek Lane, the flooding does extend to the adjacent properties.

Downstream of the culvert section of Whites Creek, the creek is followed by parkland on both sides for the majority of the length. Flooding is primarily limited to the parkland, although a number of adjacent properties are affected.

Hydrodynamics

The Sydney Harbour estuary is a drowned river valley, characterised by steep sided banks carved into Sydney sandstone between 25 and 29 million years ago. Around 17,000 years ago, the sea level rose, flooding the river valley and forming a flood tide delta. By 8,000 years ago, sea level stood at five metres below present and the sea reached its present position about 6,000 years ago. The Sydney Harbour estuary is about 30 kilometres in length, ranging in width from around 60 metres near the headwaters to about three kilometres approaching the estuary mouth (Hedge et al., 2013).

The shoreline of Sydney Harbour has been extensively modified since European settlement with over 50 per cent replaced by seawalls, boat ramps, and other man-made structures. In addition, the position and shape of the shoreline has been altered through reclamation works and localised infilling (GHD, 2015).

The design development corridor crosses three of the four main sub-catchments of Sydney Harbour – being Parramatta River catchment to the west, Lane Cover River catchment to the northwest and Port Jackson catchment to east. Water depth along the harbour crossing reaches a maximum depth of about 20 metres around 50 metres from Yurulbin Park, and is likely associated with dredging for the existing shipping channel. Bathymetric data indicates harbour floor levels in the area are typically at about 15 metres but there exists deep scour holes below these levels to depths greater than 35 metres, east and west of design development corridor. Water depths within Berrys Bay range from eight to nine metres.

6.9.2 Summary of potential issues

Construction

Flooding and hydrology

Construction of the project has the potential to result in the following flooding impacts:

- Changes to local overland flows and existing minor drainage paths through the disruption of existing flow mechanisms, both of constructed drainage systems or those of overland flow paths
- Changes to flooding regimes from construction work (eg temporary waterway diversions) and/or from the position of temporary construction infrastructure and worksites, eg at the Rozelle Interchange.

Hydrodynamics

The construction of the project has the potential to impact on hydrodynamic processes if water based works, including an immersed tube tunnel, are pursued. Potential impacts would be temporary and could include:

- Minor changes to the shoaling of waves and sediment transport patterns associated with increases in water depth from dredging
- Minor changes to wave climate (eg reduction in wave energy) which would potentially affect circulation and sediment transport patterns along the shorelines adjacent to cofferdams and worksites due to the blocking effect of the cofferdams and temporary wharf/work areas.

Waves generated by vessels or barge operations would not be expected to substantially change the wave climate in Sydney Harbour. Similarly, propeller wash from vessel and barge operations is unlikely to adversely affect the stability of sediment.

Operation

Flooding and hydrology

Operation of the project has the potential to result in changes to surface hydrology and flooding characteristics due to increased impervious surfaces and/or changes to the total catchment area of existing drainage infrastructure. Increases in runoff could potentially require upgrades to existing drainage infrastructure, and may require additional mitigation measures (eg stormwater drainage basins).

Hydrodynamics

If an immersed tube tunnel design is pursued, changes in harbour bathymetry may affect hydrodynamics.

6.9.3 Proposed further assessments

The environmental impact statement would include an assessment of potential hydrology, flooding and hydrodynamic impacts during construction and operation of the project.

In addition to applicable council floodplain risk management plans, the following guidelines would be considered as relevant during the preparation of the flooding assessment:

- NSW Government's *Floodplain Development Manual* (Department of Natural Resources, 2005)
- *Practical Consideration of Climate Change - Flood risk management guideline* (DECC, 2007)
- *Australian Rainfall and Runoff: A guide to flood estimation* (Commonwealth of Australia (Geoscience Australia) 2016).

The assessment of potential hydrology and flooding impacts would include (as a minimum):

- Identification of potential impacts on stormwater quantity, change in stormwater runoff (increase or decrease) and sensitivity of downstream waters
- Identification of potential impacts as a result of changes in surface water quantity, with respect to increases or decreases in stormwater runoff and the sensitivity of the downstream waters
- Identification of any potential changes to flood levels, discharges, velocities, duration of flood inundation and flood hazards for the 1-in-20 year and 1-in-100 year flood event and the probable maximum flood, with consideration of climate change
- Identification of appropriate mitigation and management measures.

If relevant to the project, a detailed hydrodynamic and coastal processes assessment would also be prepared including (as a minimum):

- Assessment of changes to coastal processes in Sydney Harbour, including tidal flow and velocity and wave climate impacts and effects on sediment transport patterns
- Potential for the project to alter the tidal flow and water levels
- Scouring and erosion of shoreline by natural forces and vessel operations
- Potential for existing coastal processes to increase sediment plume dispersion during immersed tube tunnel construction and dredging.

6.10 Climate change risk

This section describes the potential greenhouse gas emissions and climate change risks that are relevant to the project during construction and operation.

6.10.1 Overview

Greenhouse gas

The *NSW Government Resource Efficiency Policy* (GREP) (OEH, 2014c), requires agencies to meet the challenge of reducing energy, water and waste and to help tackle greenhouse gas emission through renewable energy use. Roads and Maritime Services' corporate commitment to sustainability is articulated in the *Roads and Maritime Environmental Sustainability Strategy 2015-19* (Roads and Maritime, 2015c), which includes the objective to minimise energy use and reduce greenhouse gas emissions.

The transport sector is identified as the third largest contributor to Australia's greenhouse gas emissions (Department of the Environment, 2015), after energy for electricity and energy for stationary sources (which excludes electricity but includes fuel combusted during construction).

Greenhouse gas emissions sources can be categorised as Scope 1, 2 or 3 (Australian Government Clean Energy Regulator, 2015). Scope 1 emissions are the direct result of an activity for example from the burning of fuel in vehicles used in the construction or from the clearing of vegetation. Scope 2 emissions are indirect emissions from the use of electricity that is generated outside the project boundary. Scope 3 emissions are indirect upstream/downstream emissions generated in the wider economy due to third party supply chains and road users, for example the emissions associated with the production and transport of materials used in construction.

Climate change

The *Roads and Maritime Environmental Sustainability Strategy 2015-19* (Roads and Maritime, 2015c) includes the objective to design and construct transport infrastructure to be resilient to climate change impacts.

The draft *Roads and Maritime Climate Change Adaptation for Road Networks Technical Guide* (Roads and Maritime, 2016c) provides guidance for State Road Network projects which require climate change adaptations in response to changes in climate processes such as rainfall intensity and sea level rise. It has been developed considering existing Roads and Maritime processes such as risk management and environmental planning and is aligned with broader NSW Government initiatives and programs responding to climate change impacts.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Bureau of Meteorology (BoM) have released climate change projections for Australia that provide updated national and regional information on how the climate may change to the end of the 21st century.

Maximum temperatures are projected to rise by an average of 1.94 degrees Celsius by 2070. Minimum temperatures are also projected to rise by 2.02 degrees Celsius by 2070. Sydney will see an increase in minimum temperature of at least 1.44 degrees Celsius.

Annual rainfall is projected to increase by an average of 8.90 per cent by 2070. Large increases of around 18 per cent are projected across the whole of Sydney throughout summer and autumn. Winter and spring rainfall is more variable and may see decreases of around 8 per cent.

The following converging climatic trends are likely to lead to an increase in likelihood and frequency of flooding events occurring in the design development corridor, with resultant financial and social impacts:

- Increasing sea level rise (about 400 mm by 2050 and 900 mm by 2100)
- Increasing intensity of rainfall events (about two per cent by 2050 and 10 per cent by 2100)
- Increasing frequency of severe storm events and storm surge.

6.10.2 Summary of potential issues

Greenhouse gas

The construction of the project would contribute to greenhouse gas emissions either directly or indirectly through the following activities:

- Embodied energy of materials used in construction
- Transport of materials used in construction
- Combustion of fuel used in construction vehicles and machinery

- Electricity consumption at worksites
- Vegetation clearance
- Transport of spoil and waste.

Operation of the project would generate greenhouse house gas emissions through the following activities:

- Fuel consumption by vehicles using the road
- Fuels and materials used in maintenance activities
- Electricity used to power tunnel systems including tunnel ventilation, lighting and electronic equipment.

Some reductions in greenhouse generation may also be attributable to the project due to improvements in traffic flow and reduced congestion.

Climate change

Due to the relatively short timeframe of the construction phase, the impacts of climate change are expected to be minimal.

Projections over the design life of the project show the potential for an increase in operational risk due to flood and storm events, which would require mitigation and adaption actions during design and operations.

Direct climate change risks during operation include:

- Increased risk of flooding impacts to road and tunnel infrastructure, with resulting risks to operations (such as preventative closure or total asset failure) and health and safety risks
- Drainage and stormwater impacts
- Increased risk of road closures
- Increased risk of landslips and erosion
- Increased rate of deterioration of road pavements due to changes in subgrade moisture content.

Indirect climate change risks during operation include:

- Disruptions to energy supply as a result of higher temperatures leading to excessive demand and increased severity and frequency of bushfires
- Disruptions to communications and increased length of outages due to increased frequency and intensity of extreme wind, lightning, bushfire and extreme rainfall events.

Climate change impacts have the potential to affect the operation of the infrastructure including interruption of delays to commuter and commercial traffic, increased maintenance costs, increased liability resulting from damage to road infrastructure and high insurance costs for road operators.

6.10.3 Proposed further assessments

Greenhouse gas

Assessment of the greenhouse gas emissions for the project would be carried out for construction and operation. This would include (as a minimum):

- Identification and quantification the sources of greenhouse gas emissions associated with the construction, operation and maintenance of the project

- Identification of opportunities to reduce the greenhouse gas emissions associated with the project.

The assessment of greenhouse gas emissions and identification of initiatives to reduce emissions would be developed through the project Sustainability Management Plan and would be documented in the environmental impact statement.

Climate change

A climate change risk assessment would be carried out for the project consistent with the *Australian Standard AS 5334-2013 'Climate Change Adaptation for settlements and infrastructure'* and the Roads and Maritime Risk Management Process.

The climate change risk assessment would be guided by the draft *Roads and Maritime Climate Change Adaptation for Road Networks Technical Guide* (Roads and Maritime, 2016c) and would consider the range of climate change variables over time, including temperature, rainfall and hail, sea level rise, wind speed and bushfire. The assessment would identify adaptation actions to be incorporated into the design and operation of the project.

Hydraulic modelling for the project would be prepared in accordance with *Australian Rainfall and Runoff: A guide to flood estimation* (Commonwealth of Australia (Geoscience Australia) 2016) and would consider predicted climate change impacts including the combination of sea level rise, a one per cent Annual Exceedance Probability flood event and an additional rainfall intensity.

6.11 Sustainability

This section describes relevant sustainability policy and drivers for the project and identifies how sustainability would be addressed through the design, construction and operation phases.

6.11.1 Overview

The *Roads and Maritime Environmental Sustainability Strategy 2015–19* aims to 'maximise project benefits by effective stakeholder engagement and integration of sustainability considerations throughout all phases of the project lifecycle'.

The *Roads and Maritime Sustainability in Infrastructure Design and Construction Technical Guide* (Roads and Maritime, 2016c) recognises that sustainability benefits are best achieved by integrating sustainability considerations early and throughout all project phases as a clear set of strategic sustainability objectives, targets and Key Performance Indicators (KPIs) will drive efficiency, reduce risk and improve whole of life asset sustainability performance.

The Infrastructure Sustainability Council of Australia (ISCA) is the peak industry body for advancing sustainability outcomes in infrastructure, through the Infrastructure Sustainability (IS) Rating Tool. The project will seek to achieve a best practice level of performance using market leading sustainability ratings tools using the ISCA rating tool or an equivalent level of performance using a demonstrated equivalent rating tool.

Developing and embedding a sustainability strategy at the early stages of project development is best practice and would deliver enhanced economic, social and environmental benefits compared to a traditional, compliance-based approach to sustainability. Given that a best practice approach to sustainability is business as usual for Roads and Maritime projects, it is not considered as a key issue in this report.

The project aligns with the objectives of the *NSW Long Term Transport Master Plan* including improving the quality of service, supporting economic growth and productivity and strengthening

transport planning processes. The *NSW Long Term Transport Master Plan* also identifies potential new connections to bridge gaps in the Sydney motorway network by 2031, including enhanced north and south links.

This would directly deliver on the goal of filling these identified gaps by creating a new north south crossing of Sydney Harbour. It would also enhance capacity and resilience of existing road corridors through reducing congestion and providing alternative routes.

By facilitating improved links between residential and employment areas, the project would also substantially contribute to city shaping and development for the next century. It would also contribute to enhanced liveability and amenity by improving resilience of the existing road network in congested areas and creating an improved environment for cycling, walking and public transport.

6.11.2 Summary of potential issues

Sustainability considerations for the construction and operation of large infrastructure projects include environmental, social and economic factors.

Construction

During the construction phase, key sustainability issues would include:

- Consumption of resources including energy, water and materials for construction
- Generation of greenhouse gas emissions during construction
- Generation and disposal of waste including spoil
- Social and community impacts including amenity, access and health and safety
- Heritage impacts arising from impacts to heritage places during construction
- Sustainable procurement of goods and services with consideration of whole of life impacts and opportunities to maximise social benefits
- Ecological impacts arising from vegetation clearing and marine construction works
- Communication and engagement with public stakeholders.

Operation

During the operation phase, key sustainability issues to address would include:

- Consumption of resources for operation including energy for ongoing tunnel ventilation and lighting
- Generation of greenhouse gases during operation, associated with energy use and vehicle transport
- Climate change mitigation and adaptation
- Ongoing social considerations related community connectedness, permanent changes to access to public areas (parks and recreational areas) and urban design strategies to enhance liveability
- Potential positive impacts associated with a more reliable and effective bus network.

6.11.3 Proposed further assessments

During detailed design, a project-specific Sustainability Management Framework and a Sustainability Implementation Plan would be prepared to guide the implementation of sustainability throughout the design and construction phases. This would include consideration of the following sustainability themes:

- Management and governance
- Using resources
- Emissions, pollution and waste

- Ecology
- People and place
- Innovation.

The Sustainability Management Framework and Sustainability Implementation Plan would identify initiatives and commitments to be implemented throughout the project lifecycle and allocate responsibility to project stakeholders.

7 Conclusion

Roads and Maritime has formed the opinion that the project would be likely to significantly affect the environment and would require the preparation of an environmental impact statement under the EP&A Act. Accordingly, the project is State significant infrastructure under Part 5.1 of the EP&A Act. Approval from the Minister for Planning is required for the project.

The key environmental issues identified for the project include:

- Traffic and transport
- Air quality
- Noise and vibration
- Human health risks
- Non-Aboriginal heritage
- Cumulative impacts.

The environmental impact statement would include the following:

- A detailed description of the project including its components, construction activities and potential staging
- A comprehensive assessment of the potential impacts on the key issues including a description of the existing environment, assessment of potential direct and indirect and construction, operation and staging impacts
- Description of measures to be implemented to avoid, minimise, managed, mitigate, offset and/or monitor the potential impacts
- Identify and address issues raised by stakeholders.

BLANK PAGE

8 References

- Advisory Committee on Tunnel Air Quality, 2016, *In-tunnel Air Quality (Nitrogen Dioxide) Policy*
- Advisory Committee on Tunnel Air Quality, 2014, *Technical Paper 2: Air Quality Trends in Sydney* (prepared by Office of Environment and Heritage)
- ASRIS, 2011, *Australian Soils Resource Information System*
- Attenbrow, V. 2010, *Sydney's Aboriginal Past: Investigating the archaeological and historical records*, UNSW Press
- Australia and New Zealand Environment Conservation Council (ANZECC), 2000, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ).
- Australia and New Zealand Environment Conservation Council (ANZECC) 1990, *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration*
- Australia International Council on Monuments and Sites (Australia ICOMOS), 2013, *The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance*
- Australian Bureau of Statistics, 2016, *Data by region*, cat. No. 1410.0, viewed 5 June 2017 <
[http://stat.abs.gov.au/itt/r.jsp?databyregion#/>](http://stat.abs.gov.au/itt/r.jsp?databyregion#/)
- Australian Government Clean Energy Regulator, 2015, *Greenhouse Gases and Energy*, available online: <http://www.cleanenergyregulator.gov.au/NGER/About-the-National-Greenhouse-and-Energy-Reporting-scheme/Greenhouse-gases-and-energy>
- Australian Government Department of the Environment, 2016, *Protected Matters Search Tool* [online]. Available: <http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf>
- Australian Government Department of the Environment, 2015, *Quarterly Update of Australia's National Greenhouse Gas Inventory: December 2015*
- Australian Government Department of the Environment, 2013, *Matters of National Environmental Significance Significant impact guidelines*
- Australian Standard AS 4282-1997 *Control of the obtrusive effects of outdoor lighting*
- Australian Standard AS 5334-2013 *Climate Change Adaptation for settlements and infrastructure*
- Beachwatch, 2016, *State of the Beaches 2015-2016*, Office of Environment and Heritage
- British Standard BS7385-2:1993 *Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration*
- Cardno (NSW/ACT) Pty Ltd, 2015, *Leichhardt Flood Study* (prepared for Leichhardt Council)
- Chapman G.A. and Murphy C.L. 1989, *Soil Landscapes of the Sydney 1:100,000 Sheet report*. Department of Conservation and Land Management, Sydney
- Cosmos Archaeology Pty Ltd, 2017 – *Western Harbour Tunnel and Beaches Link Maritime Archaeology Issues Paper – Draft*
- Cosmos Archaeology Pty Ltd, 2013, *Balls Head Coal Loader Wharf: Maritime Archaeological Assessment and Inspection* (prepared for Roads and Maritime Services)
- Department of Environment, Climate Change (DECC), 2009, *Interim Construction Noise Guideline*
- Department of Environment and Climate Change (DECC), 2007, *Practical Consideration of Climate Change - Flood risk management guideline*

Department of Environment, Climate Change and Water (DECCW), 2011, *NSW Road Noise Policy*

Department of Environment, Climate Change and Water (DECCW), 2010a, *Aboriginal Cultural Heritage Consultation requirements for proponents*

Department of Environment, Climate Change and Water (DECCW), 2010b, *Code of practice for archaeological investigation of Aboriginal objects in NSW*

Department of Infrastructure, Planning and Natural Resources, 2005, *Floodplain Development Manual: The management of flood liable land*

Department of Planning, 2008, *Acid Sulfate Soils Assessment Guidelines*

Department of Planning and Environment, 2017, *Environmental Impact Statement: Draft Environmental Impact Assessment Guidance Series June 2017*

Department of Primary Industries, 2013, *NSW DPI Policy and Guidelines for Fish Habitat Conservation and Management*

Department of Urban Affairs and Planning & Environmental Protection Authority, 1998, *Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land*

DUAC, 2001, *Crime preventions and the assessment of development applications*

enHealth, 2012, *Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards* (Commonwealth of Australia)

Environment Protection Authority (EPA), 2016, *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*

Environment Protection Authority (EPA), 2015, *NSW State of the Environment 2015*

Environment Protection Authority (EPA), 2014, *Waste Classification Guidelines*

Environment Protection Authority (EPA), 2000, *NSW Industrial Noise Policy*

Fisheries NSW, 2013, *Policy and guidelines for fish habitat conservation and management – update*

Geoscience Australia, 2016, *Australian Rainfall and Runoff: A guide to flood estimation* (Commonwealth of Australia)

German Standard DIN 4150-3 (1999): *Structural Vibration – Effects of vibration on structures*

GHD Pty Ltd, 2015, *Sydney Harbour Coastal Zone Management Plan Scoping Study* (prepared for Sydney Coastal Councils Group)

GHD Pty Ltd, 2006, *North West Rail Link Environmental Assessment: Geology, Geotechnical and Groundwater Assessment* (prepared for Transport for NSW)

Godden Mackay Logan, 2000, *Waverton Peninsula Industrial Sites: BP, Caltex, Coal Loader Conservation Management Plan* (prepared for North Sydney Council)

Greater Sydney Commission, 2016, *Draft North District Plan: Co-creating a Greater Sydney*

Hedge L.H., Johnston E.L., Ayoung S.T., Birch G.F., Booth D.J., Creese R.G., Doblin M.A., Figueira W.F., Gribben P.E., Hutchings P.A., Mayer Pinto M, Marzinelli E.M., Pritchard T.R., Roughan M., Steinberg P.D., 2013, *Sydney Harbour: A systematic review of the science*, Sydney Institute of Marine Science, Sydney, Australia

Infrastructure Australia, 2016, *Infrastructure Priority List*

Infrastructure Australia, 2015, *Australian Infrastructure Audit: Volume 1*

Infrastructure NSW, 2014, *NSW State Infrastructure Strategy Update 2014*

Infrastructure NSW, 2012, *NSW State Infrastructure Strategy*

Inner West Council, *Conservation Area 14 – Birchgrove and Ballast Point Road*. Site accessed on 12/12/2016 at: <http://www.leichhardt.nsw.gov.au/Planning---Development/Planning-Controls--DCPs--LEPs--VPAs-/Heritage/Conservation-Area-14-Birchgrove-and-Ballast-Point-Road>

Jacobs Group (Australia) Pty Ltd, 2015, *Sydney Metro City & Southwest – Chatswood to Sydenham: Environmental Impact Statement* (prepared for Transport for NSW)

NSW Department of Environment and Conservation (DEC), 2006a, *Assessing Vibration: a technical guideline*

NSW Department of Environment and Conservation (DEC), 2006b, *Using the ANZECC Guidelines and Water Quality Objectives in NSW*

NSW Government, 2017, *Draft Future Transport 2056*

NSW Government, 2015, *State Priorities: NSW Making it Happen*, available online at: <https://www.nsw.gov.au/making-it-happen>

NSW Government, 2014a, *A Plan for Growing Sydney*

NSW Government, 2014b, *Rebuilding NSW: State Infrastructure Strategy 2014*

NSW Government, 1953, *Main Road Development Plan*

NSW Health, 2009, *Healthy Urban Development Checklist*

NSW Health, 2007, *Health Impact Assessment: A practical guide*

NSW Heritage Branch, 2009, *Assessing significance for historical archaeological sites and relics*

NSW Heritage Council, 2011, *Criteria for the assessment of excavation directors*

NSW Heritage Office, 2001, *Assessing Heritage Significance*

NSW Heritage Office, 1996, *Statements of Heritage Impact*

NSW Ministry of Health, 2016, *HealthStats NSW*

NSW Office of Environment and Heritage (OEH), 2017, *NSW – Aboriginal occupation*, viewed 27 July 2017, <http://www.environment.nsw.gov.au/bioregions/BioregionsNswoutlineAboriginalWestern.htm>

NSW Office of Environment and Heritage (OEH), 2016, *BioNet Atlas of NSW Wildlife - Ecological Data* [online]. Available: http://www.environment.nsw.gov.au/AtlasApp/UI_Modules/TSM_/Default.aspx?a=1

NSW Office of Environment and Heritage (OEH), 2015, *Technical guideline for Urban Green Cover in NSW*

NSW Office of Environment and Heritage (OEH) 2014a, *Framework for Biodiversity Assessment*

NSW Office of Environment and Heritage (OEH) 2014b, *NSW Biodiversity Offsets Policy for Major Projects*

NSW Office of Environment and Heritage (OEH), 2014c, *NSW Government Resource Efficiency Policy*

NSW Office of Environment and Heritage (OEH), 2013, *Acid Sulfate Soil Risk Map*

NSW Office of Environment and Heritage (OEH), 2011, *Guide to investigating, assessing and reporting on Aboriginal Cultural Heritage in NSW*

NSW Office of Environment and Heritage (OEH), 2006, *NSW Water Quality and River Flow Objectives*

NSW Office of Environment and Heritage (OEH), 2000, *Guidelines for Consultants Reporting on Contaminated Sites*

NSW Office of Water, 2012a, *NSW Aquifer Interference Policy*

NSW Office of Water, 2012b, *Risk Assessment Guidelines for Groundwater Dependent Ecosystems*

NSW State Planning Authority, 1968, *Sydney Regional Outline Plan*

Port Authority of NSW, 2016, Port Facilities: Glebe Island and White Bay [online] Available: http://http://www.sydneyports.com.au/corporation/port_facilities/glebe_island_and_white_bay [Accessed 12/12/16]

Queensland Government, 2007, *Crime Prevention through Environmental Design: Guidelines for Queensland*

Roads and Maritime Services, 2016a, *Construction Noise and Vibration Guideline*

Roads and Maritime Services, 2016b, *Noise Model Validation Guideline*

Roads and Maritime Services, 2016c, *Roads and Maritime Service Draft Climate Change Adaption for Road Networks Technical Guide*

Roads and Maritime Services, 2015a, *Noise Mitigation Guideline*

Roads and Maritime Services, 2015b, *Noise Criteria Guideline*

Roads and Maritime Services, 2015c, *Roads and Maritime Service Environmental Sustainability Strategy 2015-2019*

Roads and Maritime Services, 2014a, *Average daily traffic data*

Roads and Maritime Services, 2014b, *Beyond the Pavement: Urban Design Policy Procedures and Design Principles*

Roads and Maritime Services, 2013a, *Environmental Planning and Impact Assessment Practice Note: Socio-economic Assessment*

Roads and Maritime Services, 2013b, *Environmental Impact Assessment Practice Note – Guidelines for Landscape Character and Visual Impact Assessment*

Roads and Maritime Services, 2012, *Bridge Aesthetics: Design guidelines to improve the appearance of bridges in NSW*

Roads and Maritime Services, 2011, *Procedure for Aboriginal Cultural Heritage Consultation and Investigation*

Roads and Maritime Services, 2008, *Erosion and Sedimentation Management Procedure*

Roads and Traffic Authority, 2002, *Guide to Traffic Generating Developments Version 2.2*

Sydney Water, 2014, *Heritage Item: Whites Creek Stormwater Channel No 95* [online] Available: <http://www.sydneyparks.com.au/SW/water-the-environment/what-we-re-doing/Heritage-search/heritage-detail/index.htm?heritageid=4570343> [Accessed 12/12/16]

Transport for NSW, 2016, *Northern Beaches Transport Action Plan*

Transport for NSW, 2013a, *Sydney City Centre Access Strategy*
Transport for NSW, 2013b, *Sydney's Bus Future: Simpler, faster, better bus services*
Transport for NSW, 2013c, *Sydney's Cycling Future: Cycling for everyday transport*
Transport for NSW, 2013d, *NSW Sustainable Design Guidelines Version 3.0*
Transport for NSW, 2012, *NSW Long Term Transport Master Plan*
Transport for NSW, undated, *NSW Roads Plan: Roads Planning Framework* (draft)

BLANK PAGE

Attachment A

Requirements of the Environmental Planning and
Assessment Regulation 2000

Requirements of the Environmental Planning and Assessment Regulation 2000

Clause 192 of the *Environmental Planning and Assessment Regulation 2000* requires that an application for approval of the Minister to carry out State significant infrastructure must include:

- a. Details of any approval that would, but for section 115ZG of the Act, be required for the carrying out of the State significant infrastructure
- b. Details of any authorisations that must be given under section 115ZH of the Act if the application is approved
- c. A statement as to the basis on which the proposed infrastructure is State significant infrastructure, including, if relevant, the capital investment value of the proposed infrastructure.

Approvals that would otherwise apply

Approvals that may be required to carry out the SSI, if not for section 115ZG of the EP&A Act, include:

- Permits under Sections 201, 205 and 219 of the *Fisheries Management Act 1994*
- Approvals under Part 4 or excavation permits under Section 139 of the *Heritage Act 1977*
- Aboriginal heritage impact permits under Section 90 of the *National Parks and Wildlife Act 1974*
- Various approvals under the *Water Management Act 2000*, including water use approvals under Section 89, water management work approvals under Section 90, and activity approvals (other than aquifer interference approvals) under Section 91.

Authorisations if the application is approved

Authorisations that may be required for the project under section 115ZH of the EP&A Act include:

- An environment protection licences (EPL) under Chapter 3 of the Protection of the Environment Operations Act 1997
- Consent under Section 138 of the Roads Act 1993 from the relevant roads authority for the erection of a structure, or the carrying out of work in, on or over a public road, or the digging up or disturbance of the surface of a road.

State significant infrastructure statement

Clause 14(1) of State Environmental Planning Policy (State and Regional Development) 2011 provides that development is declared to be State significant infrastructure pursuant to section 115U(2) of the Act if it is permissible without development consent under Part 4 of the Act under a State environmental planning policy; and is specified in the categories of development in Schedule 3.

State Environmental Planning Policy (Infrastructure) (ISEPP) permits development for the purpose of a road or road infrastructure facilities to be carried out by or on behalf of a public authority without consent. As the project is for a road and road infrastructure facilities, and is to be carried out by Roads and Maritime, the project is permissible without development consent under Part 4 of the EP&A Act.

Schedule 3 of State Environmental Planning Policy (State and Regional Development) 2011 provides that general public authority activities for infrastructure or other development that (but for Part 5.1 of the EP&A Act and within the meaning of Part 5 of the Act) would be an activity for which the proponent is also the determining authority, and would, in the opinion of the proponent, require an environmental impact statement to be obtained under the EP&A Act.

For the project, Roads and Maritime has formed the opinion that the impact of the project is likely to significantly affect the environment and would require an environmental impact statement to be obtained under Section 112 of the EP&A Act.

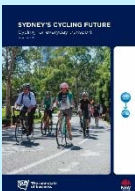
On this basis the project is State significant infrastructure. Approval from the Minister for Planning is required under section 115W of the EP&A Act.

Attachment B

Relationship of Western Harbour Tunnel and Warringah Freeway Upgrade to relevant NSW Government transport and city plans

Table B-1 Relationship of Western Harbour Tunnel and Warringah Freeway Upgrade to relevant NSW Government transport and city plans

Plan	Comment	Western Harbour Tunnel and Warringah Freeway Upgrade
Draft Future Transport 2056		
	The Draft Future Transport Strategy is an update of the NSW Long Term Transport Master Plan (2012) and sets the 40 year vision, strategic directions and outcomes for customer mobility in NSW. It will be delivered through a series of supporting plans. The Western Harbour Tunnel and Beaches Link project is identified in the strategy as a 'Committed' project (within the next 0-10 years, subject to final business case).	The project would: • Reduce congestion on existing corridors and improve public transport reliability.
NSW Long Term Transport Master Plan		
	Identified that Sydney's most congested transport corridors include the Sydney Harbour crossings and the Military Road and Spit Road corridor – with high volume to capacity ratios and road users experiencing very long delays and queues. Identified the corridor connecting the Northern Beaches with Sydney CBD as one of six strategic transport corridors in Sydney considered highly constrained in meeting travel demand in 2011 (and also in 2031 if nothing is done).	The project would: • Provide a new motorway crossing of Sydney Harbour • Reduce congestion on existing corridors and improve public transport reliability.
NSW: Making it happen		
	<i>NSW: Making it happen</i> sets out 12 priorities with 30 targets to increase accountability. One of the priorities is building infrastructure on time and on budget. Under the building infrastructure priority, there is a target of improving road travel reliability – 90 per cent of peak travel on key travel roads on time. Under the better services priority, there is a target to ensure on time running for public transport – maintain or improve reliability of public transport services over the next four years.	The project would reduce congestion on existing corridors and improve public transport reliability.
State Infrastructure Strategy Update 2014		
	Recommended further investigation of Western Harbour Tunnel and Beaches Link program of works.	Underway
Rebuilding NSW		
	Accepts the recommendations of the State Infrastructure Strategy Update 2014 and commits to further investigation and planning of Western Harbour Tunnel and Beaches Link program of works.	Underway

Northern Beaches Transport Action Plan		
	Commits to investigation and planning of Western Harbour Tunnel and Beaches Link program of works.	Underway
Draft North District Plan		
	The draft District Plan sets out aspirations and proposals for Greater Sydney's North District. One of the overarching priorities for a productive North District includes accessing local jobs, goods and services within 30 minutes. The draft plan includes the Western Harbour Tunnel and Beaches Link program of works as transport initiative that is being investigated to improve connections and access.	Underway
A Plan For Growing Sydney		
	Commits to investigation and planning of Western Harbour Tunnel and Beaches Link program of works.	Underway
Sydney's Bus Future		
	Presents a three stage approach to improve service outcomes – focusing on improving customer experience, integrating bus services across Sydney and serving future growth. Bus initiatives, include bus rapid transit for the Northern Beaches and Victoria Road, to improve capacity and efficiency for bus users. The Northern Beaches Bus Rapid Transit (B-Line) – scheduled to start operating in late 2017 to provide 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.
Sydney's Cycling Future		
	Identifies priority cycle ways to improve connection to major centres and assist in reducing congestion for trips for up to 5 km. The strategy also includes walking and cycling projects linking to public transport interchanges and stops.	Reduction in congestion on surface roads would contribute to improved conditions for cyclists.

Draft NSW Roads Plan



This draft NSW Road Planning Framework is currently under development by Transport for NSW. The draft plan aims to provide a framework for future road planning in NSW, acknowledging the importance of transport and land, and defining strategic improvements for customers.

The project is being developed with a strong focus on minimising the project footprint, delivering city shaping enhancements and meeting customer requirements.



rms.nsw.gov.au



contactus@rms.nsw.gov.au



Customer feedback
Roads and Maritime
Locked Bag 928,
North Sydney NSW 2059

RMS 17.631



Transport
Roads & Maritime
Services