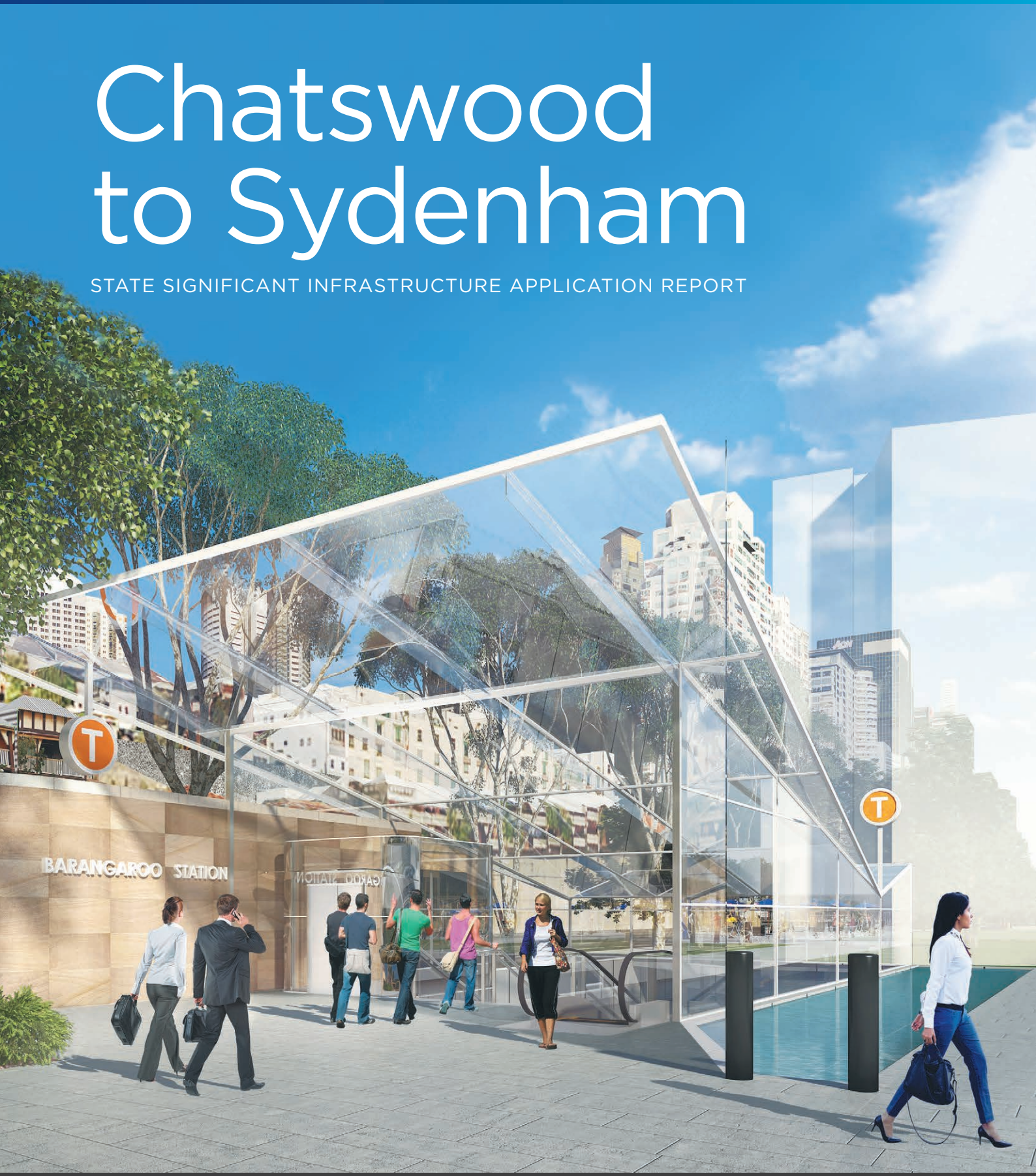
sydney METRO | city & southwest

Chatswood to Sydenham

STATE SIGNIFICANT INFRASTRUCTURE APPLICATION REPORT



NSW GOVERNMENT | Transport for NSW

NSW MAKING IT HAPPEN

Contents

Tables

Figures

Figures (continued)

Executive summary

Introduction and need

The *NSW Long Term Transport Master Plan* (Transport for NSW, 2012b) sets the direction for transport planning for the next 20 years, providing a framework for transport policy and investment decisions. An integral component of the *NSW Long Term Transport Master Plan is Sydney's Rail Future*, which provides a plan to modernise Sydney's rail network by investing in new services and upgrading existing infrastructure.

Sydney Metro is a new standalone rail network identified in *Sydney's Rail Future*. Sydney Metro consists of Sydney Metro Northwest (previously known as the North West Rail Link) and Sydney Metro City & Southwest.

Transport for NSW proposes to construct and operate a new underground rail line, about 15 kilometres long, with new stations between Chatswood and Sydenham (known as the Chatswood to Sydenham project), as part of the NSW Government's plan to implement *Sydney's Rail Future*. The Chatswood to Sydenham project forms one of two core components of Sydney Metro City & Southwest. The second core component would involve upgrading the 13.5 kilometre rail line and existing stations from Sydenham to Bankstown (Sydenham to Bankstown upgrade) and will be subject to a separate environmental impact assessment.

Once complete, Sydney Metro City & Southwest would deliver a major increase in the capacity of Sydney's rail network, with the capacity to run up to 30 trains per hour through the Sydney CBD in each direction. This provides the foundation for delivering a 60 per cent increase in the number of trains operating on Sydney's rail network in peak periods, which would cater for an extra 100,000 customers per hour.

Key features of the project

The project involves the construction and operation of a metro rail line, around 16 kilometres in length, between Chatswood and Sydenham. The key components are expected to include:

- About 15 kilometres of twin rail tunnels (that is, two tunnels located side-by-side) between Mowbray Road, Chatswood and north of Sydenham Station (near Bedwin Road, Marrickville)
- Realignment of the existing T1 North Shore Line surface track within the existing rail corridor between Chatswood Station and in the vicinity of Brand Street, Artarmon, including a new bridge for a section of the 'down' (northbound) track to pass over the proposed northern dive structure
- About 250 metres of aboveground metro tracks between Chatswood Station and the northern dive structure
- A northern dive structure (about 400 metres in length) and tunnel portal south of Chatswood Station and north of Mowbray Road, Chatswood
- A substation (for traction power supply) at Artarmon
- New metro stations at Crows Nest, Victoria Cross , Barangaroo, Martin Place and Pitt Street, as well as new underground platforms at Central Station
- A southern dive structure (about 400 metres in length) and tunnel portal north of Sydenham Station
- A services facility (for traction power supply and an operational water treatment plant) adjacent to the southern dive structure.

The project would also include a number of ancillary components, including new and alterations to existing overhead wiring, signalling, access tracks / paths, rail corridor fencing, noise walls, fresh air ventilation equipment, temporary and permanent alterations to the road network, facilities for pedestrians, and other construction related works.

In addition to the above project components, a new metro station at either The University of Sydney or Waterloo with provision for turnback facilities is currently subject to further feasibility analysis and design definition and may form part of the project scope assessed in the environmental impact statement.

Planning and assessment process

The project has sought a declaration to be State significant infrastructure and critical State significant infrastructure under sections 115U(4) and 115V of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Therefore, the project would be subject to assessment and approval by the Minister for Planning under Part 5.1 of the EP&A Act.

Purpose of this report

This document supports an application to the NSW Minister for Planning seeking the Secretary's environmental assessments requirements for the environmental impact statement. It has been prepared based on the indicative locations and design included within the plans in this report, for the purposes of informing the preparation of the Secretary's environmental assessment requirements. It is noted that the project components, location and design may be subject to further changes as part of the ongoing design development and community consultation and clarifications may be made during the environmental impact assessment process.

Key environmental issues for the project

A preliminary environmental risk analysis for the project has identified the following 'key' environmental issues:

- Traffic, transport and access
- Noise and vibration
- Property and land use
- Business impacts
- Non-Aboriginal heritage
- Aboriginal heritage
- Landscape character and visual amenity
- Groundwater and geology
- Soils, contamination and water quality
- Social impacts and community infrastructure
- Cumulative impacts.

A preliminary environmental assessment of the project's potential impact has confirmed that the above issues have the potential to result in a significant impact (without the adoption of adequate environmental mitigation measures). Detailed assessment of these issues, and the other environmental issues identified, would be undertaken as part of an environmental impact statement.

Next steps

Following the receipt of the Secretary's environmental assessments requirements, Transport for NSW will prepare and publicly exhibit an environmental impact statement, in accordance with the requirements of Part 5.1 of the EP&A Act. The environmental impact statement will include:

- A description of the project, including its components and construction activities
- A description of the existing environment and an assessment of potential direct and indirect impacts on the key and other potential environmental issues during construction and operation of the project
- Identification of measures to be implemented to avoid, minimise, manage, mitigate, offset and / or monitor potential impacts of the project
- Identification and consideration of issues raised by stakeholders and the community.

1 Introduction

This chapter provides an overview of the project, its strategic context and key features. The structure of this report is also provided.

1.1 Overview

The New South Wales (NSW) Government is implementing *Sydney's Rail Future* (Transport for NSW, 2012a), a plan to transform and modernise Sydney's rail network so that it can grow with the city's population and meet the needs of customers into the future.

Sydney Metro is a new standalone rail network identified in *Sydney's Rail Future*. The Sydney Metro network consists of Sydney Metro Northwest (previously known as the North West Rail Link) and Sydney Metro City & Southwest.

The Chatswood to Sydenham project (the project) forms one of two core components of Sydney Metro City & Southwest (refer to Figure 1.1). The project would involve construction and operation of a new underground rail line, about 15 kilometres long, with new stations between Chatswood and Sydenham. The second core component would involve upgrading the 13.5 kilometre rail line and existing stations from Sydenham to Bankstown and will be subject to a separate environmental impact assessment. The project is subject to assessment and approval by the Minister for Planning under Part 5.1 of the *NSW Environmental Planning and Assessment Act 1979* (EP&A Act). This document supports an application to the Minister for Planning seeking the Secretary's environmental assessment requirements for the environmental impact statement.

The Sydney Metro Delivery Office has been established as part of Transport for NSW to manage the planning, procurement and delivery of the Sydney Metro network.

1.2 Background

1.2.1 Strategic planning context

The *NSW Long Term Transport Master Plan* (Transport for NSW, 2012b) sets the direction for transport planning for the next 20 years, providing a framework for transport policy and investment decisions. An integral component of the *NSW Long Term Transport Master Plan* is *Sydney's Rail Future*, which provides a plan to modernise Sydney's rail network by investing in new services and upgrading existing infrastructure.

To cater for the differing and changing needs of customers, Sydney's Rail Future provides a plan for a three-tiered rail network:

- Tier 1: Metro (previously known as Rapid Transit) – based on 'turn-up-and-go' services and single-deck metro trains (see Section 1.2.2)
- Tier 2: Suburban – timetabled services with double-deck trains
- Tier 3: Intercity – timetabled services with on-board amenities for long distance trips.

Further information on the strategic context and need for the project, including a summary of the *NSW Long Term Transport Master Plan and Sydney's Rail Future*, is provided in Chapter 3.

1.2.2 Sydney Metro

Customer experience

The customer experience underpins how Sydney Metro is planned and designed. The customer experience incorporates all aspects of travel associated with the transport network, service and project including:

- The decision on how to travel
- The travel information available
- The speed and comfort of the journey
- The range and quantity of services available at stations, interchanges and within station precincts.

A high quality 'door to door' transport product is critical to attract and retain customers and also to meet broader transport and land use objectives.

The metro product

Key features of the metro product offering include:

- Comfortable carriages with space for customers to sit or stand
- A 'turn-up-and-go' service, with high frequency trains
- Reduced journey times with faster trains, and new underground alignments through the Sydney CBD
- Increased capacity to safely and reliably carry more customers per hour due to the increased frequency of trains
- Reduced dwell times at stations as each carriage is single-deck and has three doors, allowing customers to board and alight more quickly.

Components of the Sydney Metro rail network

The development of a metro rail network in Sydney is one of the key initiatives in *Sydney's Rail Future*. Sydney Metro City & Southwest would extend the metro network from Chatswood to Bankstown. This section of Sydney Metro comprises two core components: Chatswood to Sydenham (which is the subject of this report) and the Sydenham to Bankstown upgrade, which would extend the metro network from Sydenham to Bankstown (subject to a separate environmental impact assessment).

The Sydney Metro network is shown in Figure 1.1.

The first stage of the metro network is Sydney Metro Northwest (formerly the North West Rail Link), which is currently under construction. This includes a new metro rail line between Rouse Hill and Epping and conversion of the existing rail line between Epping to Chatswood to metro standards. Services will start in the first half of 2019 with a metro train every four minutes in the peak from a new station at Cudgegong Road (beyond Rouse Hill) to the existing station at Chatswood.

Figure 1.1 The Sydney Metro network

The Chatswood to Sydenham project would feature:

- Twin tunnels about 15 kilometres long between Chatswood and Sydenham, crossing under Sydney Harbour
- New metro stations at Crows Nest, Victoria Cross, Barangaroo, Martin Place and Pitt Street
- New underground metro platforms at Central Station
- The possibility of a new metro station at either The University of Sydney or Waterloo, subject to further feasibility analysis and design definition

The Sydenham to Bankstown upgrade would involve upgrading the existing 13.5 kilometre rail line and existing stations between Sydenham and Bankstown to support metro operations (subject to a separate environmental assessment process).

Capacity of the Sydney Metro rail network

The Chatswood to Sydenham project would have the capacity to run up to 30 trains per hour through the Sydney CBD in each direction, which would be a major increase in the capacity of Sydney's rail network. It would provide the foundation for delivering a 60 per cent increase in the number of trains operating in peak periods, catering for an extra 100,000 customers per hour.

1.3 Overview of the project

1.3.1 Location

The project would mainly be located underground in twin tunnels. The tunnels would extend from Chatswood on Sydney's north shore, crossing under Sydney Harbour, and continue to Sydenham Station. The indicative locations of the proposed alignment, stations and operational ancillary infrastructure are shown in Figure 1.2.

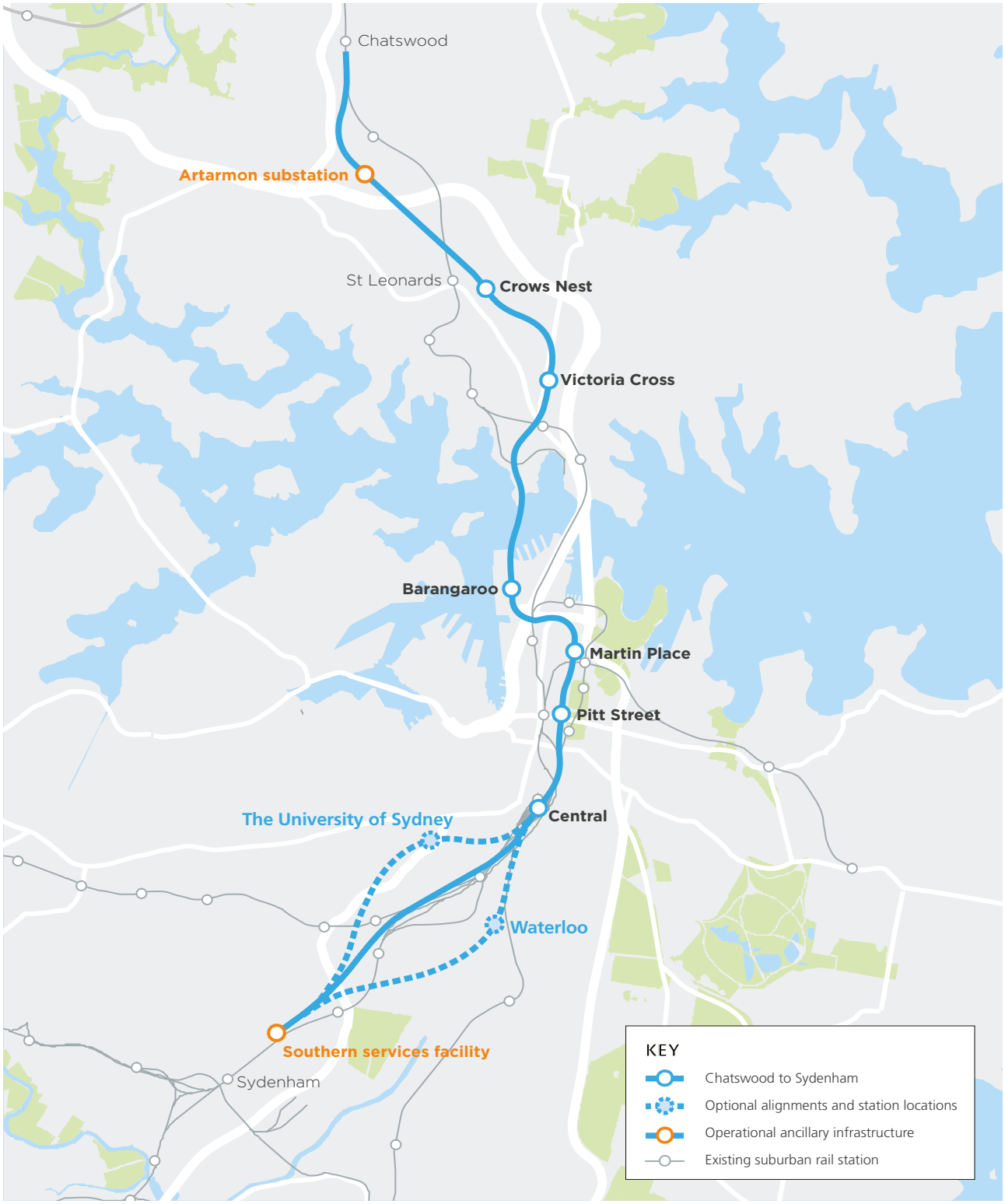


Figure 1.2 The project – indicative locations of infrastructure

1.3.2 Key features

The project involves the construction and operation of a metro rail line, around 16 kilometres in length, between Chatswood and Sydenham. The key components are expected to include:

- About 15 kilometres of twin rail tunnels (that is, two tunnels located side-by-side) between Mowbray Road, Chatswood and Bedwin Road, Marrickville
- About 250 metres of aboveground metro tracks between Chatswood Station and the northern dive structure
- A northern dive structure (about 400 metres in length) and tunnel portal south of Chatswood Station and north of Mowbray Road, Chatswood
- A southern dive structure (about 400 metres in length) and tunnel portal north of Sydenham Station and south of Bedwin Road, Marrickville
- New metro stations at Crows Nest, Victoria Cross, Barangaroo, Martin Place and Pitt Street, as well as new underground platforms at Central Station
- Underground pedestrian links and connections to other modes of transport (such as the existing suburban rail network) and surrounding land uses
- Realignment of T1 North Shore Line surface track within the existing rail corridor between Chatswood Station and Brand Street, Artarmon, including a new bridge for a section of the 'down' (northbound) track to pass over the proposed northern dive structure
- Permanent closure of the road bridge at Nelson Street, Chatswood, and provision of double right-turn lanes from the Pacific Highway (southbound) into Mowbray Road (westbound)
- Modification (including protection) of the road bridge at Mowbray Road, Chatswood to accommodate the reconfigured T1 North Shore Line track arrangement
- Services within each of the stations, including mechanical and fresh air ventilation equipment and electrical power substations
- Alterations to pedestrian and traffic arrangements and public transport infrastructure around the new stations and surrounding Central Station
- A substation (for traction power supply) at Artarmon
- A services facility (for traction power supply and an operational water treatment plant) adjacent to the southern dive structure
- Installation and modification of existing Sydney Trains rail systems including overhead wiring, signalling, access tracks / paths, rail corridor fencing and noise walls, within surface sections either end of the project at Chatswood and Sydenham
- Removal of the existing Sydney Trains maintenance access point from Hopetoun Avenue, Chatswood
- Provision of a shared Sydney Trains and Sydney Metro maintenance access point from Brand Street, Artarmon on the Down (western) side of the T1 North Shore Line
- Provision of maintenance access stairs from Albert Avenue, Chatswood to an existing Sydney Trains signalling box located on the eastern side of the rail corridor immediately south of Chatswood Station
- Temporary ancillary facilities to support the construction of the project.

The project components are subject to further design and changes or clarifications may be made during the ongoing design development and community consultation processes.

In addition to the above project components, a new metro station at either The University of Sydney or Waterloo with provision for turnback facilities is currently subject to further feasibility analysis and design definition and may form part of the project scope assessed in the environmental impact statement.

1.4 Structure of this report

The structure and content of this report are outlined in Table 1.1.

Table 1.1 Structure and content of this report

Chapter	Description
Chapter 1 Introduction	Provides an overview of the project and the proposed metro network for Sydney. Outlines the purpose and scope of the State significant infrastructure application report.
Chapter 2 Planning and assessment process	Provides information on the legislation and environmental planning instruments that would apply to the project and that would be considered in preparing the environmental impact statement.
Chapter 3 Strategic justification and project need	Provides the strategic context, explains the need for the project and identifies the project objectives.
Chapter 4 Project development and alternatives	Describes how the project was developed and reviews the strategic alternatives and options considered to date.
Chapter 5 Project description	Identifies the physical infrastructure and built form of the project. Describes the functionality of the stations and the operation of the Sydney Metro network. Outlines how the project is likely to be constructed and identifies the location and function of the main construction sites. Discusses options relating to stations and construction methods.
Chapter 6 Preliminary environmental risk analysis	Provides a preliminary environmental risk analysis taking into account the current project scope and the receiving environment. Categorises each environmental aspect as either a 'key issue' or an 'other issue' based on the risk rating.
Chapter 7 Preliminary assessment of environmental impacts	Provides a preliminary description of the existing environment of the project area, and an initial consideration of the potential direct and indirect impacts that may result during construction and operation of the project.
Chapter 8 Consultation	Outlines the consultation undertaken to date and the consultation that will occur during the environmental impact statement process.
Chapter 9 Summary of proposed environmental impact statement scope	Provides a summary of the scope of further investigations proposed during preparation of the environmental impact statement based on the initial consideration of potential direct and indirect impacts that may result during construction and operation of the project.
Chapter 10 Conclusion	Provides closing comments for consideration.

2 Planning and assessment process

This chapter provides describes the statutory planning process for the project, and identifies other NSW and Commonwealth legislation and approvals which may apply to the project.

2.1 NSW environmental planning approvals

The *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation) are the primary pieces of legislation regulating land use planning and development assessment in NSW. This legislation is supported by a range of environmental planning instruments including State environmental planning policies (SEPPs) and local environmental plans (LEPs).

Sections 115U and 115V of the EP&A Act provide for the declaration of State significant infrastructure and critical State significant infrastructure (refer to Section 2.1.1). Part 5.1 of the EP&A Act establishes the assessment and approval regime for State significant infrastructure and critical State significant infrastructure (refer to Section 2.1.3).

The requirements of Clause 192 of the EP&A Regulation for applications seeking approval of the Minister for Planning to carry out State significant infrastructure are addressed in Appendix A.

2.1.1 Critical State significant infrastructure

The project has sought an amendment to Clause 80 and Schedule 2 of *State Environmental Planning Policy (Infrastructure) 2007* to make all components of the project a development that is permissible without consent.

The project has also sought a declaration to be State significant infrastructure and critical State significant infrastructure under Sections 115U(4) and 115V of the EP&A Act, respectively. Schedule 5 of *State Environmental Planning Policy (State and Regional Development) 2011* would also be amended to include the project as critical State significant infrastructure.

2.1.2 Planning approval process under Part 5.1 of the EP&A Act

The assessment and approval process for a critical State significant infrastructure project is established under Part 5.1 of the EP&A Act. The assessment and approval process for critical State significant infrastructure is shown in Figure 2.1.

This document supports a State significant infrastructure application made by Transport for NSW and submitted to the Secretary of the Department of Planning and Environment as required by Section 115X of the EP&A Act, and seeks the Secretary's environmental assessment requirements for the project (as per Section 115Y of the EP&A Act).

An environmental impact statement will be prepared in accordance with the Secretary's environmental assessment requirements and the requirements of Schedule 2, Part 3 of the EP&A Regulation (as per Section 115Y(2) of the EP&A Act). The Department of Planning and Environment will place the environmental impact statement on public exhibition for a minimum of 30 days (as per Section 115Z of the EP&A Act). During the exhibition period, government agencies, project stakeholders and the community will be able to review the environmental impact statement and will have an opportunity to make a written submission to the Department of Planning and Environment for consideration in its assessment of the project.

At the completion of the public exhibition period, the Department of Planning and Environment will collate and provide Transport for NSW with a copy of all submissions received during the exhibition period. After reviewing the submissions, Transport for NSW will prepare a submissions report that responds to the relevant issues raised. If changes are required to the project as a result of the issues raised or to minimise environmental impact, a preferred infrastructure report may also be required. If this is required, Transport for NSW would prepare the report to address the changes to the design to minimise impacts and submit this for review to the Department of Planning and Environment. This report would be made available to the public.

Approval from the Minister for Planning is required before Transport for NSW can proceed with the project (as per Section 115ZB of the EP&A Act).

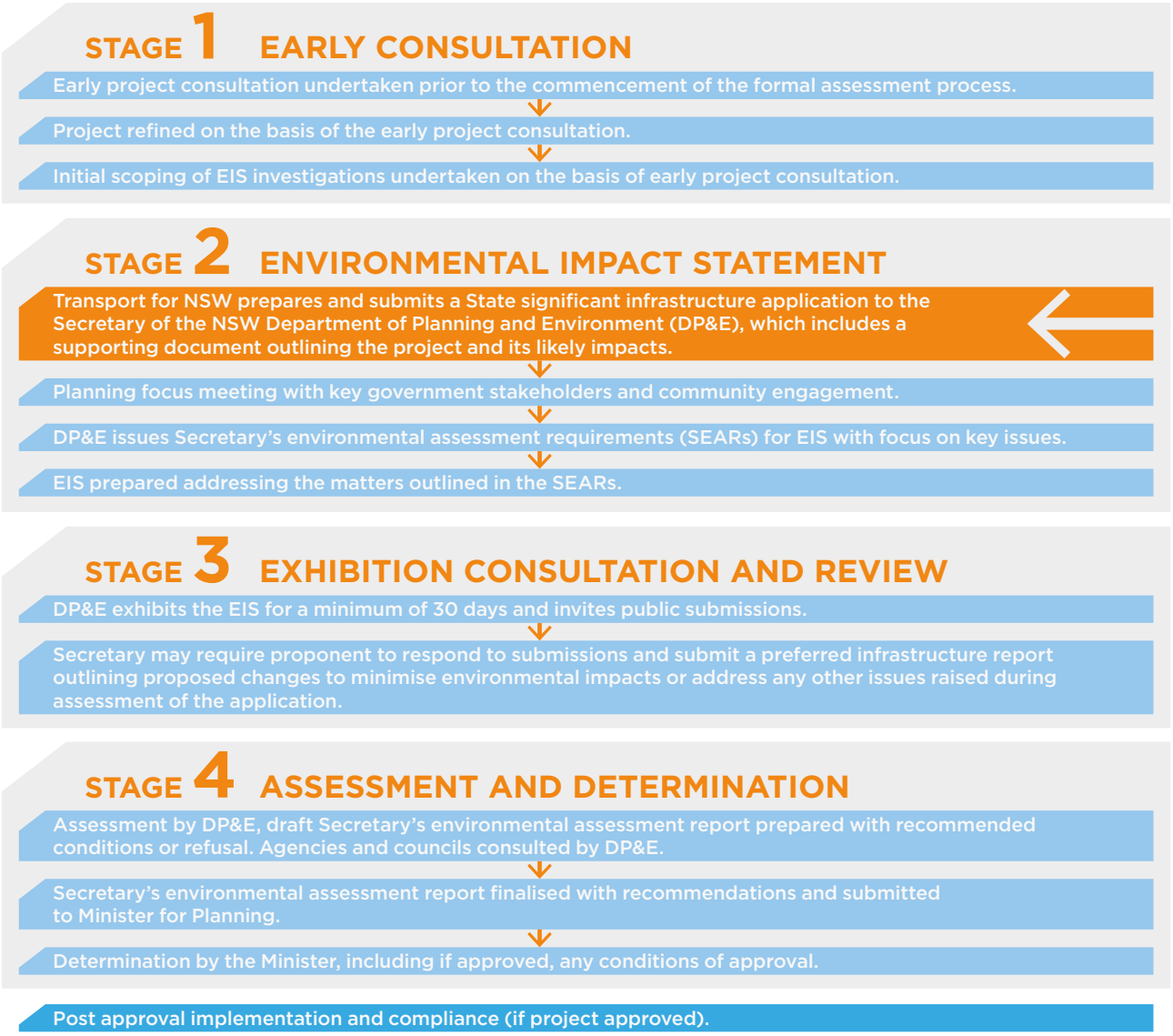


Figure 2.1 The assessment and approval process for critical State significant infrastructure

2.1.3 NSW environmental planning instruments

The declaration of the project as critical State significant infrastructure has been made through the provisions of the *State Environmental Planning Policy (State and Regional Development) 2011*, as discussed in Section 2.1.1. Section 115ZF of the EP&A Act provides that environmental planning instruments (such as LEPs and SEPPs) do not, with some exceptions, apply to State significant infrastructure projects. Notwithstanding, the environmental planning instruments that have been considered for consistency are summarised in Table 2.1.

Table 2.1 Environmental planning instruments of potential relevance to the project

Environmental planning instrument	Relationship to project
State Environmental Planning Policy (Major Development) 2005	This SEPP aims to facilitate the development, redevelopment or protection of important urban, coastal and regional sites of economic, environmental or social significance to the State – referred to as State significant sites. Both the Barangaroo site and the Redfern-Waterloo Authority site are State significant sites, which are located within or adjacent to the project area. Depending on the final location of Barangaroo Station and whether the government decides to include the Waterloo Station option, the Major Development SEPP may apply to potential future above station development (refer to Section 2.4 for further discussion on above station development).
State Environmental Planning Policy (State and Regional Development) 2011	This SEPP identifies development that is State significant development, State significant infrastructure and critical State significant infrastructure. As outlined in Section 2.1.1, the project has sought an amendment to Schedule 5 of this SEPP to include the project as critical State significant infrastructure and State significant infrastructure.
Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005	The metro tunnel crossing of Sydney Harbour and Barangaroo Station (including the entry / exit) would be located within the defined boundary of the *Sydney Regional Environmental Plan (Sydney Harbour Catchment)* 2005 (the 'Sydney Harbour Catchment SREP'). The Sydney Harbour Catchment SREP aims to (amongst other things) protect, enhance and maintain the catchment, foreshores, waterways and islands of Sydney Harbour for existing and future generations. The project also lies within the Sydney Opera House Buffer Zone under the Sydney Harbour Catchment SREP. Clause 58B of the Sydney Harbour Catchment SREP requires specific assessment of projects within the Sydney Opera House Buffer Zone in the context of potential impacts on views and vistas between the Opera House and other public places, the World Heritage value of the Opera House and the visual prominence of the Opera House (refer to Section 2.3.1 for further discussion).
State Environmental Planning Policy No. 55 – Remediation of Land	*State Environmental Planning Policy No. 55 – Remediation of Land* (SEPP 55) provides a State-wide approach to the remediation of contaminated land for the purpose of minimising the risk of harm to the health of humans and the environment. In accordance with Clause 7(1) of SEPP 55, a consent authority must not consent to the carrying out of development on any land unless: ○ It has considered whether the land is contaminated ○ If the land is contaminated, it is satisfied that the land is suitable in its contaminated state (or would be suitable, after remediation) for the purpose for which the development is proposed to be carried out ○ If the land requires remediation to be made suitable for the purpose for which the development is proposed to be carried out, it is satisfied that the land would be remediated before the land is used for that purpose. A Phase 1 contamination investigation would be undertaken in accordance with the *Managing Land Contamination Planning Guidelines SEPP 55–Remediation of Land* (Department of Urban Affairs and Planning and Environment Protection Authority, 1998) for the project to inform the design and environmental impact statement process.

2.2 Other NSW legislation

In accordance with Sections 115ZG and 115ZH of the EP&A Act, some environment and planning legislation does not apply to approved State significant infrastructure or must be applied consistently with an approval for State significant infrastructure (refer to Section 2.2.1).

2.2.1 Approvals or authorisations that are not required or cannot be refused

Section 115ZG of the EP&A Act specifies authorisations that are not required for approved State significant infrastructure. Approvals of potential relevance to the project include:

- Concurrence under Part 3 of the Coastal Protection Act 1979 of the Minister administering that Part of the Act
- Permits under Sections 201, 205 and 219 of the *Fisheries Management Act 1994*
- Approvals under Part 4, excavation permits under Section 139 and Division 8 of Part 6 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.

Similarly Section 115ZG of the EP&A Act specifies directions, orders or notices that cannot be made or given so as to prevent or interfere with the carrying out of approved critical State significant infrastructure. Of potential relevance to this project would be:

- An interim protection order (within the meaning of the *National Parks and Wildlife Act 1974* or the *Threatened Species Conservation Act 1995*)
- An order under Division 1 (Stop work orders) of Part 6A of the *National Parks and Wildlife Act 1974*, Division 1 (Stop work orders) of Part 7 of the *Threatened Species Conservation Act 1995* or Division 7 (Stop work orders) of Part 7A of the *Fisheries Management Act 1994*
- An environment protection notice under Chapter 4 of the *Protection of the Environment Operations Act 1997*
- An order under section 124 of the *Local Government Act 1993*.

Section 115ZH of the EP&A Act identifies approvals or authorisations that cannot be refused if they are necessary for carrying out approved State significant infrastructure and are substantially consistent with the Part 5.1 approval. Statutory approvals or authorisations of potential relevance to this project include:

- Environment protection licences (EPLs) 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. This approval requirement is most likely to be triggered near station locations.

2.2.2 NSW legislation and regulations that may still be applicable

Planning related legislation and regulations that may still be applicable to an approved critical State significant infrastructure project and based on current scope, may be relevant to this project is identified in Table 2.2.

Table 2.2 Legislation and regulations of potential relevance to the project

Legislation	Requirement
Water Management Act 2000	The *NSW Aquifer Interference Policy* (Department of Primary Industries, 2012) documents the NSW Government's intention to implement the requirement for approval of 'aquifer interference activities' under the *Water Management Act 2000*. The requirement for aquifer interference approvals has not yet commenced.
Contaminated Land Management Act 1997	The *Contaminated Land Management Act 1997* outlines the circumstances in which notification of the Environment Protection Authority (EPA) is required in relation to the contamination of land. This may become relevant during construction and / or operation of the project.
Crowns Land Act 1989	Ministerial approval is required to grant a 'relevant interest' (ie a lease, licence, permit, easement or right of way) over a Crown Reserve if required. The project would pass underneath a number of parcels of Crown land. In addition, there is the potential for construction compounds to be temporarily located on Crown land. Land would be managed in accordance with the objectives of this Act.
Heritage Act 1977 (Section 146)	The Heritage Council must be notified if a relic is uncovered during construction and if it is reasonable to believe that the Heritage Council is unaware of the location of the relic.
Fisheries Management Act 1994 (Section 199)	A public authority is required to give the Minister written notice of proposed dredging or reclamation work prior to carrying out or authorising the carrying out of such work. In the event that reclamation or dredging work may be required to support construction of the project, the Minister would be provided with written notice of any construction activities requiring dredging or reclamation work, in accordance with Section 199 of this Act.
Marine Pollution Act 2012	This Act includes provisions to protect the sea and waters from pollution by oil and other noxious substances discharged from vessels. Any construction activities requiring the use of a vessel (eg a barge) must comply with the requirements of this Act and the *Marine Pollution Regulation 2014*.
Marine Services Act 1935 and Ports* and *Maritime Administration Act 1995	A number of authorisations, approvals or permits may be required with respect to the placement of any structures in the water and / or with respect to obstruction to navigation. This could include the construction of the harbour crossing. Further details are provided in Chapter 5.
Management of Waters and Waterside Lands Regulations — N.S.W.	The written approval of the Harbour Master is required for any proposed works that would disturb the bed of the Special Port Areas defined under these regulations – which includes Sydney Harbour and any adjoining or adjacent land. Activities that may require approval include construction of the harbour crossing.
Native Title (NSW) Act 1994	This Act provides for native title in relation to land or waters. The project would not affect land subject to native title or to which an Indigenous Land Use Agreement applies.

Legislation	Requirement
Aboriginal Land Rights Act 1983	The NSW *Aboriginal Land Rights Act 1983* establishes the NSW Aboriginal Land Council and local Aboriginal land councils. The Act requires these bodies to: • Take action to protect the culture and heritage of Aboriginal persons in the council's area, subject to any other law • Promote awareness in the community of the culture and heritage of Aboriginal persons in the council's area. The preamble of the *Aboriginal Land Rights Act 1983* states that land was traditionally owned and occupied by Aboriginal people and accepts that as a result of past government decisions, the amount of land set aside for Aboriginal people was reduced without compensation. To redress the loss of land, Aboriginal land councils can claim Crown land which, if granted, is transferred as freehold title. 'Claimable Crown lands' includes Crown lands that are not lawfully used or occupied and that are not needed, nor likely to be needed, for an essential public purpose. No claimable Crown lands would be affected by the project.
The Land Acquisition (Just Terms Compensation) Act 1991	This Act would apply to the acquisition of land required for the project except for underground stratum acquisition where the *Transport Administration Act 1988* applies.
Transport Administration Act 1988	This Act also applies to compulsory acquisitions for the purpose of underground rail facilities.
Waste Avoidance and Resource Recovery Act 2001	This Act, among other things, encourages the most efficient use of resources in order to reduce environmental harm.

2.3 Commonwealth legislation

2.3.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) prescribes the Commonwealth's role in environmental assessment, biodiversity conservation and the management of protected areas.

Matters of national environmental significance

Under the EPBC Act, a referral to the Commonwealth Department of the Environment is required for proposed 'actions' that have the potential to significantly impact on any matter of national environmental significance or the environment of Commonwealth land (including leased land). Current matters of national environmental significance are:

- World heritage properties
- National heritage places
- Wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed)
- Nationally threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- The Great Barrier Reef Marine Park

- Nuclear actions (including uranium mining)
- A water resource, in relation to coal seam gas development and large coal mining development.

There is currently an agreement between the Commonwealth and NSW relating to environmental impact assessment under the EPBC Act (assessment bilateral agreement). For critical State significant infrastructure projects, the assessment bilateral agreement provides for a single environmental assessment process conducted by NSW.

There is also a draft approval bilateral agreement that provides for accreditation of NSW processes for the approval of proposed actions that would otherwise require approval by the Commonwealth. Submissions on the draft approval bilateral agreement are currently being considered.

Issues with respect to matters of national environmental significance are discussed in Section 7.1.5 (non-Aboriginal heritage) and Section 7.2.1 (ecology). The significance of impacts in relation to these matters will be considered during the environmental impact assessment process and a decision will be made as to whether the project is referred to the Commonwealth Department of the Environment.

World Heritage properties

The *Convention Concerning the Protection of World Cultural and National Heritage* (the World Heritage Convention) aims to promote international cooperation to protect heritage that is of such outstanding universal value that its conservation is important for current and future generations. It sets out the criteria that a site must meet to be included on the World Heritage List and the role of State Parties in the protection and preservation of the item.

To be included on the World Heritage List, a site must be of outstanding universal value, and meet at least one of 10 selection criteria.

The Sydney Opera House is included on the World Heritage List. The Sydney Opera House satisfies Criterion (i) (to represent a masterpiece of human creative genius) of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage Centre's (2013) *Operational Guidelines for the Implementation of the World Heritage Convention*.

The Sydney Opera House's World Heritage listing states that it is 'a great architectural work of the 20th century. It represents multiple strands of creativity, both in architectural form and structural design, a great urban sculpture carefully set in a remarkable waterscape and a world famous iconic building.'

Project activities associated with the construction of the harbour crossing (as described in Chapter 5) would occur within the buffer zone for the Sydney Opera House. While the project would not directly impact on the fabric of the Sydney Opera House, construction activities within the Sydney Opera House Buffer Zone have the potential to temporarily impact on this Word Heritage property's setting.

The potential for impacts is considered in Section 7.1.5 (non-Aboriginal heritage).

National Heritage List

Established under the EPBC Act, the National Heritage List is a list of places with outstanding heritage value to Australia, including places overseas. A person cannot take an action that has, will have, or is likely to have a significant impact on the national heritage values of a National Heritage Place without the approval of the Commonwealth Minister for the Environment. The potential for impacts on any National Heritage Place are considered in Section 7.1.5 (non-Aboriginal heritage).

Commonwealth Heritage List

The Commonwealth Heritage List is established under the EPBC Act. It is a list of properties owned by the Commonwealth that are assessed as having significant heritage value. If a place is included on the Commonwealth Heritage List, then its Commonwealth owner is required to prepare a heritage management plan in accordance with the *Environment Protection and Biodiversity Conservation Regulations 2000*, to ensure that activities affecting the place avoid or minimise adverse impacts on the heritage values of the place, and provide ongoing protection of the place in event of sale or transfer. The potential for impacts on any Commonwealth heritage-listed item or place are considered in Section 7.1.5 (non-Aboriginal heritage).

Actions taken on Commonwealth land

Under Section 26 of the EPBC Act, approval is required for:

- An action taken by any person on Commonwealth land (including Commonwealth leased land) that has, will have, or is likely to have a significant impact on the environment (subsection 26(1)).
- An action taken by any person outside of Commonwealth land (including Commonwealth leased land) that has, will have, or is likely to have a significant impact on the environment on Commonwealth land (subsection 26(2)).

For the purposes of Section 26, the EPBC Act defines the 'environment' as:

a. Ecosystems and their constituent parts, including people and communities; and

b. Natural and physical resources; and

c. The qualities and characteristics of locations, places and areas; and

d. Heritage values of places; and

e. The social, economic and cultural aspects of a thing mentioned in (a), (b), (c) or (d).

Section 26 of the EPBC Act provides for a broader coverage of environmental and heritage matters relating to activities on Commonwealth land including issues such as noise, pollution, visual amenity or economic impacts.

The project would affect Commonwealth leased land at Crows Nest (the Crows Nest Post Office). All potential land use and property impacts for the project will be identified and assessed in the land use and property chapter of the environmental impact statement.

2.3.2 Native Title Act 1993

The main objective of the *Native Title Act 1993* (Cth) is to recognise and protect native title. Section 8 states that the *Native Title Act 1993* is not intended to affect the operation of any law of a State or a Territory that is capable of operating concurrently with the Act. Searches of the register maintained by the National Native Title Tribunal will be undertaken to confirm if any native title claims are registered with respect to land within the area of the project. A review of Crown land within the footprint of the project will also be undertaken to determine the potential for the project to directly affect Crown land that is the subject of a native title claim.

2.3.3 Disability Discrimination Act 1992

The *Disability Discrimination Act 1992* aims to eliminate as far as possible discrimination against persons on the ground of disability in areas including access to premises and the provision of facilities, services and land. The project will be designed to be independently accessible and in compliance with the objectives and requirements of the Act.

2.3.4 Disability Standards for Accessible Public Transport 2002

Section 33.1 of the *Disability Standards for Accessible Public Transport 2002* requires all new public transport premises, infrastructure and conveyances to be compliant with the requirements of the standard and referenced to the Australian Standards and Design Rules therein, unless unjustifiable hardship is incurred by implementation. The project will be designed to be compliant with the requirements of the *Disability Standards for Accessible Public Transport 2002*.

2.4 Planning approvals process for above station development

The project stations will be designed to take into account (and make physical provision for) any design or other requirements associated with possible future above station development.

Typical examples of the infrastructure requirements of above station development would include structural support, provision of adequate space for building foyers and entrances, lift wells, and building service requirements. Elements incorporated into the project design for the purposes of making provision for future above station development will be identified and assessed as part of the environmental impact statement.

All above station development will be subject to a separate planning process. Subject to the size, scale and proposed use of the above station development this could include assessment as local development (with the local council as consent authority), assessed by the Central Sydney Planning Committee (for development in Sydney CBD >$50m), or State significant development (with the Minister for Planning or delegate as the consent authority).

3 Strategic justification and project need

This chapter outlines the strategic need and justification for the project taking into account the transport challenges that Sydney faces now and into the future. An outline of the project's consistency within the NSW strategic planning and transport policy framework is also provided.

3.1 Sydney's transport challenges

3.1.1 Population and economic growth

Sydney is Australia's financial and economic capital with half of Australia's globally competitive service sector jobs. Its economy accounts for about 70 per cent of total NSW economic output and 20 per cent of Australia's gross domestic product (SGS Economics, 2014).

The city is home to over four million people and is Australia's economic capital and a 'global city' (NSW Government, 2014a) – a status that reflects its importance in terms of its economic and cultural influences, engagement with international trade and finance, and attractiveness to globally-mobile workers and visitors. Businesses and workers are attracted to Sydney for the city's way of life and amenity, which help it score highly in international quality of life surveys.

Sydney's key employment and economic areas are clustered along a corridor that runs from Port Botany and Sydney Airport to Macquarie Park; this is known as the Global Economic Corridor (refer to Figure 3.1). In the last decade, demand for office space has seen overflow activity in the Sydney CBD and the Global Economic Corridor, extend the corridor towards Parramatta and Norwest Business Park, Sydney Olympic Park and Rhodes. The Global Economic Corridor now accounts for over 41 per cent of the NSW gross State product and provides jobs in a range of knowledge-based sectors including education, financial and other business services, communications, high-tech manufacturing and biotechnology (NSW Government, 2014a).

Sydney's population is predicted to increase from 4.3 million people (Sydney's 2011 population) to 5.9 million people by 2031. Sydney will continue to remain NSW's primary employment centre over this period, with employment in the city expected to increase from its current level of 2.1 million workers to 2.6 million workers by 2031, with about two-thirds working within the Global Economic Corridor (Transport for NSW, 2012a).

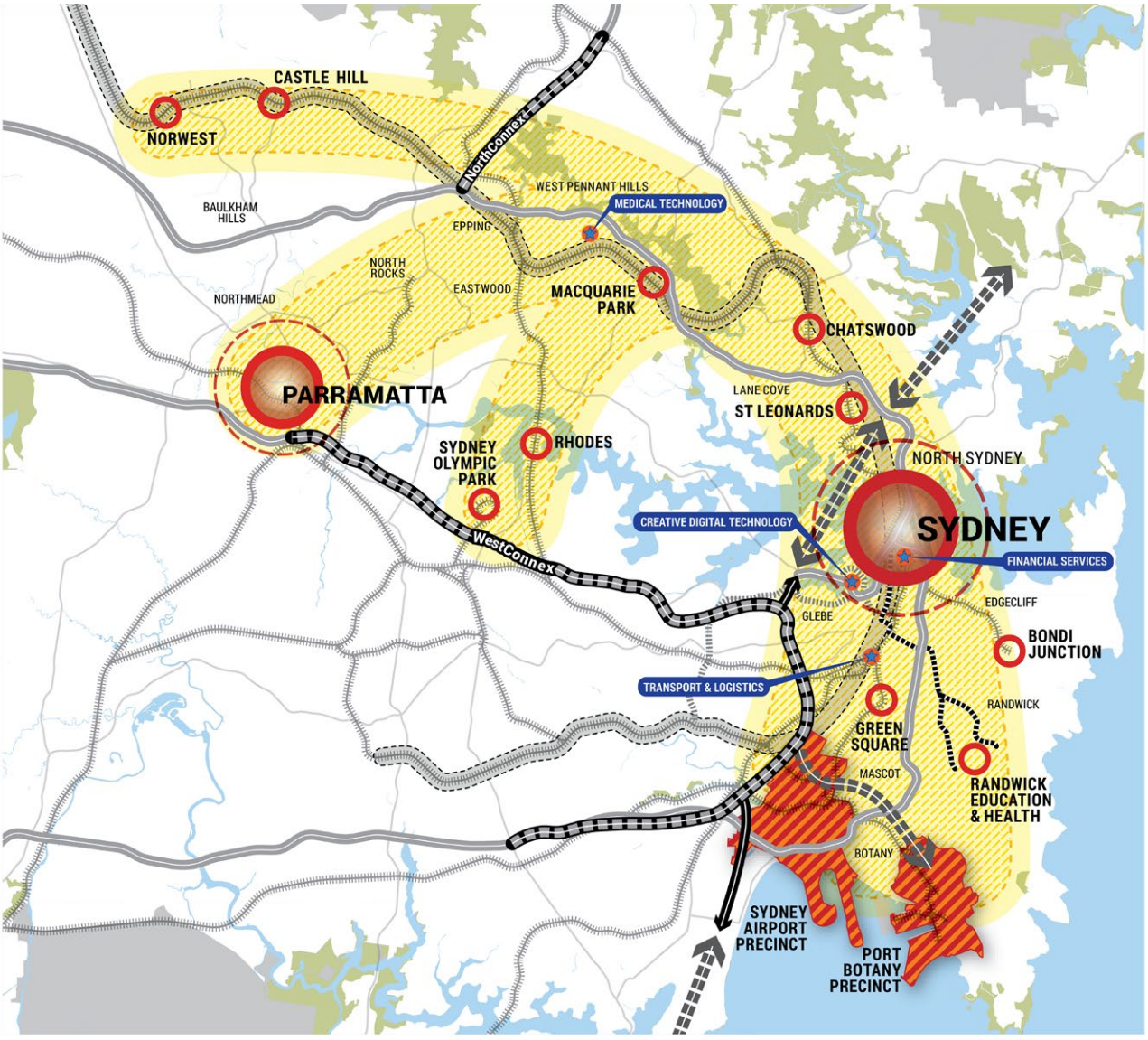


Figure 3.1 Sydney's Global Economic Corridor
(Source: A Plan for Growing Sydney)

3.1.2 Transport capacity and reliability

Sydney's suburban rail network is the backbone of the city's public transport system, which connects the city's skilled workforce with high value employment land located throughout the Global Economic Corridor. On a typical workday, commuters make about one million journeys on the rail network, with one third occurring in the morning peak (between 6am and 9.30am) (Transport for NSW, 2012b). Rail is the dominant mode of public transport for commuters travelling to and from the Sydney CBD and North Sydney, and a significant mode for commuters travelling to and from Chatswood, St Leonards and Macquarie Park.

However, the rail network is heavily congested, with customers on most rail lines often experiencing significant crowding on trains and station platforms during the morning and evening peaks. The reliability and capacity of Sydney's rail network is currently constrained by a number of factors, which include:

- Large numbers of at-grade 'junctions' on the rail network (ie points where two train tracks converge, requiring trains to cross paths)
- A large number of tracks that enter Sydney's CBD
- Complex train timetables that demand trains with different service patterns share the same track, which can result in slower trains delaying fast and express trains
- Crowded trains with 3 + 2 seating arrangements, which are slow to load and unload, resulting in long 'dwell times' (the time a train needs to stop in a station for passengers to board and alight)
- Crowded stations characterised by narrow platforms in busy CBD stations that rely on stairs instead of escalators as the principal means of accessing platforms and concourse levels.

The number of people travelling to Sydney's CBD each day is forecast to grow to 775,000 by 2031, which equates to an extra 145,000 trips each day. Rail is predicted to experience the highest growth in travel demand, with an additional 116,400 trips expected on Sydney's rail network during the morning peak by 2036. This will place additional pressure on the rail network.

It is predicted that without further investment Sydney's rail network will reach capacity in the Sydney CBD and on critical suburban rail lines by the mid to late 2020s (Transport for NSW, 2012a). This means most rail lines on the network will be overcrowded in the morning peak. The closer the rail network gets to capacity, the less reliable it will become and the more likely it will fail to meet the needs and expectations of rail customers.

As population and employment continue to grow, key stations in the Sydney CBD will not be able to cater for increased passenger movements. Increased platform crowding at Sydney CBD stations will contribute to increased dwell times (the time that a train must wait at a station platform to let passengers off and on), decreased network reliability and reduced network capacity. Without addressing platform crowding at Sydney CBD stations, investment to improve the suburban line capacity will not deliver capacity improvements, and reliability will continue to decline.

Increased platform crowding at Sydney CBD stations will also impact on the level of customer comfort and journey times. Given that timeliness and comfort are key drivers of customer satisfaction, poor customer outcomes are expected to cause a shift away from rail. However, alternative transport modes have limited capacity to absorb Sydney's forecast long-term travel demand growth.

Sydney's roads are already some of the most congested in Australia. As transport demand grows there is limited ability to augment the existing road network to increase capacity and reduce congestion, particularly within Sydney's CBD and Global Economic Corridor. Accessing the Sydney CBD by car is further constrained by a lack of available on-street car parking.

Sydney's bus network is complex, consisting of over 600 bus routes with many different types of bus services that provide more than 220 million bus trips each year (Transport for NSW, 2012a). With buses competing for road space with cars, the bus network is affected by the growing congestion on Sydney's roads, especially along arterial connections and routes to the CBD. Road congestion will increasingly slow down bus services, resulting in longer and more volatile travel times across the network during peak periods. In the morning peak, more than 1,000 buses converge on the Sydney CBD.

Previous attempts to meet extra demand have involved adding new services to Sydney's already complex bus network. While extra buses can carry more people, these services are not necessarily faster or more reliable. Without measures to improve journey times, adding more buses simply adds to congestion and each bus becomes less effective in meeting customer needs. Services continue to experience significant delays in peak times, even with bus lanes and traffic light prioritisation.

The CBD and South East Light Rail project responds to the complexity within the Sydney CBD with increased capacity and improved traffic flow at key intersections.

3.2 Why a Sydney Metro?

Given the current and predicted travel demand for rail services within Sydney, and the limited capacity of other modes of transport to absorb forecast population and employment growth, improvements in rail capacity, through initiatives like the Sydney Metro network, are critical.

The proposed Sydney Metro network, comprising Sydney Metro Northwest and Sydney Metro City & Southwest, would deliver a seamless metro network between Rouse Hill and Bankstown. The Sydney Metro network is shown in Figure 1.1 and described in Section 1.2.2.

At ultimate capacity, the Sydney Metro network would be able to run up to 30 trains per hour in each direction through Sydney's CBD, providing the foundation for a 60 per cent increase in the number of trains that could operate in the peak periods and catering for an extra 100,000 customers per hour. At ultimate capacity, the Chatswood to Sydenham component would provide additional capacity of more than 80,000 passengers per hour through Sydney's CBD.

Sydney Metro would significantly improve reliability across the rail network by addressing current and emerging constraints such as train crowding, platform and station crowding, and network complexity. The metro rail network would be capable of carrying more people, more quickly, than any other form of public transport ever seen in Sydney.

Sydney Metro would therefore deliver a new rail tier for Sydney's integrated public transport network, supporting high demand with a high-capacity, turn-up-and-go service. It is also being developed with an emphasis on meeting the needs of customers for their entire 'door to door' journey from origin to destination as shown in Figure 3.2. Sydney Metro would also be Australia's first fully automated rail network.

Figure 3.2 Customer 'door to door' journey

3.3 The key benefits of the Sydney Metro network

3.3.1 Key transport benefits

Increased rail network capacity

The project would considerably increase network capacity by introducing two new high-capacity lines connecting the Sydney CBD to other key economic centres in the broader Sydney area. On day one of operations, the project as part of the Sydney Metro network would enable an increase in services on the Sydney rail network.

Increasing rail line capacity through Sydney's CBD and removing T3 Bankstown Line services from the City Circle would enable a fundamental change in the network service plan, diverting passengers from the T1 North Shore Line and T1 Western Line; and allowing additional capacity on the T2 Airport, Inner West & South Line.

Improved travel times

The project would improve travel times by:

- Providing more direct routes to key destinations
- Reducing crowding on trains and at stations, which would improve the reliability of services.

The largest travel time savings would be experienced in areas where new stations are provided (such as Crows Nest) and where more direct routes are provided (such as Martin Place to Chatswood).

Travel time savings would be experienced by existing rail service customers (who would directly benefit from shorter travel times), new rail customers (who would transfer from road-based transport to rail) and road users (who would experience less congestion).

Reduced train crowding

By enabling additional train services on the rest of the suburban rail network and diverting passengers from existing services, Sydney Metro would significantly reduce train crowding on the T1 North Shore Line, T1 Western Line; T2 Airport, Inner West and South Line; and T3 Bankstown Line.

Reduced station crowding

A key benefit of the project would be a relief to platform crowding at existing Sydney CBD stations and a reduction in the amount of passenger time spent under heavily crowded platform conditions. The project would provide an alternative route through the Sydney CBD, increasing the number of high capacity inner city stations from two to four and providing two new underground platforms at Central Station with interchange capability.

The project would also provide vital relief to crowding at Town Hall and Wynyard stations and higher utilisation of Central and Martin Place stations. The provision of a new Pitt Street Station allows for a further dispersal of passengers. The project would also provide relief to North Sydney Station with an alternative station at nearby Victoria Cross.

Increased rail network reach and use

The project would increase the use of the rail network by:

- Providing new stations at Crows Nest, Victoria Cross and Barangaroo
- Providing more direct connections to high-capacity Sydney CBD stations at Barangaroo, Martin Place and Pitt Street
- Increasing the Sydney CBD rail catchment areas
- Providing additional interchange capability at Chatswood, Martin Place and Central stations.

The introduction of a metro station at The University of Sydney or Waterloo would also increase the use of the rail network by increasing the effective Sydney CBD rail catchment area.

The project would also provide a direct link for Sydney Metro Northwest customers to the Sydney CBD.

Improved conditions for bus customers

By connecting with Sydney Metro Northwest at Chatswood, the project would provide a direct connection from Sydney's northwest, allowing for a reduction in the number of bus services from the northwest to the Sydney CBD during the morning peak. The project would contribute to:

- Improve the reliability of journey times for the remaining bus passengers
- Reduce the number of buses in the Sydney CBD
- Reduce the number of buses accessing the Sydney CBD via the Harbour Bridge
- Reduce the number of bus services using the already congested Wynyard Bus Interchange, freeing it for use by other services
- Reduce journey times for existing bus passengers using Sydney Metro for all or part of their journey.

People around Waterloo and The University of Sydney have traditionally relied on buses and walking as a transport solution. The introduction of a metro station at either of these locations would benefit existing bus customers by providing a high quality metro / bus connection and by reducing reliance on the bus network. A metro station at either of these locations would also result in more reliable journey times for remaining bus passengers.

Improved conditions for road users

By encouraging mode shift to the rail network, the project would reduce the number of trips that would otherwise be made on the road network. This is particularly the case for sections of the road network that are constrained, such as the Harbour Bridge and the Sydney CBD, where the project would provide a high-quality transport alternative. Reduced congestion would mean that those road users who do not shift modes would gain from travel time and reliability benefits.

3.3.2 Broader benefits for Sydney

Improved accessibility

The project would improve accessibility through the introduction of stations at Crows Nest, Victoria Cross and Barangaroo, more direct connections to new higher capacity Sydney CBD stations at Martin Place and Pitt Street, and additional interchange capability at Central Station and Martin Place. This would deliver an increase in access to jobs along the majority of the project corridor, and expanded access to jobs along much of the Sydney Trains network.

The project would connect areas of high value employment land located throughout the Global Economic Corridor including greater access to and between employment opportunities, education and health precincts, retail and commercial centres and cultural and open spaces.

The introduction of a metro station at The University of Sydney or Waterloo would also improve accessibility. A metro station at The University of Sydney would improve accessibility to retail, education and health precincts. A metro station at Waterloo would improve accessibility to the Australian Technology Park and to future developments around Waterloo and Redfern.

The project would also contribute to an increase in the number of people living close to high quality transport services through provision of stations within new rail catchments. Additional residents are expected along the corridor as a result of potential transit oriented development due to Sydney Metro.

3.3.3 Economic benefits

An economic appraisal was completed for Sydney Metro City & Southwest to understand the economic benefits and costs of the project.

The economic appraisal considered a range of potential benefits, including:

- Continuing rail customers – comprising travel time, reliability, train de-crowding, station de-crowding and amenity
- New and lost rail users – same as continuing rail users but the 'rule-of-half' was applied to benefits
- Continuing bus users and road users – road decongestion due to higher rail mode share
- Residual value – the remaining asset life at the end of the appraisal period
- Wider economic impacts – productivity impacts from agglomeration and worker accessibility
- Land use change impacts – productivity impacts and externalities from higher density land use.

Sydney Metro City & Southwest would provide a substantial increase in capacity for the Sydney rail network and enable the future development of a broader metro network.

3.4 Consistency with NSW strategic planning and policy

The project is consistent with key NSW Government planning strategies, as outlined in this section.

3.4.1 State planning strategy

State and Premier priorities

In September 2015 the NSW Premier released 30 'State priorities', including 12 'Premier priorities' to grow the economy, deliver infrastructure, and improve health, education and other services across NSW. Key priorities relevant to the Sydney Metro Chatswood to Sydenham project include 'building infrastructure' and 'creating jobs'.

The project would contribute to economic growth by providing direct benefits to customers in terms of reduced travel time and better reliability. It would also deliver wider economic benefits by facilitating increased connectivity, land development and business logistics improvements, particularly for knowledge based businesses.

There are a number of health benefits associated with the project that relate to increased urban density and increased active transport (walking and cycling) opportunities around transit stops.

Over the next 15 years, NSW will require infrastructure to support 40 per cent more train trips, 30 per cent more car trips and 31 per cent more households (online; https://www.nsw.gov.au/making-it-happen). Sydney Metro City & Southwest is identified as a key infrastructure project as part of the NSW government's infrastructure investment program.

The NSW government is committed to the creation of 150,000 new jobs over the next four years. Through investment in infrastructure such as the Chatswood to Sydenham project, new jobs and apprenticeships are being created for the construction sector.

3.4.2 Sydney metropolitan planning strategy

A Plan for Growing Sydney (NSW Government, 2014a) sets out the NSW Government's strategy for accommodating Sydney's future population growth over the next 20 years. The plan consists of goals, directions and actions that provide a framework for strengthening the global competitiveness of Sydney and delivering strong investment and jobs growth in Western Sydney. The project's expected contribution to achieving these goals, directions and actions is outlined in Table 3.1.

Table 3.1 Expected contribution to achieving the goals of *A Plan for Growing Sydney*

Directions of the Plan	Corresponding actions of the Plan	Project contribution to achieving the plan's directions and actions
Goal 1: A competitive economy with world-class services and transport		
Direction 1.6: Expand the Global Economic Corridor	**Action 1.6.2:** Invest to improve infrastructure and remove bottlenecks to grow economic activity	The project would support the Global Economic Corridor by providing faster and more reliable access and by fostering clusters of activities that support more economic growth.
Direction 1.7: Grow strategic centres – providing more jobs closer to home	**Action 1.7.1:** Invest in strategic centres across Sydney to grow jobs and housing and create vibrant hubs of activity	The project would improve capacity and reliability of links along the Global Economic Corridor to the Sydney CBD. Together with Sydney Metro Northwest, the project would also improve links to the strategic centres of Chatswood, Macquarie Park, Castle Hill, Norwest and Rouse Hill.
Direction 1.11: Deliver infrastructure	**Action 1.11.1:** Preserve future transport and road corridors to support future growth	*A Plan for Growing Sydney* specifically identifies preserving a future corridor for Sydney Metro. The project is consistent with this action.
Goal 2: Sydney's housing choices		
Direction 2.2: Accelerate urban renewal across Sydney – providing homes closer to jobs	**Action 2.2.2:** Undertake urban renewal in transport corridors which are being transformed by investment, and around strategic centres	The project has significant potential to act as a catalyst for new housing development, giving new communities shorter and more reliable commutes to major job centres.

3.5 Consistency with NSW strategic transport infrastructure policy

3.5.1 Rebuilding NSW: State Infrastructure Strategy 2014

Rebuilding NSW: State Infrastructure Strategy 2014 (Rebuilding NSW; NSW Government, 2014b) outlines the NSW Government's plan to invest $20 billion in new productive infrastructure to sustain productivity growth in NSW's major centres and regional communities, as well as to support a forecast population of almost six million people in Sydney and more than nine million in NSW. Projects identified in Rebuilding NSW are based on investment recommendations made by Infrastructure NSW.

Rebuilding NSW identifies that $7 billion has been reserved to fully fund a second rail crossing of Sydney Harbour as part of Sydney Metro. The project is therefore consistent with this document.

3.5.2 NSW Long Term Transport Master Plan

The *NSW Long Term Transport Master Plan* (Transport for NSW, 2012b) is the NSW Government's 20 year plan to improve the NSW transport system by delivering an integrated, modern transport system that puts the customer first. The plan identifies the transport challenges that will need to be addressed to support NSW's economic and social performance over the next 20 years and establishes a number of short, medium and long-term actions to address those challenges. These actions provide the overall framework for how the NSW transport system develops, in terms of services and infrastructure.

A key element of the *NSW Long Term Transport Master Plan* is the need to increase the capacity of Sydney's rail network to meet existing customer needs and accommodate the additional travel demand created by Sydney's forecast population and economic growth over the next few decades. The plan notes that over the next 20 years, the number of trips made by rail is expected to increase by 26 per cent (Transport for NSW, 2012b). This growth cannot be accommodated on Sydney's existing rail network, which is already approaching its capacity and is subject to significant crowding on most lines at the height of the morning and evening peak periods (Transport for NSW, 2012b).

Without the creation of additional rail capacity, crowding levels on the network will continue to increase, with many parts of the rail network predicted to be near capacity in 2031, even with service improvements that are possible within the constraints of the current network configuration, as outlined in Section 3.1 (Transport for NSW, 2012b).

The *NSW Long Term Transport Master Plan* identifies a 'three-tiered network' approach to expand the capacity of Sydney's transport system. This approach involves the implementation of high-capacity metro into the current two-tier arrangement of suburban and intercity services to untangle the current system and ensure fast, efficient and reliable services throughout the network. The plan identifies a second Sydney Harbour rail crossing and Sydney CBD rail line, which connects Redfern to Chatswood via the Sydney CBD, as the centrepiece of Sydney's modernised rail system.

The project is therefore a key long-term action of the *NSW Long Term Transport Master Plan*, which would improve access and connectivity for the T1 North Shore Line and Sydney Metro Northwest, and improve travel times and capacity through the city from the north and south. The project would provide the largest increase in capacity to the Sydney rail network for 80 years, while proposed new stations within the Sydney CBD would relieve pressure on Central, Wynyard and Town Hall stations.

The *NSW Long Term Transport Master Plan* is accompanied by *Sydney's Rail Future* (Transport for NSW, 2012a), which details how the NSW Government will deliver the core elements needed to give Sydney a world-class rail network that can support the city's growth. *Sydney's Rail Future* is discussed in Section 3.5.3.

3.5.3 Sydney's Rail Future

Sydney's Rail Future: Modernising Sydney's Trains (Sydney's Rail Future; Transport for NSW, 2012a) is the NSW Government's long-term plan to increase the capacity of Sydney's rail network by investing in new services and upgrading existing infrastructure. It aims to improve the customer's experience, improve reliability and increase services across the rail network. *Sydney's Rail Future* forms an integral part of the *NSW Long Term Transport Master Plan* (discussed in Section 3.5.2) and will eventually enable Sydney's rail network to carry another 90,000 to 100,000 people per hour in the peak period.

Sydney's Rail Future recognises key challenges for Sydney's rail system, including increased demand for rail transport driven by employment and population growth, the limited capability of the current network, capacity constraints, Sydney CBD congestion, the need to support the on-going development of the Sydney CBD and suburban bottlenecks. *Sydney's Rail Future* is based on the NSW Government's strategy to meet customer needs, which include:

- Create a more reliable service
- Get Sydneysiders to work on time
- Maintain a safe, clean and comfortable commuting environment
- Run more services
- Reduce travel times.

Sydney's Rail Future describes the plan to transform and modernise Sydney's rail network based on a three-tiered system, comprising:

- Tier 1 – Metro (previously known as Rapid Transit): based on 'turn-up-and-go' services and single-deck metro trains
- Tier 2 – Suburban: timetabled services with double-deck trains
- Tier 3 – Intercity: timetabled services with double-deck trains and on-board amenities for long distance commutes.

Sydney's Rail Future is being delivered in five stages. An overview of these stages is provided in Figure 3.3. The project comprises Stage 4 of *Sydney's Rail Future*.

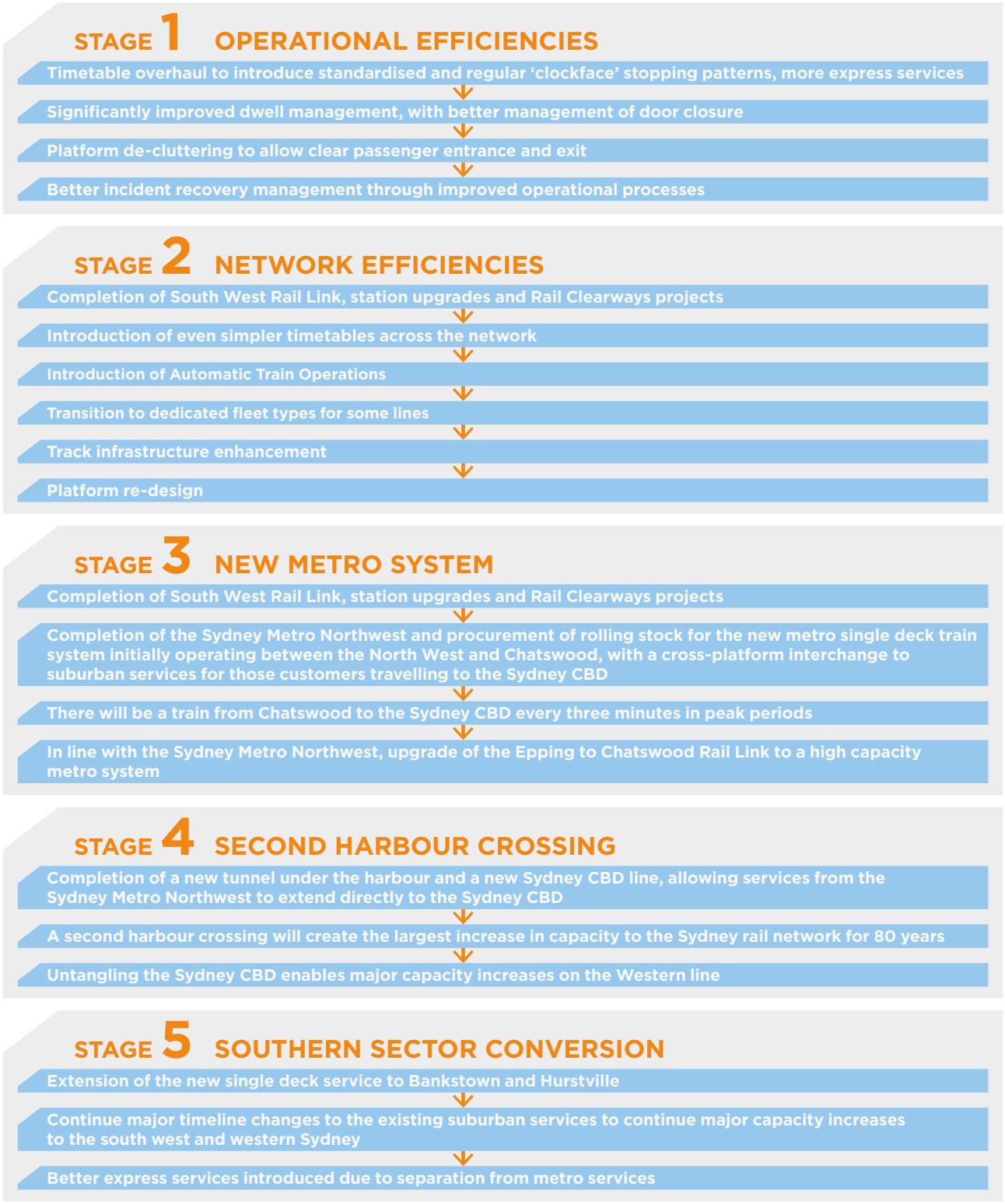


Figure 3.3 The five stages of Sydney's Rail Future

3.5.4 Sydney City Centre Access Strategy

The *Sydney City Centre Access Strategy* (Transport for NSW, 2013) is the NSW Government's plan to deliver a fully integrated transport network in Sydney's city centre that puts the customer first and meets the city's growing transport task. The strategy outlines how people will enter, exit and move in and around the Sydney CBD over the next 20 years and demonstrates how light rail, buses, trains, ferries, cars, taxis, pedestrians and cyclists will interact in the heart of Sydney. The strategy also provides a clear direction for how all the different transport modes will work together in the city centre to:

- Reduce congestion
- Provide for future growth
- Improve the customer experience.

Under the *Sydney City Centre Access Strategy*, rail will remain the dominant mode for getting to the city centre. Key features of the integrated network identified in the *Sydney City Centre Access Strategy* are:

- Light rail on George Street between Central and Circular Quay
- Pedestrianisation of George Street between Bathurst Street and Hunter Street
- Improved pedestrian connections throughout the city centre such as Wynyard Walk
- Redesigned bus services with priority routes on Elizabeth Street / Castlereagh Street, Park Street / Druitt Street, Clarence Street / York Street and Hickson Road
- New interchange precincts at Town Hall, Wynyard, Central and Circular Quay, and also at Martin Place and Museum stations
- An integrated cycleway network
- A new ferry hub at Barangaroo
- A new railway line and train stations for the city centre
- New designated traffic routes through and around the city centre.

The project is a key action of the *Sydney City Centre Access Strategy*, which identifies the following benefits to the Sydney CBD:

- Unlock the Sydney CBD rail bottleneck and enable more rail services from the west, southwest, Illawarra, Bankstown, North Shore and the northwest
- Provide up to an extra 60 train services per hour (30 in each direction) across the harbour and through the city centre
- Create new train stations to relieve pressure on existing crowded platforms in the city centre
- Enable better connections to employment opportunities across Sydney
- Help reduce the number of buses travelling into the city centre from north of the Sydney Harbour Bridge.

3.6 Project objectives

The objectives of the project are to:

- Improve the quality of the transport experience
- Provide a system that is able to satisfy long-term demand
- Grow public transport patronage and mode share
- Support the productivity of the Global Economic Corridor
- Serve and stimulate urban development
- Improve the resilience of the transport network
- Improve the efficiency and cost effectiveness of the public transport system
- Implement a feasible solution recognising impacts, constraints and delivery risk.

4 Project development and alternatives

This chapter describes the alternatives and options evaluation process undertaken to determine the preferred option. An overview is provided of the strategic alternatives, the alignment and station options considered, and the strategic station options subsequently evaluated. This chapter also identifies the consequences of not proceeding with the project.

4.1 Overview of the project development process

A large number of studies have identified and assessed potential transport solutions between northern Sydney and the Sydney CBD, including heavy rail and metro alignments. The potential transport solutions have influenced strategic rail planning in documents such as the *NSW Long Term Transport Master Plan* (Transport for NSW, 2012a) and *Sydney's Rail Future – Modernising Sydney's Trains (Sydney's Rail Future)* (Transport for NSW, 2012b). Therefore, they have also influenced the development process for the Chatswood to Sydenham project.

4.2 Strategic alternatives

A number of strategic alternatives relevant to a metro rail system were considered during the development of the *NSW Long Term Transport Master Plan* and *Sydney's Rail Future*. These options were:

- Regulatory, governance and better-use reforms
- Investment in road, bus and light rail
- Rail network options.

These options are discussed below, together with an assessment of their overall effectiveness in meeting Sydney's growing transport needs.

4.2.1 Regulatory, governance and better-use reforms

The NSW Government has considered a range of regulatory, governance and better-use reforms to improve transport outcomes and meet Sydney's growing population needs. The reforms include:

- Regulatory reform (including review of passenger transport legislation to allow for more flexible transport services)
- Governance reform (including centralising transport planning and policy functions within Transport for NSW and integrating land use and transport planning, including for major growth corridors)
- Better-use reform (including continued implementation of integrated electronic ticketing system, bus priority system, interchange upgrades, and improvements, expansion and modernisation of train and bus fleets).

While these reforms are vital to meeting the government's policy objectives and are already being implemented, additional investment in transport infrastructure will also be required to ensure Sydney's transport network meets future demand.

4.2.2 Investment in road, bus and light rail

The NSW Government is currently delivering or has delivered a number of road, bus and light rail projects across Sydney as part of the *NSW Long Term Transport Master Plan* and the *Sydney City Centre Access Strategy* (Transport for NSW, 2013). These projects include WestConnex, NorthConnex, the CBD and South East Light Rail, Inner West Light Rail and a number of bus priority projects including the Northern Beaches Bus Rapid Transit project.

However, while investments in road, bus and light rail projects will form part of the solution to Sydney's transport need, these options are, by themselves, insufficient to address forecast growth in travel demand (the number of people travelling to the Sydney CBD each day is forecast to grow to 775,000 by 2031, which equates to 116,000 more cars or 2685 more buses each day).

Sydney's mature road network has limited opportunity for additional capacity to connect in to the Sydney CBD. New roads where possible, e.g. a possible 'Western Harbour Tunnel' to provide additional cross-regional links, cannot provide the mass transit capacity required to support Sydney's growth.

With respect to buses and light rail, these are complementary modes, bringing customers to and dispersing them from the major transport hubs served by suburban and metro rail services. However, buses and light rail cannot wholly support the large hourly commuter movements required in and out of the Sydney CBD. Buses can potentially provide a flexible response to local demand pressures and light rail offers medium capacity solutions for major transport corridors, replacing lower capacity bus services. However, both modes would not provide sufficient mass transit capacity to address Sydney's transport bottlenecks.

4.2.3 Rail network options

Based on projected population growth and transport demand, additional investment in rail is seen as a more efficient and effective solution than other strategic alternatives discussed above. In developing *Sydney's Rail Future*, 15 alternative capital investment options for an expansion of the transit network were identified. The 15 options were grouped into four broad network options (refer to Table 4.1):

- Rail Future A: Use of the existing suburban rail network
- Rail Future B: Rebuilding parts of the existing network in order to run single-deck metro trains
- Rail Future C: A metro rail system that would integrate with the existing rail network
- Rail Future D: An independent metro rail system that would not integrate with the existing rail network.

Each option was strategically assessed against a number of evaluation criteria. These criteria included their ability to meet customer requirements; network capacity requirements; ability to improve network resilience; delivery risk; and cost effectiveness. A two-step process was used to select the preferred strategic option.

The first step involved an assessment of whether existing rail operations should be expanded and improved to provide continued operation of a double-deck fleet with a two-tiered system of suburban and intercity services (Rail Future A) or whether a separate, independent 'differentiated' system should be constructed to provide metro turn-up-and-go services (Rail Future B, C and D). An assessment of these two options found that a metro service is required to meet demand in both the short and long term. Rail Future B requires conversion of the T1 North Shore Line services across the Harbour Bridge and rebuilding of other parts of the existing network, resulting in major disruptions and inconvenience for customers would impact on network reliability and resilience. Accordingly, Rail Future A and Rail Future B were discarded and not further evaluated.

The second step involved an analysis of the differentiated service options that would best deliver against the assessment criteria. Criteria applied when assessing differentiated service options included delivery of capacity increases in key sections of Sydney's rail network; high-quality service levels and provision of significant improvements in operational reliability required to service Sydney's growth. The analysis found that Rail Future C would be superior to Rail Future D, so Rail Future D was discarded.

Table 4.1 The four rail network options considered in *Sydney's Rail Future*

Option	Key features
Rail Future A – suburban option	This option would involve the use of the existing double-deck rolling stock on the existing network, including for all future expansions (ie a second harbour crossing). This option would have a capacity of 20 trains per hour per direction (or 24,000 people per hour per direction). However this option could not meet the long-term capacity and service improvements required by the *NSW Long Term Transport Master Plan* and would not meet customer expectations for reliability, improved journey times and convenience.
Rail Future B – rebuild option	This option would involve rebuilding parts of the existing network in order to run single-deck metro trains. It would require conversion of the T1 North Shore Line services across the Harbour Bridge and major upgrading of the existing CBD infrastructure and stations. Although rebuilding the existing network would improve capacity in the medium term, it would not meet demand in the long term because capacity would be restricted to the current single train line across Sydney Harbour. Conversion of the existing line to accommodate a metro rail system would need to occur while maintaining existing services (to the extent possible), and would result in major disruptions and inconvenience for customers for a number of years. Further, the existing stations at Town Hall and Wynyard are already congested and an increase in the number of services using these stations would impact on network reliability and resilience and affect customer safety.
Rail Future C – Sydney's Rail Future (Sydney Metro network)	This option would involve construction of a metro rail network that would operate independently of the existing rail network, however it would provide integration and interchange points with the existing rail network. New infrastructure would mainly be used; however, a section of Sydney Metro Northwest (historically referred to as the Epping to Chatswood Rail Line) and the existing rail line between Sydenham and Bankstown would be converted to metro and form part of the metro network. This option includes a second crossing of Sydney Harbour and a new underground line within the Sydney CBD. Interchanges would be provided at key stations (eg Chatswood and Central). Rolling stock design would ensure that boarding and alighting would be faster, which would reduce dwell and journey times.
Rail Future D – an independent transit system	This option would operate independently and not integrate with the existing rail network. It would require construction of a harbour crossing and a CBD line. This option would only benefit customers along the new lines and would not adequately address the future requirements of the rail network. It would result in marginal benefits in terms of service enhancement, capacity improvements and improved operating efficiency on the existing rail network. This would also be the most expensive of the four options and would divert funding from service improvements on the existing rail network.

Rail Future C (referred to from this point as Sydney Metro, and incorporating the whole proposed Sydney Metro network) was selected as the preferred rail network option because it would:

- Be more flexible and provide frequent services which benefit customers
- Provide the required capacity and flexibility to respond to growing demand for rail in Sydney
- Create a more modern, resilient and faster service
- Deliver a seamless and less disruptive way of modernising Sydney's rail
- Deliver transport benefits more cost effectively.

In terms of expanding capacity on the rail network, Sydney Metro would substantially expand capacity on Sydney's most constrained transport corridors and eliminate dependence on the Harbour Bridge as the only mass transit harbour crossing between the North Shore and the Sydney CBD.

The new cross-harbour rail capacity, combined with new stations on the North Shore and in the Sydney CBD would also allow for a reduction in buses crossing the Harbour Bridge, offering the potential for substantial reductions in congestion at North Sydney, Wynyard and Town Hall stations and a reduction in road congestion in Sydney's CBD.

The introduction of a metro station at either The University of Sydney or Waterloo is consistent with, and would further realise the benefits of Rail Future C.

Conversion of the Bankstown line between Sydenham and Bankstown

The full delivery of the Sydney Metro including Sydney Metro Northwest from Cudgegong Road and Sydney Metro City & Southwest to Bankstown was identified as a strategic option in *Sydney's Rail Future*.

Various options were considered for the southern and western component of the Sydney Metro network beyond Central Station.

Converting the Bankstown Line between Sydenham and Bankstown into a dedicated metro line would improve the rail network reliability by reducing the number of rail lines sharing the same existing tracks and would facilitate much needed increased capacity from the west and southwest. The Sydenham to Bankstown upgrade would unlock the capacity at Central Station platforms and enable reallocation of train paths on the City Circle. It would also significantly reduce platform and train crowding.

The T3 Bankstown Line would also be less complex to convert and segregate from existing rail network, when compared with other lines, as the T3 Bankstown Line operates independently to other lines and rail freight rail between Sydenham and Bankstown. The T3 Bankstown line would require less infrastructure to convert to a metro service when compared with other lines, such as the T2 South Line and T4 Illawarra Line, which would require additional tunnels and tracks, significant enabling works such as alternative freight routes and a new train stabling and maintenance facility for Sydney Trains.

The decision to proceed with a conversion of the T3 Bankstown Line to a metro service determines the alignment of the project from south of Central Station to just north of Sydenham Station.

The Sydenham to Bankstown upgrade, including work at Sydenham Station will be subject to a separate environmental impact assessment process.

4.3 Station location options

The station options evaluation process used to determine preferred station locations involved a number of stages, each with an increasing level of detailed analysis. The project objectives (refer to section 3.6) underpinned the evaluation criteria used in the options evaluation process.

The evaluation of station location options has followed a three-phase process:

- Phase 1 – This involved the identification and assessment of a long list of 34 station options to ensure all possible metro station locations were considered. Some potential station options were grouped into station localities to reflect their close proximity to each other. This resulted in 20 station localities being subject to a preliminary station assessment. Of the 20 localities, 13 were shortlisted for further evaluation
- Phase 2 – This involved detailed analysis of the 13 short-listed station localities. This identified a preference for two North Shore station localities and three Sydney CBD station localities
- Phase 3 – This involved stakeholder and community consultation on the preferred station localities and the identification of additional station locations seen as having merit to enhance the project and increase project benefits.

This evaluation of station locations is described in more detail in the following sections.

4.3.1 Phase 1 – preliminary station location options

Initially a long list of 34 station options was identified. The selection of preferred station locations on North Shore required a different approach to the selection of station locations in the Sydney CBD that were more heavily influenced by alignment constraints such as building basements. Station locations between Chatswood and Sydney Harbour were identified as 'North Shore' station locations and station locations between Sydney Harbour and Central were defined as Sydney CBD station locations.

Of the 34 options, some were grouped into station localities to reflect their close proximity to each other. This resulted in 20 station localities being subject to a preliminary station assessment. Of the 20 localities, 13 were shortlisted for further evaluation. These locations are shown in Figure 4.1.

The evaluation resulted in the removal of seven station locations from further assessment, as discussed in Table 4.2.

Table 4.2 **Preliminary station location options that were not short-listed for further evaluation**

Station option	Rationale for not being short-listed for further evaluation
Willoughby Naremburn	These stations would be located in residential areas with small centres. While these locations would result in a new rail catchment area, they would not serve or stimulate development.
Wollstonecraft Waverton	The existing suburban rail stations at these locations serve a small residential catchment (comprising detached housing and strata development) and a metro station would not serve a new rail catchment.
North Sydney	The existing North Sydney Station is constrained and would not serve a new rail catchment.
Milsons Point	The existing suburban rail station at Milsons Point serves a small residential catchment (characterised by detached housing and strata development). There are a number of heritage constraints at this location (including thet Harbour Bridge – an item of outstanding national heritage significance).
Hickson Road (Dawes Point)	Although a station in the north Hickson Road area (at Dawes Point) would introduce public transport to an area currently with limited access, there is only a small catchment (population and employees) that would use the station.

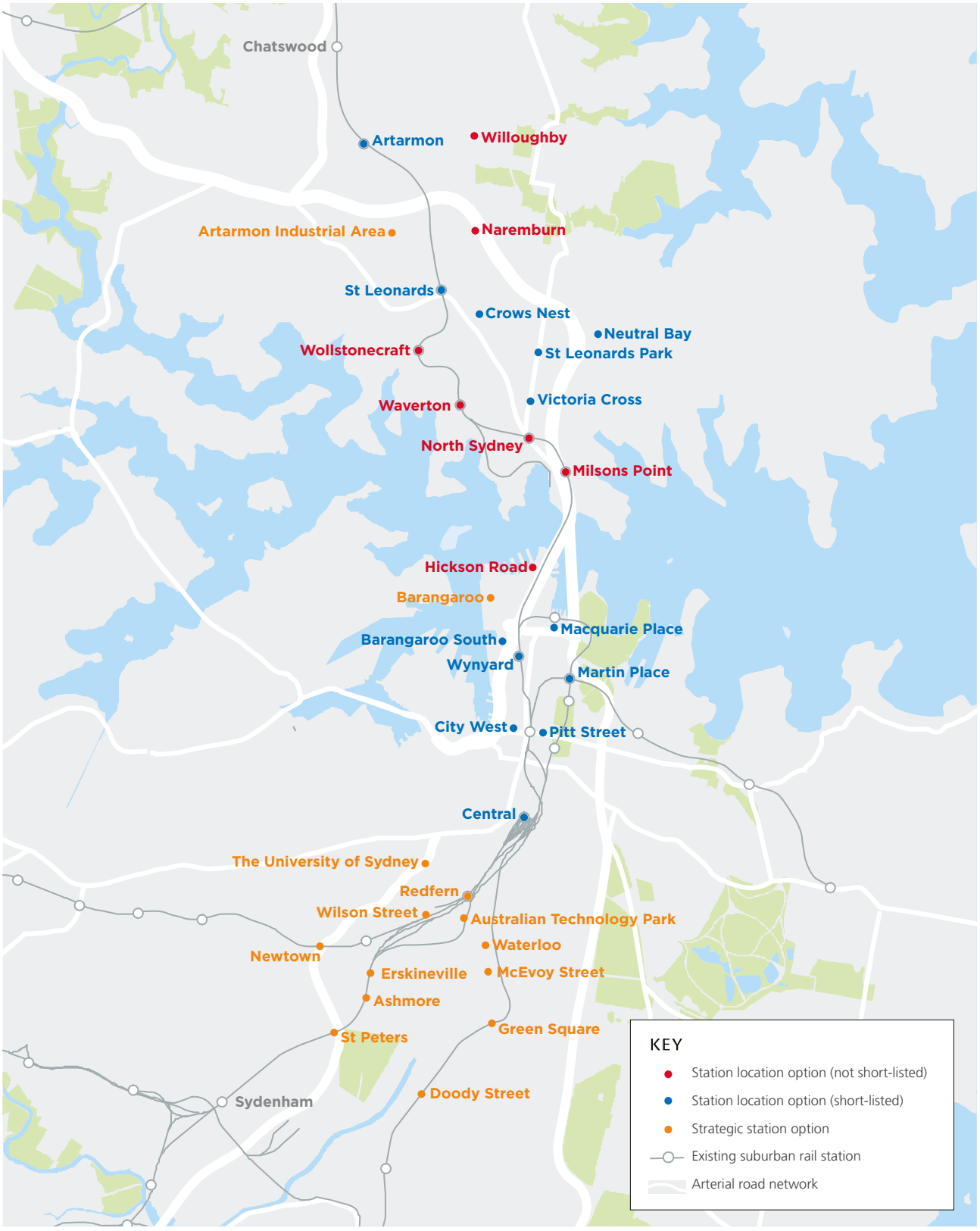


Figure 4.1 Preliminary station location options

4.3.2 Phase 2 – short-listed station location options

Phase two involved detailed analysis of the 13 short-listed station localities. Each of the remaining localities was evaluated against the project objectives using the process shown in Figure 4.2.

The process resulted in the selection of the preferred station location options (base case station locations).

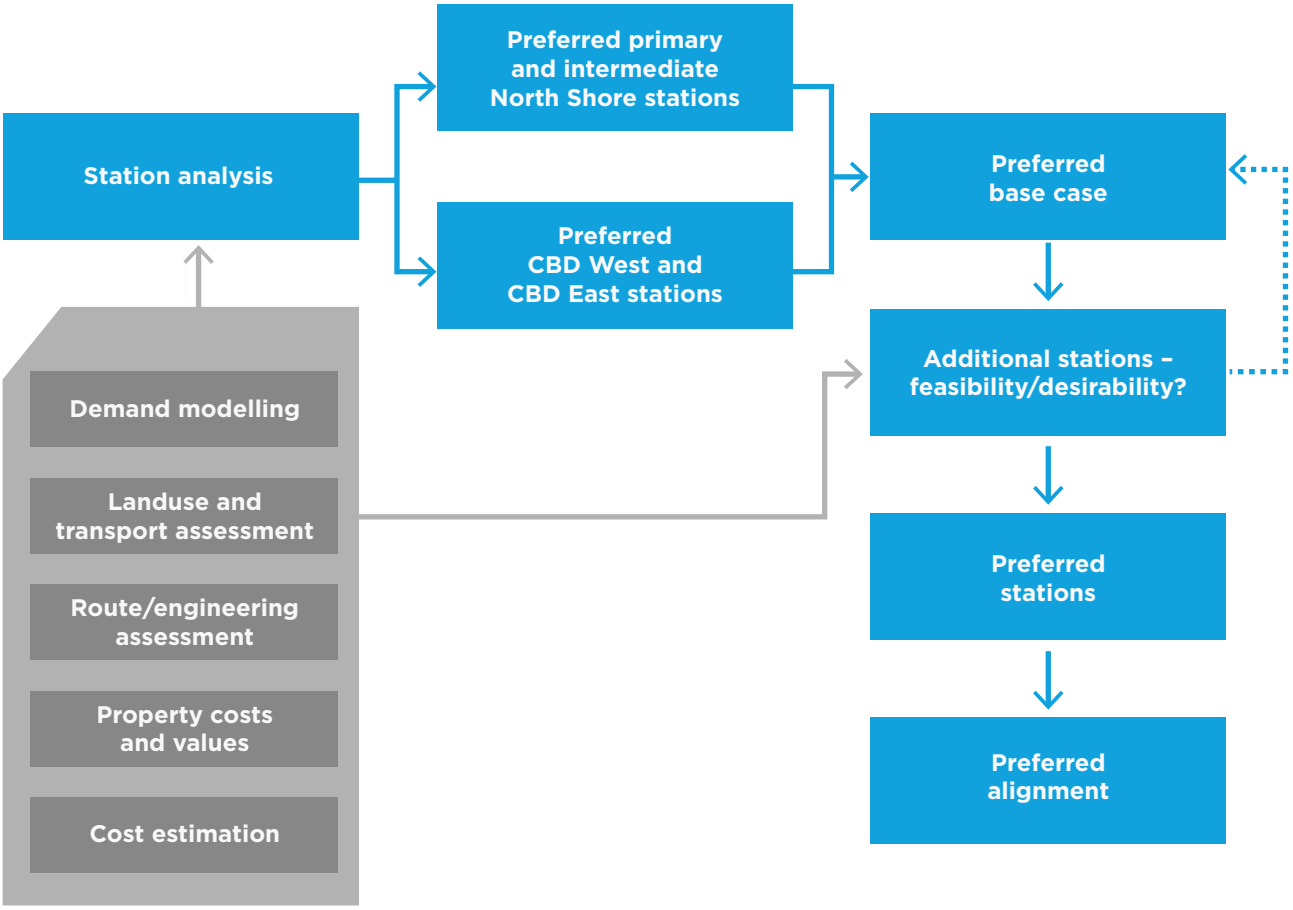


Figure 4.2 Process for evaluating the short-listed station locations

The performance of each of the remaining station locations was assessed against each of the project objectives as either 'positive alignment' (green), 'some alignment or neutral / not applicable' (orange) or 'no alignment, or negative impacts' (red), as shown in Figure 4.3.

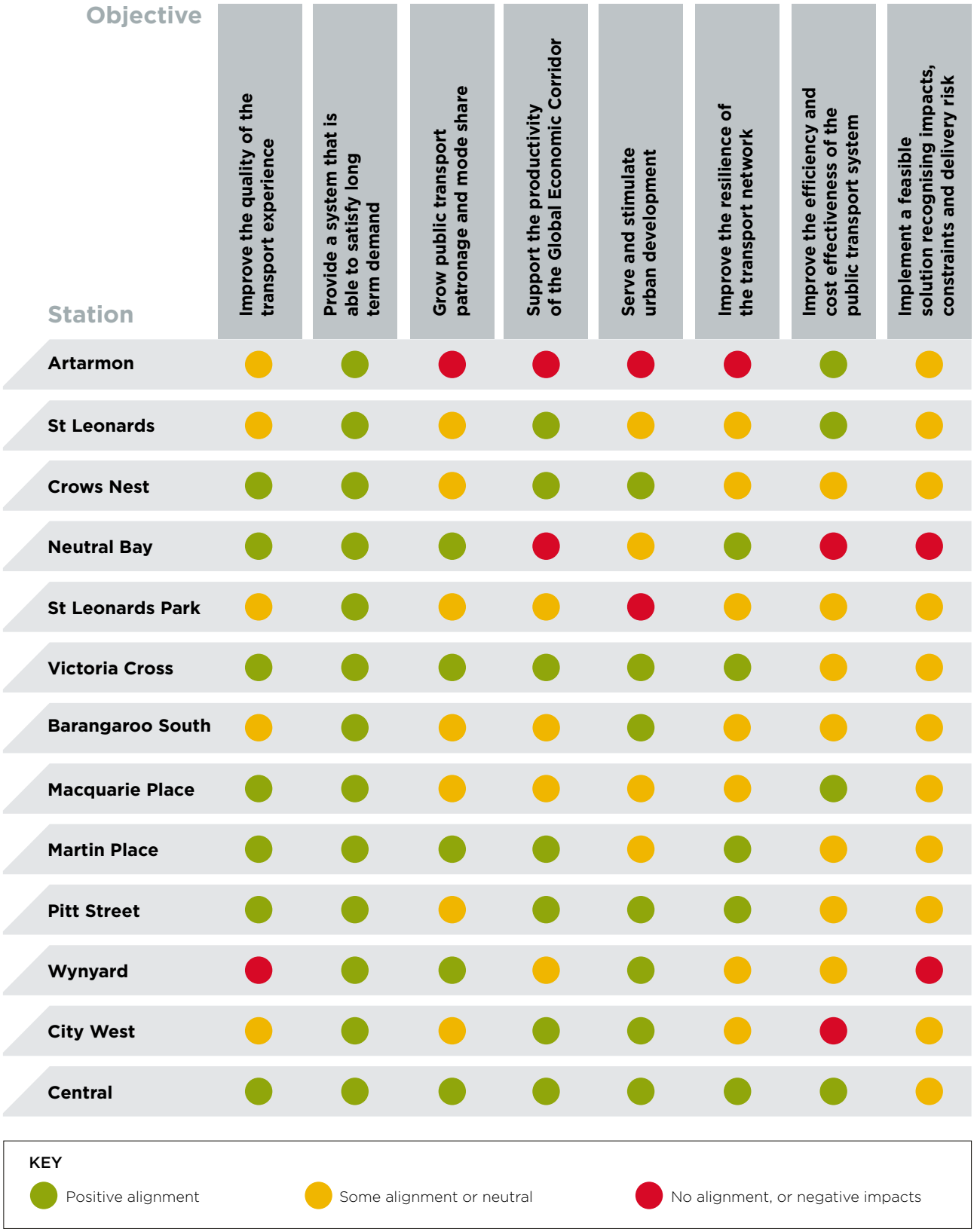


Figure 4.3 Performance of each station against each of the project objectives

The Artarmon, Neutral Bay and Wynyard station options were discarded as all performed poorly in the evaluation against more than one of the Sydney Metro project objectives.

St Leonards Park and City West also performed poorly on at least one of the objectives. St Leonards Park was subsequently compared with the alternative station at Victoria Cross. Victoria Cross was considered superior as it has a greater catchment area and a greater potential for residential, commercial and transit oriented development. St Leonards Park also has a number of heritage and environmental issues and was consequently discarded.

Further review of City West and Barangaroo South stations indicated that they would have a smaller current and potential future catchment than other Sydney CBD locations such as Martin Place. They would also have a number of physical constraints including the Cross City Tunnel alignment that would influence the location and depth of the stations, resulting in a material impact on the overall project cost. Given the relative advantages of alternative Sydney CBD stations (and a Sydney CBD eastern alignment) these stations were subsequently discarded.

A station at St Leonards would meet all the project objectives. However, further consideration indicated that, relative to a station at nearby Crows Nest, it would not extend the rail catchment and all future employment and dwelling growth would be within the existing rail catchment which is already well connected by public transport. In addition, construction of the station would cause disruption to existing customers during construction, and environmental and social issues associated with a tunnel boring machine launch site located close to sensitive receivers including the hospital. Sporting teams that utilise Gore Hill Oval would also need to be relocated. Accordingly St Leonards was not considered further as a preferred location for a metro station.

A station at Macquarie Place would meet all the project objectives. Compared to other Sydney CBD station locations Macquarie Place would have a smaller catchment and would overlap with the existing Circular Quay Station catchment, which already provides direct connections to Wynyard, Town Hall and Central stations and beyond. Accordingly Macquarie Place was not considered further as a preferred location for a metro station.

Crows Nest and St Leonards station options both performed well against the majority of the project objectives. These were carried forward fur further investigation as part of Phase 3.

The preferred station locations are described in Chapter 5. During the development of preferred station designs a number of alternative station configurations may be considered. Changes to the station configurations may be made for a number of reasons, including:

- Orientation of station buildings and associated infrastructure to provide effective and efficient access for customers, accessibility of station entry points, and integration with surrounding land uses
- The need to minimise environmental and property impacts
- Constructability
- The need to not preclude the potential for future above station development.

Further detail on the optimisation of station locations will be included in the environmental impact statement where relevant.

Outcomes of short-listed stations assessment

Based on the assessment of the short-listed stations, the NSW Government proceeded with a project incorporating new metro stations at Crows Nest / St Leonards, Victoria Cross, Martin Place and Pitt Street, as well as new underground platforms at Central Station.

4.3.3 Phase 3 – additional station options (strategic options)

This phase involved stakeholder and community consultation on the preferred station localities and the identification of additional station location options, which were seen to have the potential to strategically enhance the project. This included further evaluation of a station location at either Crows Nest or St Leonards and the introduction of an additional metro station:

- At Barangaroo
- In the Artarmon Industrial Area
- Between Central and Sydenham.

These additional station options, described below, were included because they would serve strategic transport needs.

Crows Nest or St Leonards

Based on further evaluation of both options and stakeholder and community feedback, the preferred station location is at Crows Nest. Crows Nest Station would support the St Leonards specialised centre as a southern gateway to commercial and mixed use activities. The station would also improve access to the restaurants and specialist shops in the Crows Nest village.

The Crows Nest Station location best meets the needs to this area by ensuring the new metro station us as close as possible to the St Leonards centre while also extending the rail catchment.

Barangaroo

A station at Barangaroo (as opposed to Barangaroo South, as discussed in Section 4.3.2 above) would serve the Barangaroo development and potentially some of the catchment area for Wynyard Station given connectivity improvements in the area associated with projects like Wynyard Walk.

Given the flexibility of the metro tunnel alignment, the provision of a metro station in the central to northern part of Barangaroo is possible while also providing a station at Martin Place.

The station would deliver a unique east-west connection between Martin Place and Barangaroo, result in improved travel times between Barangaroo and other Global Economic Corridor centres, and reduce future passenger demand on suburban rail platforms at Wynyard Station.

A station at Barangaroo would benefit from the high-quality public domain and amenity to be delivered as part of the broader Barangaroo development. It would connect the Central Barangaroo precinct to the metro network with cultural facilities, Barangaroo Point Reserve and entertainment within five minutes' walk and the Barangaroo South precinct within 10 minutes' walk. It would also provide a connection to the public domain and entertainment activities at East Darling Harbour. A station at Barangaroo would also service a residential catchment at Millers Point, Walsh Bay and future residents at Barangaroo.

A number of constraints have been considered during the development of sub-options and in the selection of the preferred location for a metro station at Barangaroo. The preferred location and configuration of Barangaroo Station would have the following benefits:

- It would promote access to the Barangaroo precinct
- It would optimise the balance between station cost and customer outcomes (station depth, travel times, etc)
- It would minimise or avoid impacts on heritage items in the area including Millers Point Conservation Area, the Walsh Bay Wharves Precinct and the Millers Point / Dawes Point Village Precinct, although noting potential archaeological heritage significance as outlined in sections 7.1.5 and 7.1.6.

A reference design for Barangaroo Station was assessed against the performance objectives referenced in Section 4.3.2 above. Considering that assessment (refer to Figure 4.4) and further consultation with key stakeholders, the NSW Government decided to include a station at Barangaroo as part of the Sydney Metro project.

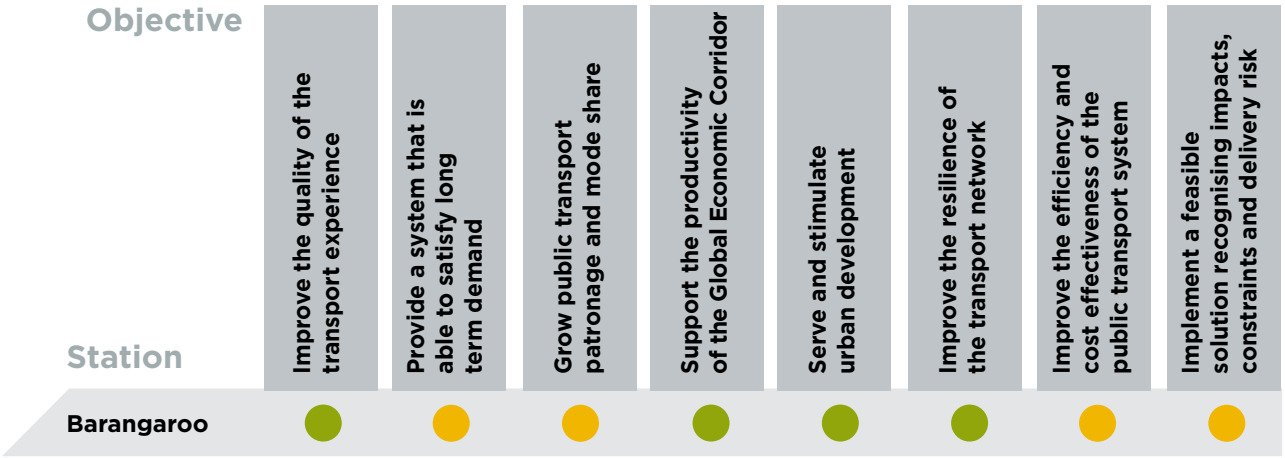


Figure 4.4 Performance of Barangaroo Station location against the project objectives

Artarmon Industrial Area

A station in the Artarmon Industrial Area would facilitate easier access to Artarmon employment areas and result in greater opportunities for commercial, mixed use and higher density residential dwellings.

There is a clustering of traditional light industrial activities, as well as specialist activities such as health and media. The Artarmon Industrial Area is uniquely located with high-quality access for medium and large vehicles, and with a substantial buffer between industry and residential uses. The area supports over 11,000 jobs, has low vacancy and high rents. It has an estimated contribution of $1.6 billion to the NSW economy each year.

The benefits of a station at this location are dependent on the realisation of urban renewal opportunities in the area. However, consultation with major stakeholders indicated that there was limited support for such a major land use change.

The importance of the wide range of industrial uses was recognised. The area would therefore retain its industrial uses, employment and services, resulting in a low demand for transport and a poor return on investment for a station in this area. The performance of an Artarmon Industrial Area Station was assessed against the project objectives (refer Figure 4.5). Given the high cost of construction of an underground station, and limited ability to serve and stimulate urban development and relieve the existing transport network, an Artarmon Industrial Station was not considered further.

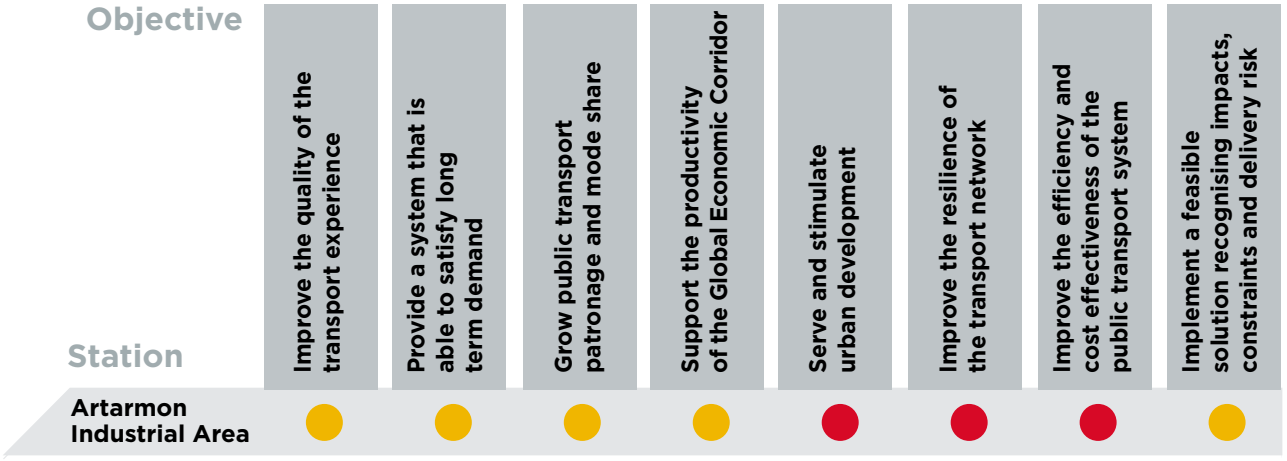


Figure 4.5 Performance of Artarmon Industrial Area Station against the project objectives

A station between Central and Sydenham

A long list of 12 station options was identified for the area between Central and Sydenham. An assessment of these station options against the project objectives was carried out (refer to Figure 4.6).

Based on the outcome of the assessment, the NSW Government decided to further consider two locations between Central and Sydenham (The University of Sydney and Waterloo).

The University of Sydney is located between Parramatta Road and City Road and close to other arterial roads such as Cleveland Street and Glebe Point Road. The university is a key education precinct and is also close to health and retail precincts such as Royal Prince Alfred Hospital and the Broadway shopping area.

A metro station at The University of Sydney would:

- Improve connections between the university, nearby precincts, and the Global Economic Corridor
- Increase access to rail services for the area's educational, health and retail / business precincts
- Support further development of the university to the south of City Road
- Generate all-day patronage
- Support The University of Sydney Campus Improvement Master Plan.

The NSW Government has earmarked Waterloo for greater residential development and urban renewal. Waterloo has been retained as a strategic option for a possible metro station.

People around Waterloo have traditionally relied on cars, buses and active transport (cycling and walking) as a transport solution. A new metro station at Waterloo would:

- Help revitalise the Waterloo precinct
- Provide a high quality connection with bus services along Botany Road
- Provide additional connectivity to Australian Technology Park

- Contribute to the NSW Government objective for greater residential development and urban renewal in Waterloo and Redfern
- Promote further development and expansion of the Global Economic Corridor between the Sydney CBD and Green Square.

The definition of a possible metro station at The University of Sydney or Waterloo is continuing, and the performance of each station location will be further considered against the project objectives. The environmental impact statement will provide further detail on the options assessment process for these station locations.

Outcomes of strategic options assessment

Based on the assessment of the strategic options against the project objectives, the NSW Government decided to:

- Include a station at Crows Nest rather than at the existing St Leonards Station
- Include an additional station at Barangaroo
- Not include a station in the Artarmon Industrial Area.

The NSW Government is continuing investigations and assessment of the relative performance of a potential station at either The University of Sydney or Waterloo.

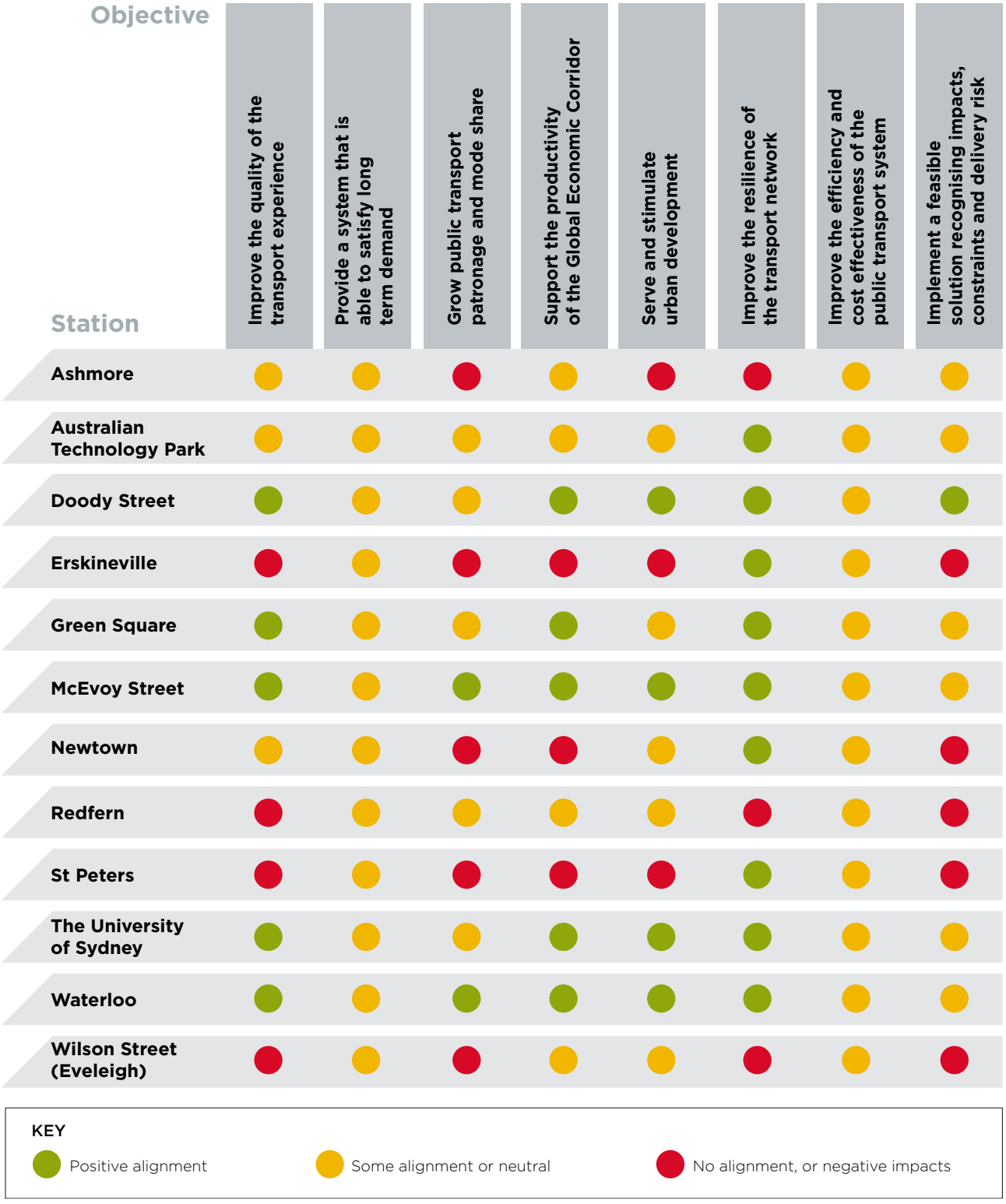


Figure 4.6 Performance of station options between Central and Sydenham against the project objectives

4.4 Alignment options

The alignment of the Chatswood to Sydenham project has been influenced by:

- Historical investigations (refer to Section 4.1)
- Station locations
- Design criteria such as vertical and horizontal alignment requirements
- A decision on a Sydney CBD east or Sydney CBD west alignment
- Avoidance of underground constraints such as deep basements and major utilities.

More recent alignment options (based on possible station location combinations) are shown in Figure 4.7.

4.4.1 Sydney CBD east vs Sydney CBD west alignment

A number of studies have focused on rail / metro alignments through the Sydney CBD. These have been separated into eastern and western options and hybrids of the two. As a result of these previous studies, two protected corridors have previously been created through the Sydney CBD – the CBD Rail Link corridor and the CBD Metro interim rail corridor.

Key issues considered in the selection of the alignment (in the context of metro rail system performance parameters) included the point of connection with the existing rail network in the north and south, and the preferred Sydney CBD station locations. As discussed in Section 4.3.3, given the flexibility of the metro tunnel alignment, the provision of a metro station in the central to northern part of Barangaroo was not an influencing factor in the selection of a Sydney CBD east or a Sydney CBD west metro alignment.

Both the CBD east and CBD west alignment options identified a combination of new and augmented existing stations:

- The eastern alignment included a new station at Martin Place and at Pitt Street (between Park and Bathurst streets) and an augmented Central Station
- The western alignment included an augmented Wynyard Station, a new City West Station (between Town Hall Station and Darling Harbour) and an augmented Central Station.

The evaluation process resulted in the eastern alignment being preferred based on a number of factors:

- The separation of the metro rail network from the existing rail network, especially at Wynyard Station (eastern alignment), means the project could accommodate long-term future demand (of up to 30 trains per hour in the morning peak across Sydney Harbour)
- The inclusion of a Wynyard metro station (western alignment) would increase pedestrian numbers and congestion within the Wynyard precinct beyond what would otherwise be expected in 2036; and by about 13,000 additional passenger exits in the morning peak hour
- Augmentation of existing operational stations (western alignment) would have substantial constructability issues and result in additional construction costs and an extended construction program (Central Station is the only station augmentation required for the Sydney CBD eastern alignment)
- New stations along the eastern alignment would provide better interchange opportunities (Martin Place Station with the T4 Eastern Suburbs Line, and Pitt Street Station with buses, light rail and Town Hall Station). These interchange opportunities would better relieve passenger demand at critical stations including Martin Place and Town Hall.

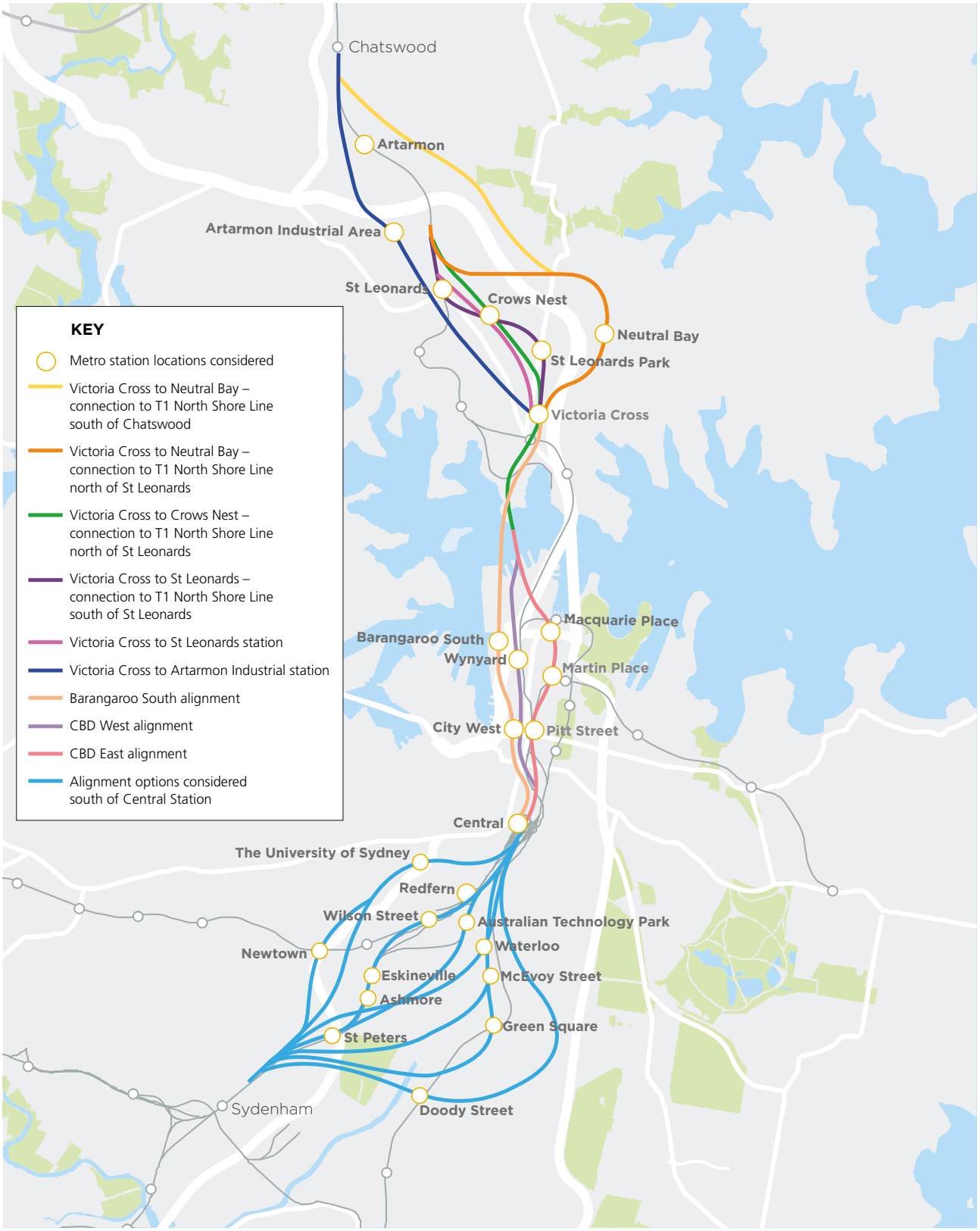


Figure 4.7 More recent indicative alignment options considered based on possible station location combinations

4.5 Crossing of Sydney Harbour

Aboveground and underground options were considered for crossing Sydney Harbour. These included:

- A new carriageway beneath the Sydney Harbour Bridge
- A new rail viaduct above lanes seven and eight of the Sydney Harbour Bridge
- Conversion of lanes seven and eight of the Sydney Harbour Bridge to accommodate metro rail
- An immersed tube tunnel resting on the seabed
- Bored tunnels below the seabed through rock
- Bored tunnel below the seabed through rock and sediments

4.5.1 Aboveground options

Options to install a new carriageway beneath the Sydney Harbour Bridge or to install a new viaduct above lanes seven and eight were found to have a number of constraints, such as impacts on (reductions to) shipping heights and / or substantial modification to the Sydney Harbour Bridge, which is a major landmark and a listed place on the National Heritage List. These options would also have broader network impacts during construction and operation (particularly in terms of access to the Sydney CBD for other transport modes). Consequently, these options were not progressed further.

The conversion of lanes seven and eight to accommodate the metro network would require connections to metro tunnel alignments to the north and south of the Harbour Bridge. Unlike the tunnel option (see below), use of the Sydney Harbour Bridge would require the use of existing suburban rail stations and platforms at North Sydney and Wynyard. The use of existing infrastructure for the project would largely result in replication of the existing T1 North Shore Line and would not provide additional rail services to new areas. Construction would result in substantial disruption of the T1 North Shore and Western Line services between Wynyard and Town Hall for the duration of the modification of the stations and tunnel south of Wynyard. Further, using existing infrastructure would have operational limitations; in particular, this option could not meet long-term capacity requirements (that is, there would be less than 30 trains per hour) and would result in longer journey times than a new tunnel. In addition, using the Sydney Harbour Bridge is estimated to cost substantially more than the preferred bored tunnel option (by over $400 million).

4.5.2 Underground options

Options investigated for underground crossing of Sydney Harbour included an immersed tube tunnel, bored tunnels through the bedrock and bored tunnel through a combination of bedrock and sediments. These options are shown on Figure 4.8.

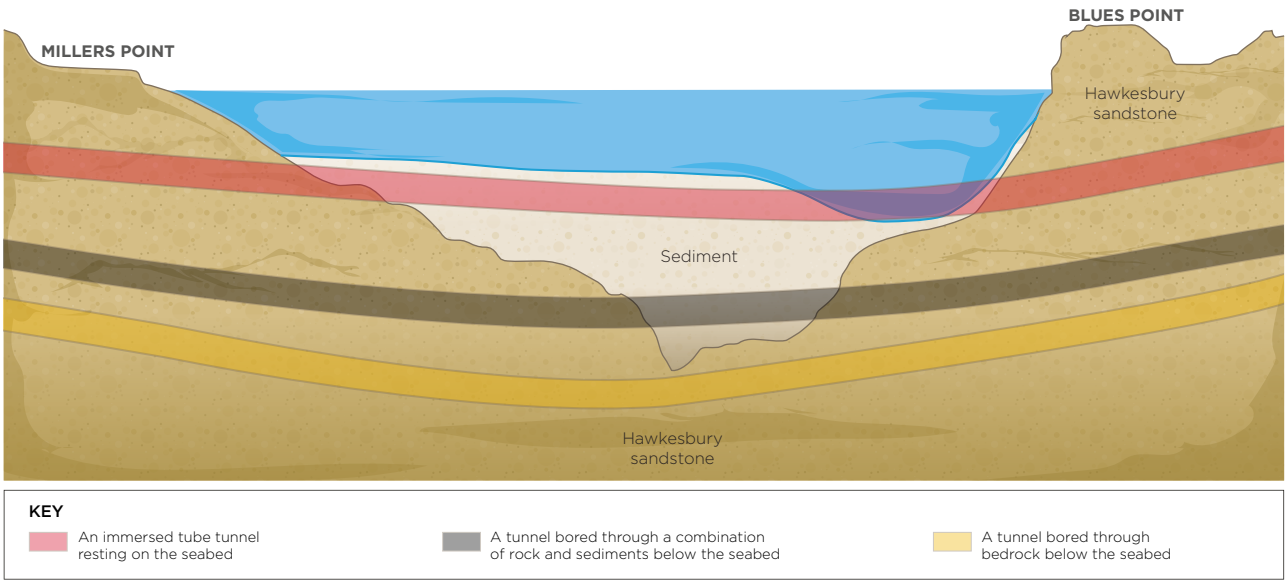


Figure 4.8 Sydney Harbour crossing vertical alignment options considered

A comparative assessment was carried out for these options which found:

- An immersed tube option is a favourable option in terms of station depth and tunnel gradient, but the likely environmental impacts associated with dredging and cofferdam construction in the harbour would be considerable, as compared with tunnel boring machine based solutions. Costs are also likely to be significantly higher than the bored tunnel options
- Given the depth to rock below the harbour, a tunnel bored entirely through rock would result in unacceptable station depths at Barangaroo and at Victoria Cross and / or unacceptable tunnel gradients
- A shallower tunnel involving tunnelling through rock and sediments would result in acceptable station depths. Whilst there would be some construction risks associated with tunnelling through sediments and transition zones from rock to sediment, they are considered to be manageable. The options for managing these transition zones from rock to sediment are discussed in Section 4.5.3.

4.5.3 Sydney Harbour sediment ground improvement options

The feasibility of a shallower tunnel below the harbour through rock and sediments was investigated further including advice from international tunnelling experts. Based on this advice it was considered:

- It would be practical to tunnel below Sydney Harbour through rock and sediments using either a traditional slurry tunnel boring machine or a mix-shield tunnel boring machine
- It would be important to consider ground treatment at the tunnel rock-sediment transition zones to prevent damage or excessive wear of cutter tools and provide an opportunity to inspect the tunnel boring machine cutter head prior to driving through the soft sediments. Ground treatment is likely to be required from above ground by methods such as jet grouting from barges in Sydney Harbour, however other ground improvement methods, including ground freezing and deep soil mixing, would also be considered further.

At this stage, the requirements for tunnelling and ground improvement are still under investigation in consultation with industry. Further details will be provided in the environmental impact statement.

4.6 Dive structures and tunnel portal options

4.6.1 Northern dive structure

Due to a number of factors, including topography, proximity of adjacent infrastructure, and engineering requirements, there are limited options for the dive structure location. However, three options were considered:

- A dive commencing south of St Leonards Station, transitioning into a tunnel north of River Road
- A dive commencing north of St Leonards Station adjacent to Naremburn Park, transitioning into a running tunnel north of Ella Street / Dalleys Road
- A dive commencing south of Chatswood Station, transitioning into a running tunnel north of Mowbray Road.

Given that Crows Nest has been identified as the secondary North Shore station for Sydney Metro, a dive south of St Leonards Station was discarded based on a number of factors including journey time impacts and vertical and horizontal alignment limitations (that is, the tunnel alignment could not meet design requirements and access a Crows Nest Station location).

Factors influencing the selection of the northern dive structure and tunnel portal location include:

- Extent of new tunnel versus existing rail line quadruplication and impacts on existing infrastructure and the extent of 'associated infrastructure' work required
- Interface with existing Sydney Trains and Sydney Metro Northwest operations
- Property impacts including the extent and type of property acquisition required
- Environmental constraints and potential community and business impacts
- Constructability considerations, including customer disruption associated with rail network impacts.

Given these factors, it was found that the preferred arrangement for the northern dive structure was to begin in the area south of Chatswood Station with a tunnel portal just north of Mowbray Road. This dive location is preferred because it would minimise acquisition of non-government property and would be superior to the option north of St Leonards Station on all other factors listed above. In addition, a dive south of Chatswood Station would:

- Avoid a complex construction interface around Artarmon Station, thereby avoiding substantial customer, community and business impacts in Artarmon
- Avoid direct impacts on the heritage listed Artarmon Station and Artarmon Heritage Conservation area
- Avoid impacts on Blue Gum High Forest (a critically endangered ecological community listed on the *NSW Threatened Species Conservation Act* and *Environment Protection and Biodiversity Conservation Act*) that is located next to (and east) of the rail line between Artarmon Station and the Gore Hill Freeway
- Reduce the extent of noise walls required along the existing rail corridor by over one kilometre.

4.6.2 Southern dive structure

Options for the location of a southern dive structure and tunnel portal close to Central Station are limited by:

- Suitable available land within and adjacent the existing suburban rail corridor (between Central and Sydenham stations) to accommodate additional tracks
- Maximum allowable vertical track grades (which influence the length of transition of the tunnel from an underground station at Central to the surface).

Surface track options would require widening and significant property acquisition adjacent to the existing rail corridor to accommodate the additional tracks and other infrastructure including noise walls.

A tunnel option is preferred over a surface option as it would considerably reduce direct and indirect impacts on properties adjacent to the existing rail corridor (such as property acquisition, noise and vibration from surface rail operations and visual amenity impacts associated with new overhead wiring and rail infrastructure). The dive structure and portal location in the area to the north of Sydenham Station would:

- Allow for the desired alignment and future conversion of the T3 Bankstown Line to a metro service
- Minimise property acquisition
- Enable the efficient integration of the Metro network into the existing rail corridor.

4.7 Consequences of not proceeding with the project

Demand on much of Sydney's rail network is nearing capacity during the morning and evening peak periods.

In particular, demand on the T1 North Shore, Northern and Western Line already exceeds capacity and is forecast to grow over the next 20 years. Patronage will continue to grow as land is released or rezoned along the Sydney Metro Northwest corridor. Changes in patronage growth will exacerbate crowding at Chatswood Station and on the T1 North Shore, Northern and Western Line. When Sydney Metro Northwest opens in 2019, the T1 North Shore, Northern and Western Line will be operating almost at capacity during the morning peak period, with customers on individual services experiencing crowded conditions.

By 2026 demand for rail transport will grow by 83,900 trips to a total of 249,000 trips in the morning peak (representing a 51 per cent increase in travel demand). The existing transport system cannot provide the capacity to accommodate this forecast growth:

- The road and bus networks are already heavily constrained and cannot be effectively augmented to accommodate the additional capacity required
- Sydney's rail network is complex and becoming more crowded and more unreliable.

Even with the additional services provided by Stages 1 and 2 of Sydney's Rail Future (refer Section 4.2.3), the rail network will run out of capacity at some point during the mid to late 2020s.

To ensure continued growth in productivity, cater for forecast employment and population growth, and sustain the city's liveability, Sydney's transport capacity will need to substantially increase. This is particularly important given the leading role Sydney plays in the Australian economy.

5 Project description

This chapter describes the project including the metro operations, key features of the alignment, the proposed stations and other ancillary infrastructure. An outline of the construction works is also provided. The project components are subject to further design and changes or clarifications may be made during the ongoing design development and community consultation processes.

5.1 Overview and key components

The Chatswood to Sydenham project (the project) involves the construction and operation of a metro rail line, around 16 kilometres in length, between Chatswood and Sydenham.

The proposed corridor identifies the area within which the tunnels may be located. Indicative corridor maps are provided in Appendix B.

The indicative project alignment and proposed station locations are shown on Figure 5.1 to Figure 5.3. The design will be further defined during the development of the environmental impact statement. The key components include:

- About 15 kilometres of twin rail tunnels (that is, two tunnels located side-by-side) between Mowbray Road, Chatswood and Bedwin Road, Marrickville
- About 250 metres of aboveground metro tracks between Chatswood Station and the northern dive structure
- A northern dive structure (about 400 metres in length) and tunnel portal south of Chatswood Station and north of Mowbray Road, Chatswood
- A southern dive structure (about 400 metres in length) and tunnel portal north of Sydenham Station and south of Bedwin Road, Marrickville
- New metro stations at Crows Nest, Victoria Cross, Barangaroo, Martin Place and Pitt Street, as well as new underground platforms at Central Station
- Underground pedestrian links and connections to other modes of transport (such as the existing suburban rail network) and surrounding land uses
- Realignment of T1 North Shore Line surface track within the existing rail corridor between Chatswood Station and Brand Street, Artarmon, including a new bridge for a section of the 'down' (northbound) track to pass over the proposed northern dive structure
- Permanent closure of the road bridge at Nelson Street, Chatswood, and provision of double right-turn lanes from the Pacific Highway (southbound) into Mowbray Road (westbound)
- Modification (including protection) of the road bridge at Mowbray Road, Chatswood to accommodate the reconfigured T1 North Shore Line track arrangement
- Services within each of the stations, including mechanical and fresh air ventilation equipment and electrical power substations
- Alterations to pedestrian and traffic arrangements and public transport infrastructure around the new stations and surrounding Central Station
- A substation (for traction power supply) at Artarmon
- A services facility (for traction power supply and an operational water treatment plant) adjacent to the southern dive structure

- Installation and modification of existing Sydney Trains rail systems including overhead wiring, signalling, access tracks / paths, rail corridor fencing and noise walls, within surface sections either end of the project at Chatswood and Sydenham
- Removal of the existing Sydney Trains maintenance access point from Hopetoun Avenue, Chatswood
- Provision of a shared Sydney Trains and Sydney Metro maintenance access point from Brand Street, Artarmon on the Down (western) side of the T1 North Shore Line
- Provision of maintenance access stairs from Albert Avenue, Chatswood to an existing Sydney Trains signalling box located on the eastern side of the rail corridor immediately south of Chatswood Station
- Temporary ancillary facilities to support the construction of the project.

In addition to the above project components, a new metro station at either The University of Sydney or Waterloo with provision for turnback facilities is also being investigated and may form part of the project scope assessed in the environmental impact statement. The project does not include any changes to Sydenham Station, which will be subject to a separate assessment in the future as part of the proposed Sydney Metro Sydenham to Bankstown upgrade project.

5.2 Metro operations

The fully automated Sydney Metro would deliver a step-change in the capacity and customer experience of Sydney's transport network, with a high capacity, turn-up-and-go service consistent with customer expectations. It would operate every day of the year and would stop at all stations along the metro line. The metro trains would operate independently from the existing suburban rail network with a high reliability.

As part of the future Sydney metro network, at opening the project would operate as six-car trains. The project could operate between Chatswood and either Waterloo or The University of Sydney. As demand increases, these could be increased to eight-car trains, and service frequency could be increased. The ultimate operational capacity of the Sydney Metro network would be for 30 trains per hour in each direction through Sydney's CBD.

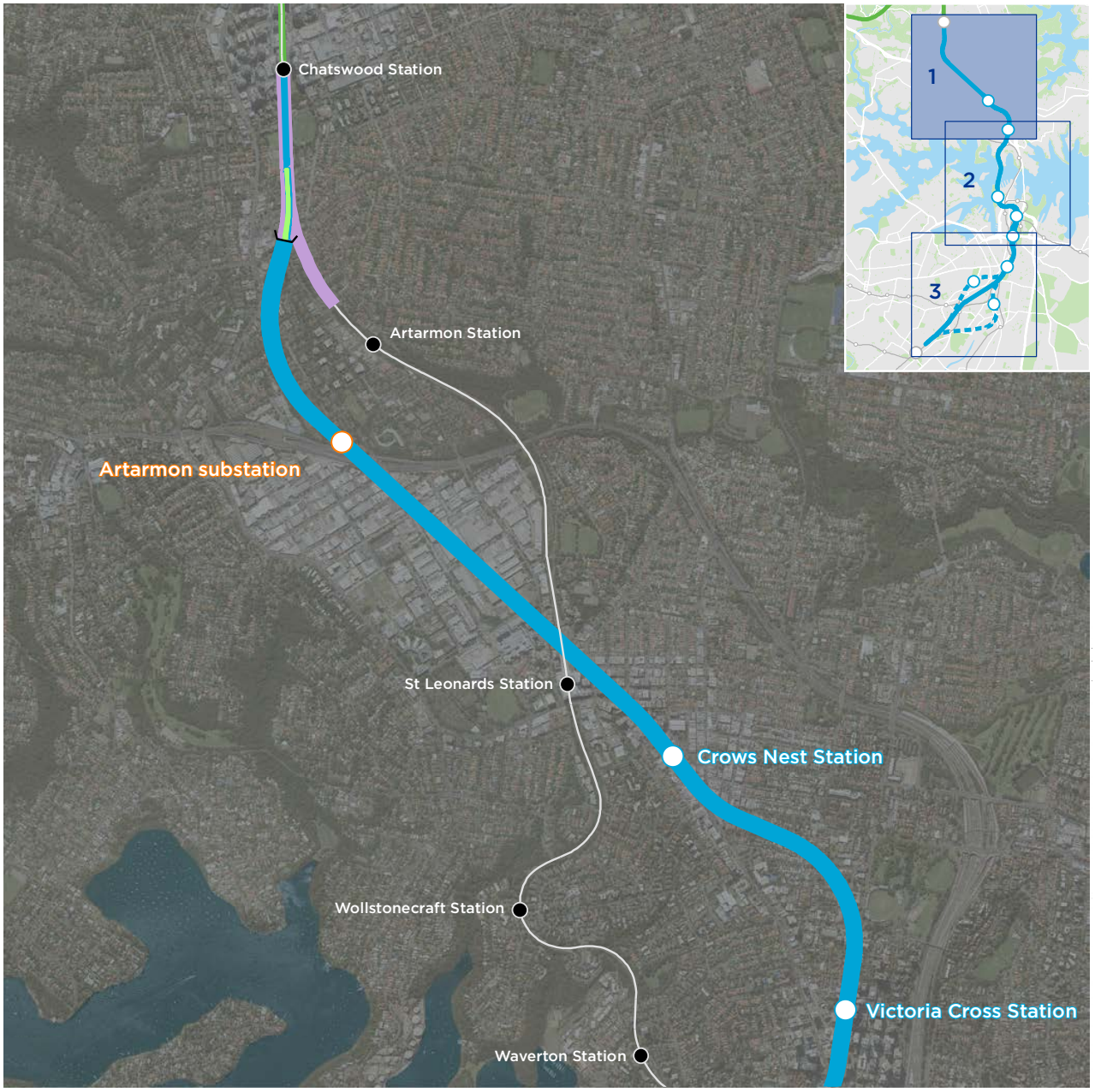


Figure 5.1 The project – Map 1

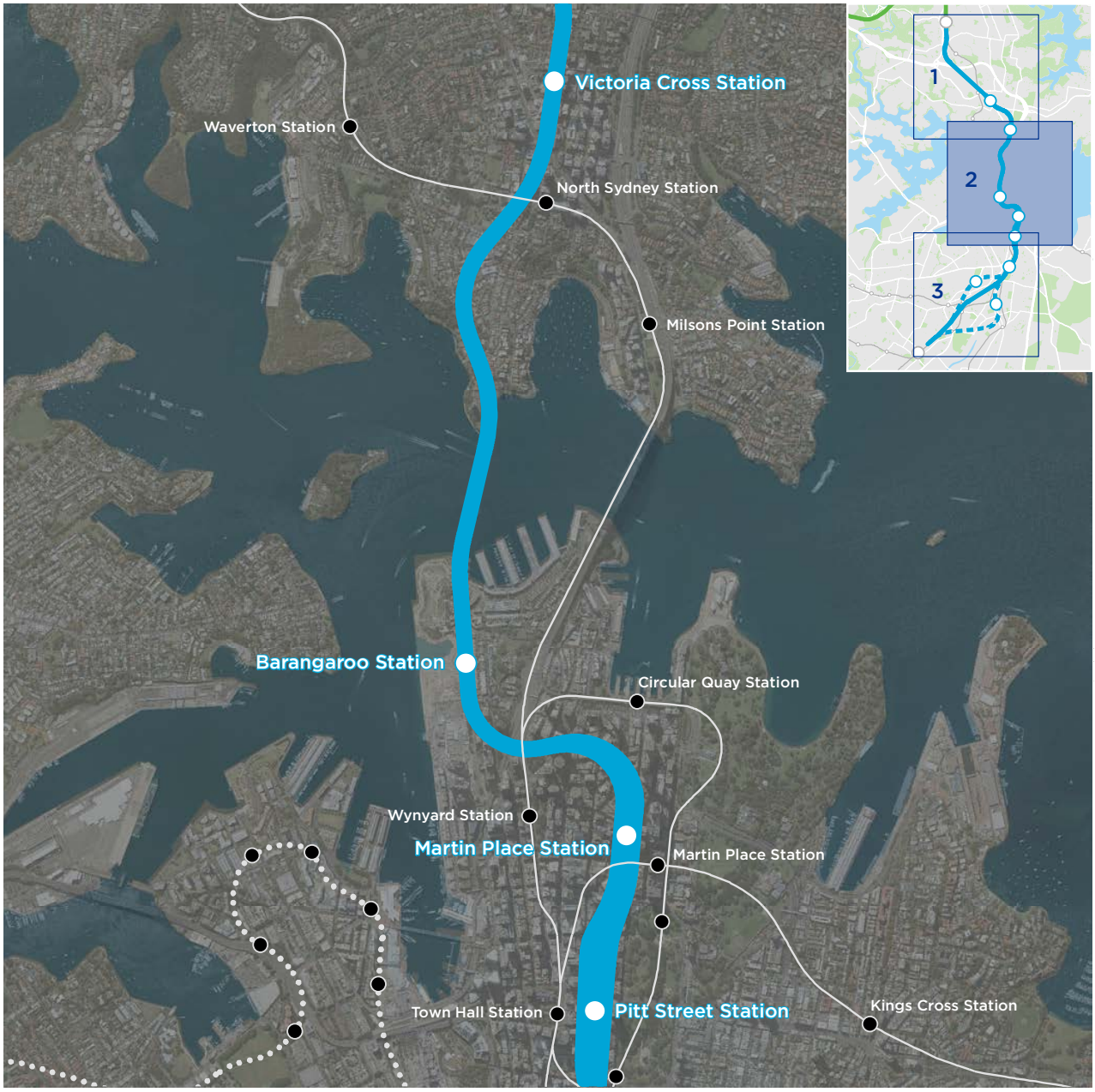


Figure 5.2 The project – Map 2

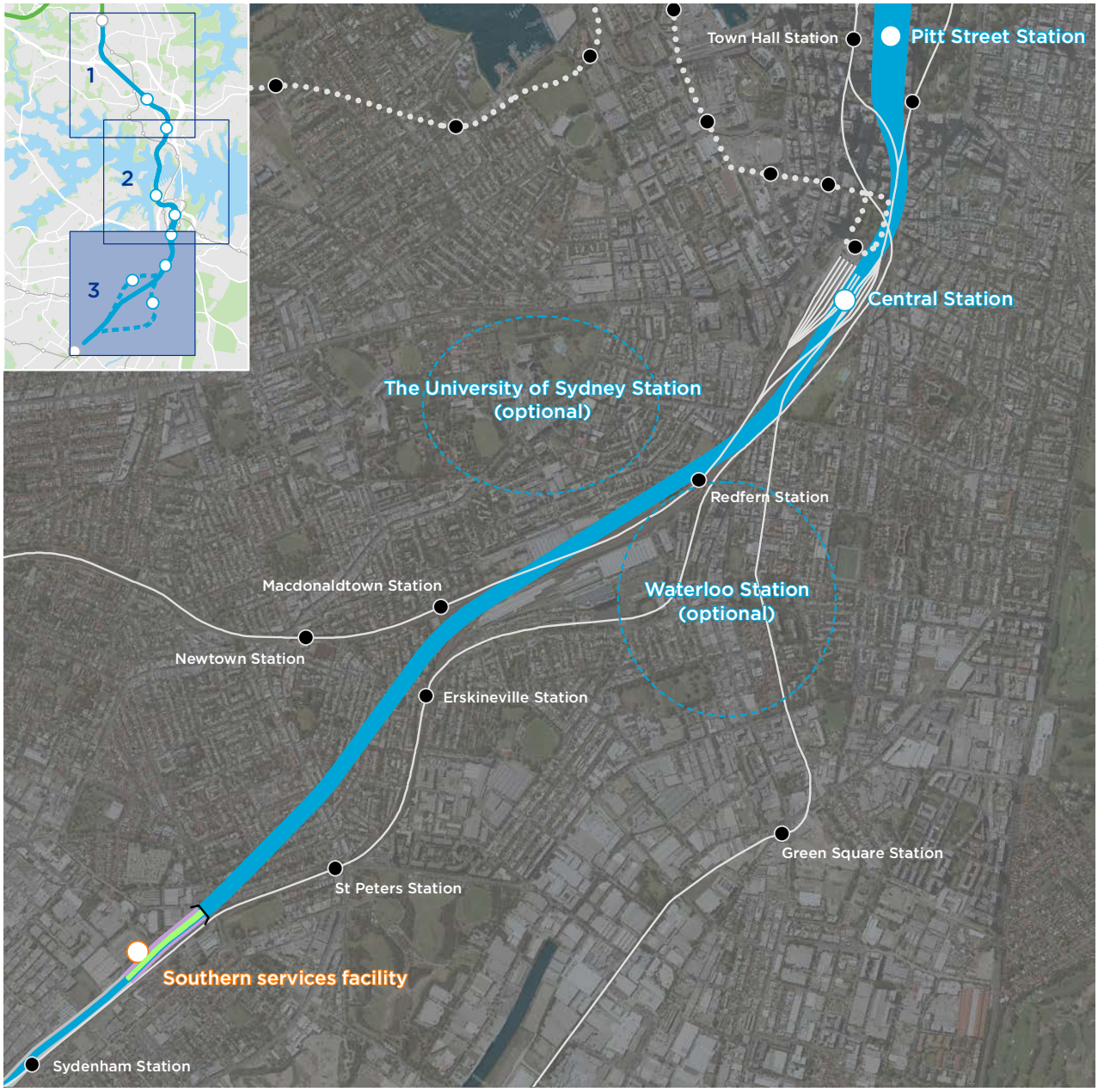


Figure 5.3 The project – Map 3

5.2.1 Hours of operation

Once the Sydney Metro network is operating, the first metro service to depart Cudgegong Road Station (Sydney Metro Northwest) and Bankstown Station (Sydenham to Bankstown upgrade) would arrive at Central Station early mornings and the last metro service to arrive at Cudgegong Road and Bankstown stations would depart Central Station late at night. To accommodate for planned special events, the operating hours could be extended.

The final operating hours would be determined by the operator as part of the development of the services schedules for the project.

5.2.2 Train types

All trains would be new, single-deck metro trains. The new-generation trains would deliver a fast, safe and reliable journey for customers with high performance standards and good customer amenities including air conditioning; emergency help points; provision of accessible priority seating for those with a disability or using a wheelchair or mobility device, the elderly or those travelling with a pram or luggage; ability to transport bicycles; efficient seating and standing arrangements for access and alighting the metro; and provision of clear transport information whilst on board the metro.

The Sydney Metro network would be able to carry more passengers per hour than would be the case with double-deck trains. This is because single-deck trains allow customers to get on and off at stations more efficiently and faster than double-deck trains which reduces dwell times (the time a train is stopped at a station). The modern signalling technology is also more efficient for running the trains by providing fully automated trains and less dwell times at stations, which would increase the capacity of the metro network.

An artist's impression of the type of train proposed is provided as Figure 5.4. The key features of these trains include:

- Six air-conditioned carriages, with eight-carriage trains to be introduced as demand increases
- Three doors per side per carriage, allowing fast boarding and alighting
- A mixture of seating arrangements and provision for customers in wheelchairs
- Priority seating for mobility impaired, the elderly and people with prams
- Level access between the platform and train.

Figure 5.4 Artist's impression of a metro train

5.3 Alignment

5.3.1 Dive structures and tunnel portals

The northern dive structure would commence about 250 metres south of Chatswood Station and the tunnel portal would be located immediately to the north of Mowbray Road, Chatswood.

The southern dive structure would commence about 400 metres north of Sydenham Station and the tunnel portal would be located in the suburb of Marrickville about 840 metres north of Sydenham Station (immediately south of Bedwin Road).

Both dive structures would comprise an initial length of open section, which would then transition to a cut-and-cover tunnel portal.

5.3.2 Tunnel alignment

The twin underground metro rail tunnels would extend about 15 kilometres from the northern tunnel portal in Chatswood to the southern tunnel portal in Marrickville. The alignment is shown in Figure 5.1 to Figure 5.3.

The proposed tunnel alignment was guided primarily by the general location of metro stations. The alignment was then refined by the functional requirements of a metro network and the specific constraints of station design, namely:

- The location, depth and platform configurations of preferred metro stations
- A maximum vertical grade of about 4.5 per cent
- Station platforms located along a straight and level section of track (that is, a zero per cent grade)
- Tunnel depth to, where possible, provide suitable competent rock cover above the tunnel crown (the top surface of the tunnel structure) to minimise the requirement for ground support
- Appropriate curvature to, where possible, accommodate a train operating speed of 100 kilometres per hour. Tighter radius curves have been adopted at some locations for a number of reasons, including to avoid subsurface constraints such as building basements and foundations
- The vertical and horizontal alignment across Sydney Harbour has been optimised to respond to a number of physical constraints, including major submarine utilities, services and structures; shipping channel requirements; and to ensure acceptable depths of stations at Barangaroo and Victoria Cross.

The alignment was also influenced by a number of environmental factors. In particular, there is a need to:

- Locate the southern dive structure in a way that would avoid potential impacts on a TransGrid 132 kilovolt (kV) underground cable and minimise impacts on Sydney Trains operations
- Set the transition between surface and tunnel dive structures and the entries to underground stations and facilities at or above the probable maximum flood level to minimise the potential of floodwaters entering the tunnel during flood events
- Avoid known built form constraints including existing buildings, basements, utilities, infrastructure (including other rail and road infrastructure)
- Minimise direct impact on property.

5.3.3 Key tunnel and underground track features

The metro rail tunnels would have a circular cross-section with a clear internal lined diameter of about six metres, and would accommodate the metro trains which will operate on Sydney Metro Northwest.

The tunnels would be lined with pre-cast concrete segments to ensure the long-term life of the tunnels and to minimise groundwater ingress. In addition to space for the trains and tracks, the tunnels would provide space for other equipment and services including rail signalling, controls and communication, overhead traction power, fresh air ventilation, fire and life safety systems, lighting and drainage.

An indicative cross-section of the underground tunnel is shown in Figure 5.5.

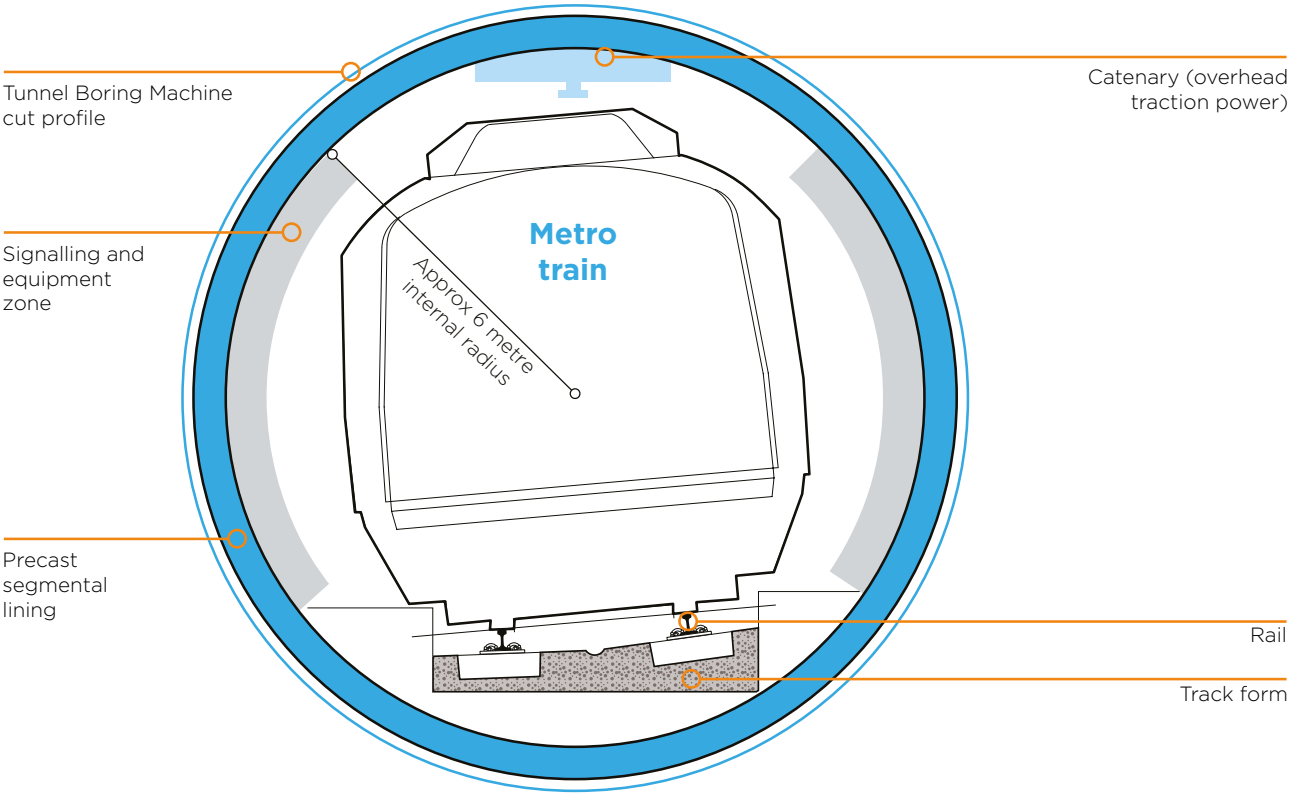


Figure 5.5 Indicative cross-section of a metro tunnel

5.3.4 Key surface track features

Metro tracks

Metro tracks would be installed at the surface for about 250 metres south from Chatswood Station to the northern dive structure within the centre of the T1 North Shore Line corridor (with the T1 North Shore Line tracks located to the outside (either side) of the metro tracks). These metro tracks would connect with Sydney Metro Northwest at Chatswood Station. The connection of the metro tracks to Sydenham Station would be subject to a separate assessment as part of the Sydenham to Bankstown upgrade project.

The surface tracks would generally be placed on ballast with concrete sleepers.

The rail gauge would be the same as the existing rail gauge on Sydney's rail network.

Suburban rail tracks

Adjustment to the T1 North Shore Line tracks and rail systems would be required between the southern end of Chatswood Station and in the vicinity of Brand Street, Artarmon to accommodate the metro surface tracks and northern dive structure.

Between Chatswood Station and the northern dive structure and tunnel portal (near Mowbray Road), the existing T1 North Shore Line tracks would be re-located to the outside of the metro tracks in a widened rail corridor, within existing rail corridor zoned land.

To accommodate the new metro tracks, the dive structure and tunnel portal, the existing T1 North Shore Line 'Down' (northbound) track would be relocated to the west and would pass over the dive structure on a bridge.

The operation of the T1 North Shore Line would continue to be managed by Sydney Trains.

5.4 Stations

New underground metro stations would be located at Crows Nest, Victoria Cross, Barangaroo, Martin Place, and Pitt Street, with new underground metro platforms at Central Station. The potential for an additional station between Central and Sydenham at either The University of Sydney or Waterloo is currently being investigated.

5.4.1 Preliminary design principles for metro stations

The preliminary design principles to guide the design of the stations are in Table 5.1. The design principles would be further developed and identified in the environmental impact statement.

Table 5.1 Preliminary station design principles

Station aspect	Design principles
 **Functionality and access**	Quick and efficient transfer between metro and other transport modes is critical to station design. Station design would be guided by an 'access for all' philosophy. Stations would be designed using 'priority of access' principles, with pedestrians and cyclists first, followed by buses, taxis and 'kiss and ride' customers. Station design includes emergency exit and access facilities, such as lifts, escalators and fire stairs to allow for customer evacuation and emergency services access. The Sydney Metro network would be integrated into the Opal electronic ticketing system.
 **Customer information and wayfinding**	Customer information and wayfinding using the following guiding principles: • Customers would be provided with accurate, comprehensive, consistent and real-time multimodal information during multiple phases of their trip (ie before their trip, at the station and aboard the train) • Real-time information would be delivered to customers through multiple media to make transit journeys as seamless and convenient as possible • The NSW Government would work with councils to develop an easy, intuitive and consistent wayfinding system that facilitates efficient customer movements to, from and through stations.

Station aspect	Design principles
 **Safety**	The safety of customers, staff and areas surrounding stations has been considered in station design in accordance with 'crime prevention through environmental design' principles. Well-designed and efficiently controlled lighting systems, visible closed circuit television (CCTV) surveillance and appropriate staffing during operational hours would contribute to safe station environments. Passive station design elements that promote safety would include clear visibility lines in and around stations and the use of natural daylight and adequately wide paths to avoid blind spots.
 **Customer comfort**	Escalators, platforms, passageways, mezzanines and concourses would be designed to accommodate maximum customer flows and avoid and manage overcrowding and queuing during peak periods. The station and public access areas would be designed to be aesthetically pleasing and include public art and landscaping (where appropriate) and would also maximise the use of natural daylight. The design would also protect customers from weather (covered access paths, waiting shelters etc) at stations and also at interchange areas. Furniture on station platforms would be minimised to reduce clutter, however options would be provided to cater for a range of customers including seating and standing spaces.
 **Fresh air ventilation**	Effective natural ventilation and supplementary mechanical ventilation systems would ventilate underground areas of stations. A number of service buildings (including at-surface ventilation outlets) would be required within each station precinct. Stations would also provide a separate fresh air ventilation system for the tunnels. The fresh air ventilation systems would be designed to meet the criteria for normal, congested and emergency operating scenarios.
 **Provision for retail areas**	Each station location would include space for retail outlets that meet customer needs (eg café, newsagent, drycleaner, etc). Shops and service facilities in or near stations and interchanges result in additional activity in the area, which contributes to the provision of passive surveillance of public areas and, therefore, greater safety.
 **Sustainability**	Sustainability measures at stations would include (where feasible) the use of natural light; solar panels; collection, treatment and storage of rainwater for reuse; passive ventilation and shading; the use of durable and low maintenance materials; and energy-efficient lighting (including demand-controlled lighting in plant and staff areas).
 **Provision for potential above station development** (subject to separate future approvals)	Typical examples of the infrastructure requirements of above station development would include structural support, provision of adequate space for building foyers and entrances, lift wells, and building service requirements. Elements incorporated into the project design for the purposes of making provision for future above station development will be identified and assessed as part of the environmental impact statement.

The preferred locations of the proposed new stations are explained below. These locations are indicative and will be refined during ongoing design development. There may be the need to change the locations or configurations to respond to issues which are considered during ongoing design development and community consultation.

5.4.2 Crows Nest

The preferred location of Crows Nest Station is between the Pacific Highway and Clarke Lane (eastern side of the highway) and between Oxley Street and south of Hume Street (Figure 5.6). It would be strategically located to the south of the existing station at St Leonards and close to the entertainment and retail strip along Willoughby Road.

Station strategy

Crows Nest Station would support the St Leonards specialised centre as a southern gateway to commercial and mixed use activities. The station would also improve access to the restaurants and specialist shops in the Crows Nest village.

The station strategy for Crows Nest would:

- Create a new transport focus on the southern side of the St Leonards specialised centre
- Maximise legibility and connectivity with the local urban structure
- Integrate the station with local improvement plans and make a positive contribution to the sense of place.

The key features of Crows Nest Station are provided in Table 5.2.

Table 5.2 Crows Nest Station key features

KEY FEATURES

Customers

- Existing residents within walking and cycling distance
- Visitors and patrons accessing the entertainment and retail strip along Willoughby Road
- Existing employment area extending along Willoughby Road, Christie Street and the Pacific Highway

Station entry/egress

- Near the corner of Hume and Clarke Street
- Near the corner of Pacific Highway and Oxley Street

Centre type	Transport interchange	Platform depth	Provision for potential future above station development (subject to seperate future approvals)
SC Strategic centre	Bus, Taxi, Kiss-&-Ride	25m	✓

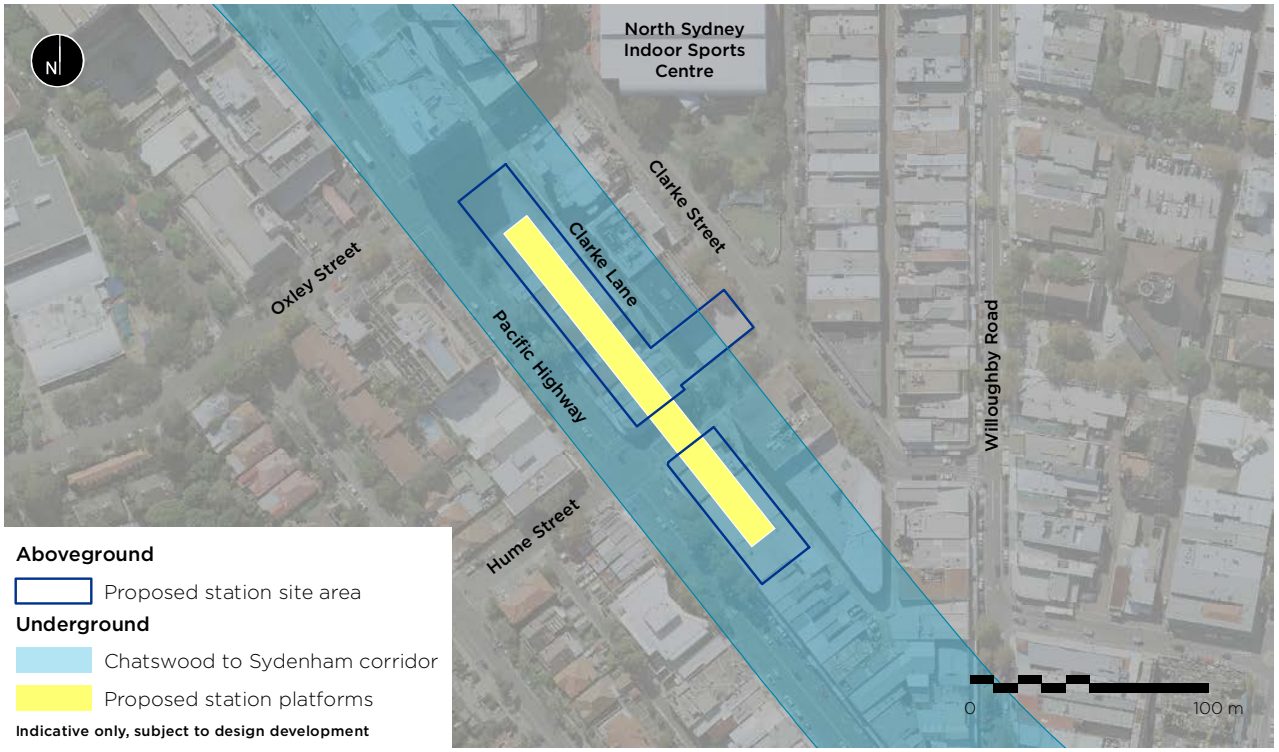


Figure 5.6 Crows Nest Station

5.4.3 Victoria Cross

The preferred location of the underground Victoria Cross Station is beneath Miller Street (to the north of the Pacific Highway) between McLaren Street and south of Berry Street (Figure 5.7). It would be strategically located within the North Sydney Commercial Centre and close to a number of educational institutions (including the Australian Catholic University and Northern Sydney Institute of TAFE Bradfield Campus) and mixed employment areas along Miller Street, Walker Street and the Pacific Highway.

Station strategy

A metro station at Victoria Cross would support the continued growth of the North Sydney CBD as an integral part of Global Sydney. The new station would improve customer experience at the existing North Sydney Station by relieving demand in peak times.

The station strategy for Victoria Cross would:

- Create a new transport focus in the North Sydney CBD
- Contribute to the attractiveness of the North Sydney CBD by adding to and integrating with the public domain
- Improve the permeability of the immediate station context.

The key features of Victoria Cross Station are provided in Table 5.3.

Table 5.3 Victoria Cross Station key features

KEY FEATURES			
Customers Customers travelling to nearby employment, education and residential precincts **Station entry/egress** From Miller Street to the south of Berry Street			
Centre type GC Global Sydney (North Sydney CBD)	**Transport interchange** Bus Taxi	**Platform depth** 31m	**Provision for potential future above station development** (subject to seperate future approvals) ✓

Figure 5.7 Victoria Cross Station

5.4.4 Barangaroo

The preferred location of the underground Barangaroo Station is beneath the northern end of Hickson Road (Figure 5.8). It would be strategically located with a station entrance within the 'Central Barangaroo' precinct, providing immediate access to commercial, mixed use (residential and commercial) and entertainment areas within the Barangaroo development. A station at Barangaroo would also service a residential catchment at Millers Point, Walsh Bay and future residents at Barangaroo.

Station strategy

The Barangaroo Station would improve accessibility to Barangaroo and the Walsh bay Arts and Culture precinct.

The station strategy for Barangaroo would:

- Maximise connectivity and legibility to the primary uses within and near the Barangaroo precinct
- Ensure legible and direct access to Barangaroo Reserve and Barangaroo Ferry Hub
- Integrate with the development plans for Barangaroo.

The key features of Barangaroo Station are provided in Table 5.4.

Table 5.4 Barangaroo Station key features

KEY FEATURES			
Customers • Customers travelling to nearby employment, recreation and tourist precincts • Customers travelling to and from nearby existing and future residential areas **Station entry/egress** • Within the Barangaroo Development area			
Centre type GC Global Sydney (Sydney CBD)	**Transport interchange** Bus Taxi Ferry	**Platform depth** **To be advised**	**Provision for potential future above station development** (subject to seperate future approvals) ✓

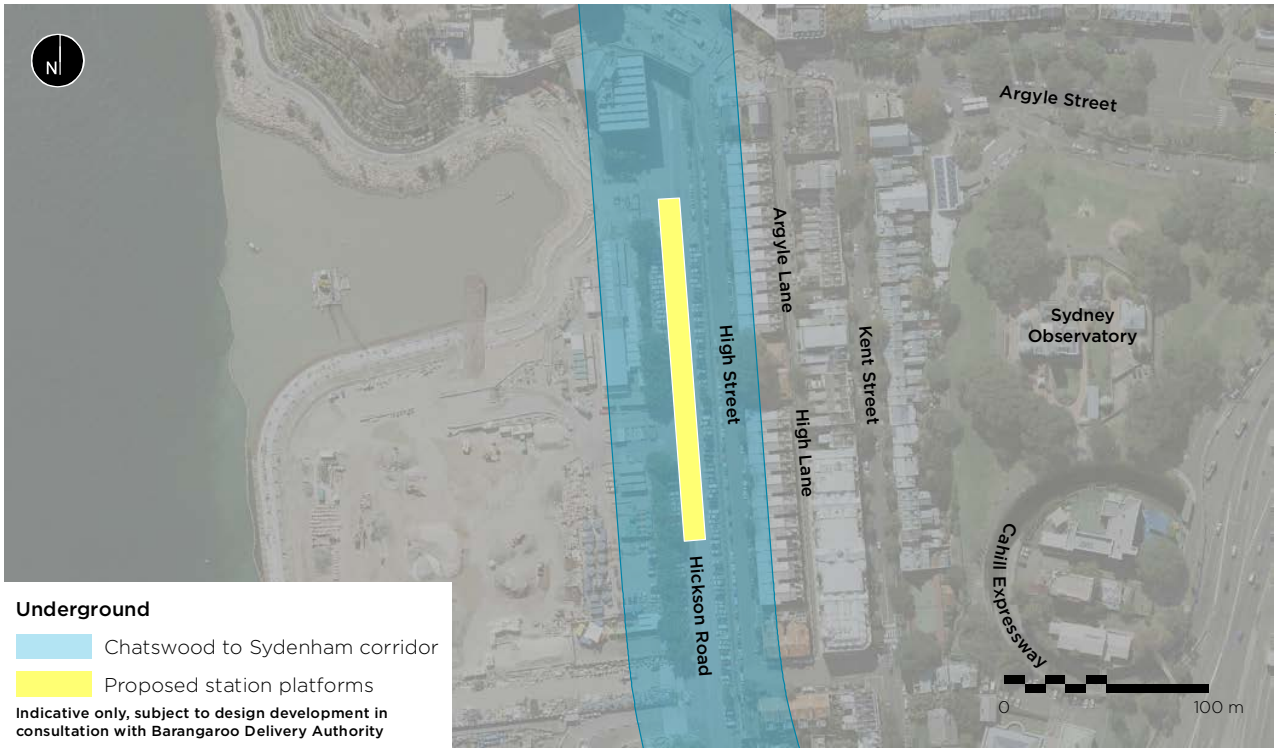


Figure 5.8 Barangaroo Station

5.4.5 Martin Place

The preferred location of the underground Martin Place Station is to the south of Hunter Street between Castlereagh and Elizabeth Streets (Figure 5.9). The metro station would be integrated with the existing Martin Place suburban rail station and strategically located close to Sydney's financial district, the Macquarie Street civic precinct, the Pitt Street retail zone and Martin Place (Sydney CBD's primary east-west pedestrian corridor).

Station strategy

A metro station at Martin Plan would serve Sydney's high-end commercial and financial district, the Macquarie Street precinct and the George Street retail zone.

The station strategy for Martin Place would:

- Reflect the significance of Martin Place and flagship status of the station by designing clear, legible, iconic, integrated entries
- Provide generous space for customers in a busy pedestrian environment by extending the public domain into to station entries
- Efficient interchange in the centre of the Sydney CBD through convenient, direct connections to the existing T4 Eastern Suburbs and Illawarra line platforms
- Integrate with the public domain and transport access improvements.

The key features of Martin Place Station are provided in Table 5.5.

Table 5.5 Martin Place Station key features

KEY FEATURES

Customers

- Customers travelling to nearby employment, civic, commercial, retail and entertainment precincts
- Customers interchanging to and from metro services and other modes of transport

Station entry/egress

- Near the corner of Castlereagh and Hunter Street
- Near the corner of Elizabeth and Hunter Street
- Near the south-eastern corner of Martin Place and Castlereagh Street

Centre type

GC

Global Sydney (Sydney CBD)

Transport interchange

Bus, Taxi, Light rail, Suburban rail

Platform depth

25–27m

Provision for potential future above station development (subject to seperate future approvals)

✓

Figure 5.9 Martin Place Station

5.4.6 Pitt Street

The preferred location of the underground Pitt Street Station is between Pitt and Castlereagh streets, north of the Park Street intersection and south of Bathurst Street intersection (Figure 5.10). It would be strategically located at the junction of Sydney's southern CBD and the midtown retail precinct and close to the mixed employment, residential, entertainment, cultural and events-based activities within the southern Sydney CBD and Chinatown. A station at Pitt Street would also service the residential catchment within the southern Sydney CBD.

Station strategy

A metro station at Pitt Street would serve the retail centre of the Sydney CBD on George and Pitt Streets, the civic and entertainment uses on George Street and the emerging southern Sydney CBD residential developments between Park Street and Belmore Park.

The station would be an opportunity to improve the public realm of the Park Street gateway to the CBD.

The station strategy for Pitt Street would:

- Provide generous space for customers in a busy pedestrian environment by extending the public domain into the station entries
- Integrate with the Sydney City Centre Access Strategy and other Sydney CBD planning
- Anticipate connections to a future Town Hall Square and other nearby developments
- Create a new transport focus along Park Street, near Pitt Street.

The key features of Pitt Street Station are provided in Table 5.6.

Table 5.6 Pitt Street Station key features

KEY FEATURES			
Customers • Customers travelling to mid-town retail, employment and entertainment precinct **Station entry/egress** • North-eastern corner of Pitt and Park Street • Northern side of Park Street between Pitt and Castlereagh Street • Southern side of Bathurst Street between Pitt and Castlereagh Street			
Centre type GC Global Sydney (Sydney CBD)	**Transport interchange** Bus, Taxi, Light rail Suburban rail	**Platform depth** 17–20m	**Provision for potential future above station development** (subject to seperate future approvals) ✓

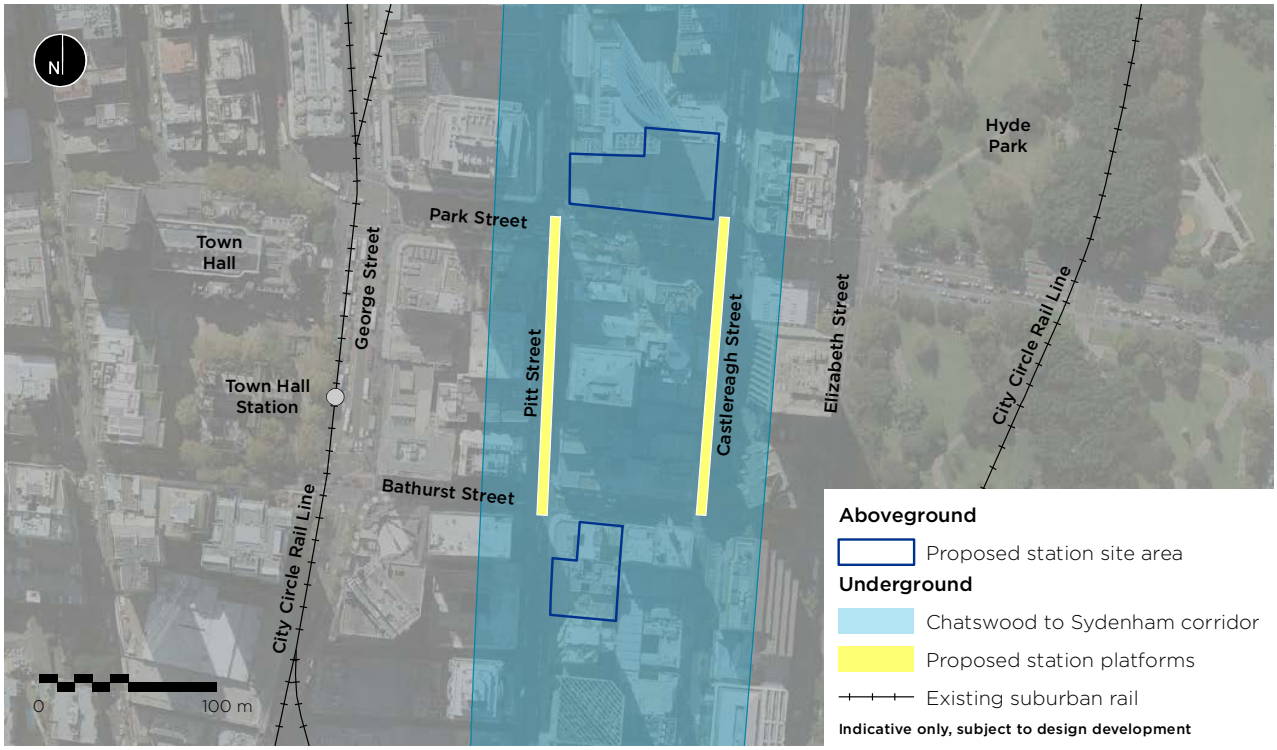


Figure 5.10 Pitt Street Station

5.4.7 Central

The preferred location of Sydney Metro underground platforms is within the existing Central Station precinct, with the two new underground metro platforms situated below suburban rail service platforms 13, 14 and 15 (Figure 5.11). The location of the two new underground metro platforms at Central would facilitate a critical interchange with intercity and suburban rail services, light rail and bus services. To provide access for Sydney Metro and Sydney Trains once the project is operational, an access bridge for maintenance vehicles would be provided from Regent Street to 'Sydney Yard', located between the suburban and intercity rail lines.

Station strategy

The new underground metro platforms at Central Station would have a major interchange role with suburban and intercity trains, light rail, buses and coaches.

Metro platforms at Central Station would provide access to retail and mixed use precincts in the locality including Haymarket, Chinatown, Central Park, Surry Hills and to educational facilities including the University of Technology Sydney and the University of Notre Dame, Australia.

The strategy for Sydney Metro underground platforms at Central Station would:

- Provide a high quality interchange environment linking customers to other public transport services
- Respect the heritage significance of the Central Station precinct
- Integrate with the Sydney City Centre Access Strategy and the Central Station Blueprint
- Support connectivity with major destinations and developments in the locality.

The key features of Sydney Metro at Central Station are provided in Table 5.7.

Table 5.7 Central Station platforms key features

KEY FEATURES			
Customers • Customers travelling to nearby employment, education and entertainment precincts • Customers interchanging to and from metro services and other modes of transport **Station entry/egress** • Via the existing main northern concourse at Central Station	**Centre type** GC Global Sydney (Sydney CBD)	**Transport interchange** Bus, Taxi, Kiss-&-Ride Intercity, Suburban & Light rail	**Platform depth** 16m	**Provision for potential future above station development** (subject to seperate future approvals) ✗

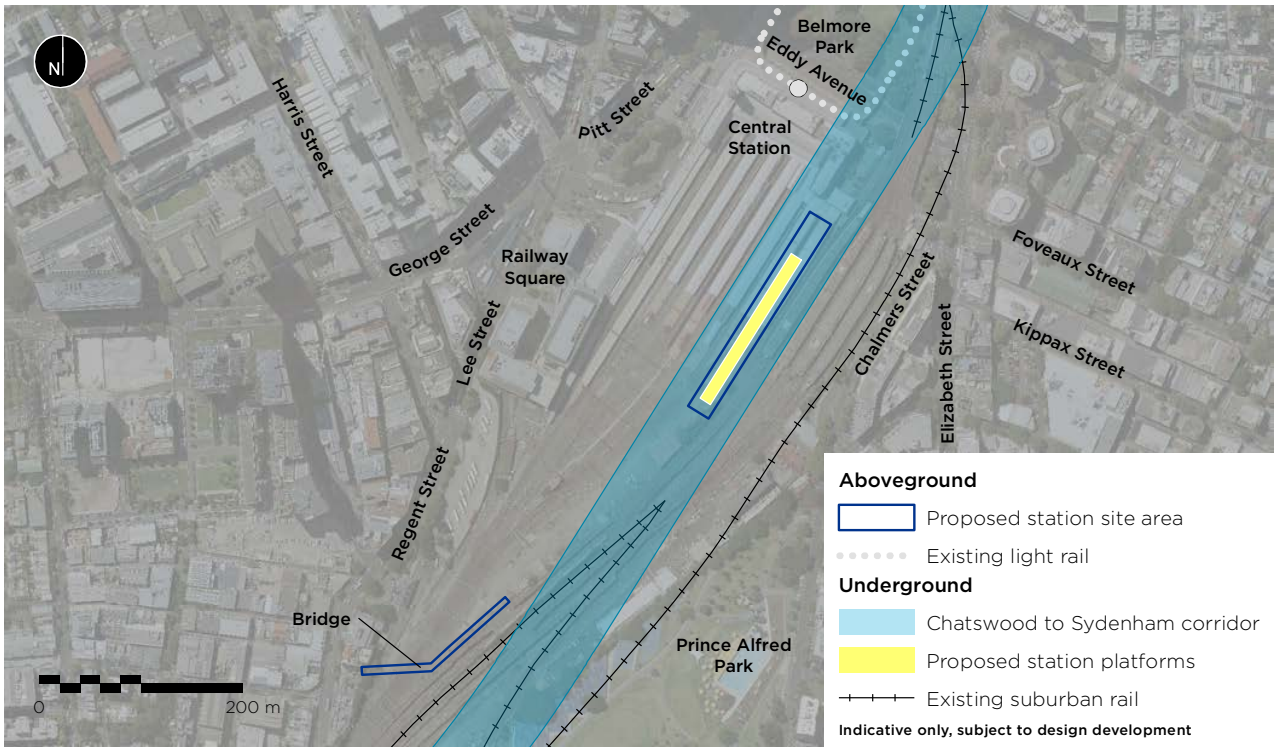


Figure 5.11 Sydney Metro platforms at Central Station

5.4.8 Station options

The NSW Government is currently investigating the potential for a metro station at either The University of Sydney or Waterloo with provision for turnback facilities. Potential features of these station options are described below.

The University of Sydney

If The University of Sydney Station is progressed, the preferred location is near the corner of Cleveland Street and City Road (Figure 5.12). Options for the arrangement and design of this potential station are being investigated.

A metro station at The University of Sydney would serve the key education precinct, health and retail precincts including the Royal Prince Alfred Hospital and the Broadway shopping centre, and other attractors in the locality including Carriageworks and employment areas around Chippendale.

The station strategy for The University of Sydney would:

- Contribute to the sense of place and public domain
- Create a new transport focus on City Road
- Efficient and attractive connections to the university campus.

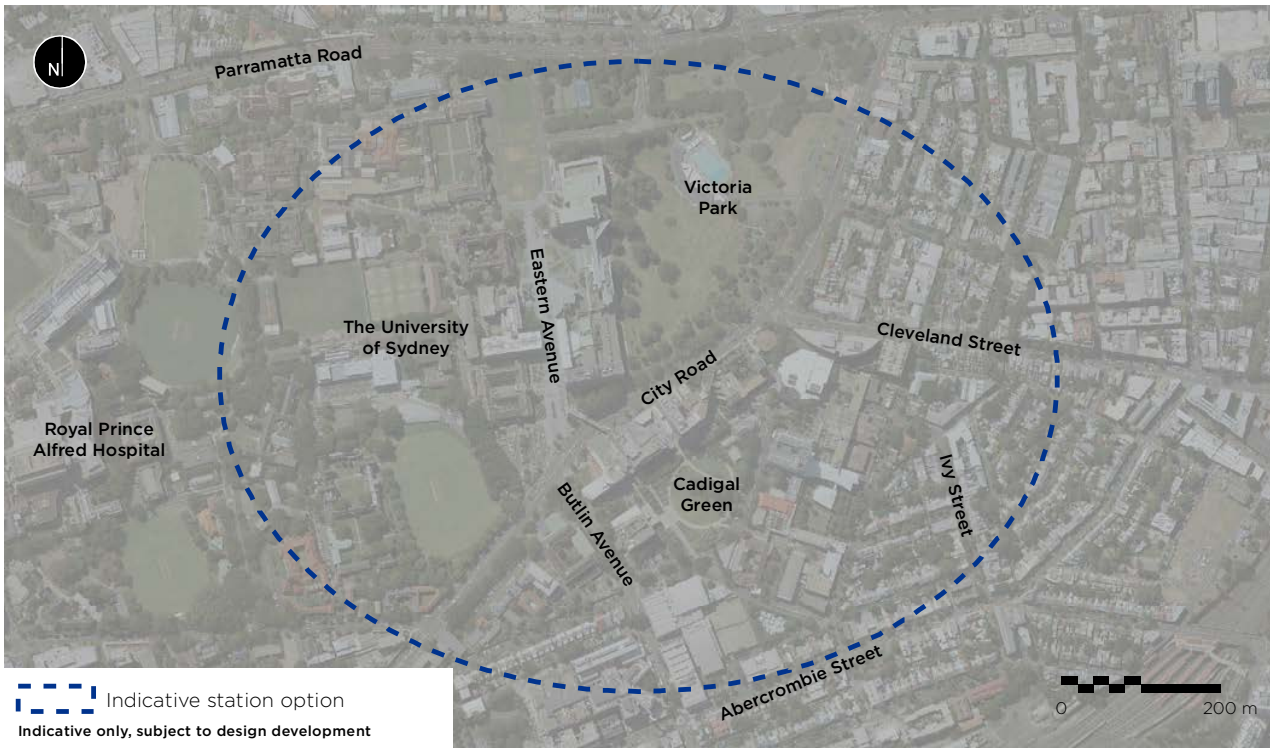


Figure 5.12 Location of possible The University of Sydney Station

Waterloo

If a Waterloo Station is progressed, the preferred location is near Botany Road and Raglan Street (Figure 5.13). Options for the arrangement and design of this potential station are being investigated.

A metro station at Waterloo would be a catalyst for a Waterloo transformation program to regenerate social housing stock, support greater residential development and urban renewal, and support the extension of the Sydney CBD to the south. In addition a metro station at Waterloo would connect the Australian Technology Park and the residents in the Waterloo and Redfern areas with Sydney Metro.

The station strategy for Waterloo would:

- Contribute to the sense of place and public domain
- Create a new transport focus in Waterloo
- Integrate the station with local improvement plans.

Figure 5.13 Location of possible Waterloo Station

5.5 Operational ancillary infrastructure

Fresh air tunnel ventilation and traction power supply for the project would be generally provided at the proposed stations. However, additional facilities are required at Artarmon and adjacent to the southern portal (refer to Sections 5.5.1 and 5.5.2).

5.5.1 Artarmon substation

The Artarmon substation (located between the northern tunnel portal and Crows Nest Station) would contain a traction substation to supply traction power for the running of the metro trains.

The facility would be located above the tunnel alignment, within land adjacent to the Gore Hill Freeway as shown in Figure 5.14. An aboveground building for a traction substation and ancillary equipment would be provided, with a small shaft to reticulate cables to the tunnels below.

Figure 5.14 Artarmon substation

5.5.2 Southern services facility

The southern services facility would be located adjacent to the southern tunnel portal. This services facility would include an operational water treatment plant and a traction substation.

The water treatment plant would treat wastewater pumped from the tunnels, stations and other underground facilities. The source of wastewater generated during operation of the project would be:

- Groundwater inflow into underground stations in the event they are not tanked structures (tanked structures are constructed to be waterproof and prevent the inflow of groundwater)
- Surface water captured within the tunnel dive structures
- Water used to test the tunnel fire hydrant system or undertake periodic tunnel cleaning.

An aboveground building for a traction substation and ancillary equipment would be provided, with cables reticulated into the tunnels.

5.6 Stabling and maintenance

5.6.1 Infrastructure maintenance

Maintenance planning for the project would generally allow routine and major periodic maintenance of infrastructure to be undertaken with a view to maximising service availability and minimising impacts on customers. Scheduled maintenance would generally occur between the last and first train services, or during planned weekend maintenance periods, when train services would not be in operation on parts of the line.

Rail maintenance vehicles would be able to use the network, and the project has been designed to allow access for maintenance crews. The following types of maintenance activities would be required:

- Scheduled maintenance – involving routine inspections and repairs to enable the project to operate at prescribed levels of safety, reliability and service frequency; this type of maintenance would be performed on a regular and recurring basis at specified intervals
- Non-scheduled maintenance – involving emergency repairs to address unexpected defects (such as signal failure), vandalism and breakage that would impact on the project's prescribed levels of safety, reliability and / or service frequency; this type of maintenance would be performed as needed
- Overhaul and repairs – involving the repair, replacement and testing of project infrastructure that has been removed from its working location.

5.6.2 Stabling and metro train maintenance

Trains operating on the Sydney Metro network would be maintained and stabled at the Sydney Metro Trains Facility in Rouse Hill. Stabling may also occur at a dedicated facility near the southern end of the project.

These maintenance and stabling facilities do not form part of this project and are not addressed in this report. The Sydney Metro Trains Facility forms part of the Sydney Metro Northwest project. Any additional facility required to support operations would be delivered and assessed as part of the Sydenham to Bankstown upgrade component of the Sydney Metro City & Southwest.

5.7 Construction

5.7.1 Pre-construction and enabling works

Pre-construction and enabling works are those activities that would typically be undertaken before the start of substantial construction in order to make ready the key construction sites and provide protection to the public. Pre-construction and enabling works may include activities such as:

- Demolition of buildings
- Utility supply including power and water
- Utility adjustments and protection
- Transport network modifications to roads, public transport, and pedestrian and cyclist facilities
- Heritage investigations, protection and archival recordings
- Additional geotechnical and contamination investigations.

The environmental impact statement will identify in more detail the activities proposed to be undertaken as pre-construction and enabling works.

5.7.2 Dive structures and tunnel portals

Construction of the tunnel dive structures and tunnel portals would generally involve:

- Piling works along the walls of the dive structure
- Excavation of existing material to below track level
- Placement of pre-cast concrete for the cut-and-cover section and to form the tunnel portal.

The dive structures would be designed and constructed to be protected from the probable maximum flood level.

5.7.3 Tunnelling

Tunnelling methods

Tunnel excavation is likely to be undertaken using tunnel boring machines with roadheaders used for caverns and stub tunnels. Tunnel boring machines are likely to be used to excavate the majority of the twin tunnels as they operate at a quicker rate than roadheaders and excavate the desired circular tunnel profile.

It is anticipated that the tunnel boring machines tunnelling operations would occur from three sites, being:

- A tunnel boring machine launch and support site south of Chatswood Station and north of Mowbray Road), referred to as the Chatswood dive site (northern)
- A tunnel boring machine launch and support site north of Sydenham Station (south of Bedwin Road), referred to as the Marrickville dive site (southern)
- A tunnel boring machine launch and support site at the proposed Barangaroo Station. This site would support a specialised tunnel boring machine for the harbour crossing component.

These three construction sites would provide the necessary support for the tunnelling operation including spoil storage and removal, power supply to the tunnel boring machines, fresh air ventilation, grout batching, water treatment and disposal, material storage as well as office facilities, worker amenities and parking. The approach to tunnelling under Sydney Harbour is currently being investigated in consultation with industry.

Work trains would be required within the tunnels to transport materials, pre-cast concrete lining segments and the workforce to the cutting face. Tracks for the work train would be progressively laid in sections as the tunnel boring machines advance. At the completion of the tunnel boring machine works, the temporary rail tracks would be removed. Alternatively, transport may be undertaken with conveyor systems and special purpose rubber tyred vehicles.

Tunnel lining associated with the tunnel boring machines would be assembled from pre-cast concrete segments as the tunnel boring machines move forward.

Roadheaders and rock hammers are likely to be used to construct stub tunnels, cross passages and niches within the tunnels. These would generally be constructed following excavation of the main tunnels by the tunnel boring machines. Tunnel support for roadheader sections would consist of a primary lining (such as pattern rock bolting and shotcreting) and a final cast in-situ or sprayed concrete lining.

Depending on the geology encountered, or to minimise ground-borne noise impacts, drill and blast or penetrating cone fracture techniques may also be used as part of tunnel excavation works.

Pre-cast concrete segment facility

A pre-cast concrete segment facility would be required as part of the project to manufacture the pre-cast concrete tunnel lining segments. This facility may be located at one of the construction sites or at an alternative site. Following industry engagement a position on the preferred location for a facility would be confirmed. Storage of segments would be required at the tunnel boring machine launch sites.

Sydney Harbour ground improvement works

In order to support the tunnelling works across Sydney Harbour, ground improvements works would be required at the two locations below Sydney Harbour where the tunnel transitions between rock and sediment. The transition zones requiring treatment are expected to be around 20 to 30 metres in length, 35 metres in width and 16 metres in depth.

Indicatively, the ground improvement works may involve cement grouting of blocks using a jet grouting method. This grouting would be achieved from above by barge (or barges) located within Sydney Harbour. Alternative ground improvement methods, including ground freezing and deep soil mixing, would also be considered further in consultation with industry.

Tunnel rail systems fit-out

The main access points for tunnel fit-out would be via the northern and southern tunnel portals and Barangaroo Station, with secondary access provided via the other underground stations (where such access does not conflict with station fit-out).

Tunnel and tunnel rail systems fit-out works would include:

- Fresh air tunnel ventilation fit-out
- Track slab and rail fastening
- Rail installation, fixing and welding
- Cable and equipment installation including signalling, communications and electricity systems
- Overhead wiring installation for rolling stock
- Other equipment including – lighting (including emergency lighting), drainage works, and fire and life safety systems (including walkways connecting to emergency egress and fire hydrant systems).

5.7.4 Station construction

Six new stations are proposed as part of the project, and the potential for an additional station at either The University of Sydney or Waterloo is also being investigated. The anticipated station types, subject to further design development, are presented in Table 5.8.

Table 5.8 Indicative Metro station details

Station	Station configuration	Depth to platform (m)	Indicative spoil generation (m^3)
Crows Nest	Cut-and-cover	25	150,000
Victoria Cross	Cavern	31	175,000
Barangaroo[1]	Cavern or cut-and-cover	To be advised	To be advised
Martin Place	Cavern	25 – 27	175,000
Pitt Street	Cavern	17 – 20	160,000
Central	Cut-and-cover	16	230,000

Note 1: Barangaroo Station subject to design development in consultation with Barangaroo Delivery Authority

Construction of the stations would generally be undertaken in the following sequence:

- Enabling works including protection or diversion of utilities and establishment of site access points
- Demolition of structures on the site and clearance of landscaped vegetation
- Excavation and structural works for station boxes and underground pedestrian passages including piled walls
- Station fit-out including mechanical, electrical, lighting and fresh air tunnel ventilation equipment, signage and wayfinding equipment and station furniture.

The construction sites for the metro stations would generally be contained within the project's operational footprint (that is, the land that would be occupied permanently by the station building and associated infrastructure / works).

The exception would be Central Station, where a number of other construction sites would be required nearby to minimise disruption to suburban and intercity rail services. Additional land would also be required at Barangaroo to minimise disruption to the Barangaroo development. These construction sites are described in Section 5.7.8.

Cut-and-cover stations

Cut-and-cover stations (including the area for escalators and lifts) would be constructed by excavating the space from the surface. The structural elements would be constructed concurrently with the excavation. Following excavation, a roof structure would be constructed and then either backfilled to reinstate the ground surface or constructed above to form station entries and services infrastructure. This approach is likely to be used at Crows Nest and Central stations, and potentially Barangaroo Station.

Cavern stations

For cavern stations, an access shaft would preferably be constructed within the footprint of the future station entry and vertical transport (escalator and lift) structure. Excavation machinery such as roadheaders and excavators would be lowered through the shaft to excavate the station cavern. This approach is likely to be used for Victoria Cross, Martin Place and Pitt Street stations, and potentially Barangaroo Station.

Depending on the geology encountered, or to minimise ground-borne noise impacts, drill and blast or penetrating cone fracture techniques may also be used to excavate the stations.

5.7.5 Surface track works

Metro track works

The main access point for the surface metro rail fit-out between Chatswood Station and the northern dive structure would be the Chatswood dive site. The fit-out works would include:

- Fastening of track slab and rail
- Installation, fixing and welding of rails
- Construction of retaining walls and noise walls
- Installation of cable and equipment including signalling, communications and electricity systems
- Installation of overhead wiring for rolling stock
- Installation of drainage, and fire and life safety systems (including walkways connecting to emergency egress and fire hydrant systems).

T1 North Shore Line track works

Adjustment works to the T1 North Shore Line would be required from Chatswood Station to in the vicinity of Brand Street, Artarmon (as shown on Figure 5.1). These works would be undertaken predominately within the existing rail corridor and would include:

- Earthworks to construct new formations
- Structural bridge works for the proposed bridge over the northern dive structure. This would involve piling works and cast in-situ concrete for the sub-structure and placement of pre-cast concrete units for the super structure
- Construction of new retaining walls
- Slewing of the T1 North Shore Line tracks
- Adjustments to overhead wiring, signalling and other rail services
- Adjustment to existing noise walls
- Construction of new maintenance access stairs from Albert Avenue, Chatswood
- Construction of new maintenance access from Brand Street.

5.7.6 Ancillary infrastructure construction

Artarmon substation

The Artarmon substation would be constructed in the following sequence:

- Excavation of a vertical shaft to the tunnels below. This may be undertaken using excavators and rock hammers; however, drill and blast or penetrating cone fracture techniques may also be used
- Lining and reinforcement of the shaft
- Building works for aboveground components
- Installation of electrical equipment including transformers and electrical switchboards.

Southern services facility

The southern services facility would be constructed adjacent to the Marrickville dive site and would incorporate an operational water treatment plant and a traction substation.

The operational water treatment plant would typically be a modular unit constructed on a concrete base slab. Drainage pipes would connect the water treatment plant with the tunnels.

The traction substation would involve building works for aboveground components and installation of electrical equipment. Trenching and / or aboveground conduits would be provided to reticulate electrical cables into the tunnels.

5.7.7 Road modifications

The northern dive structure and tunnel portal would result in the permanent closure of the Nelson Street overbridge. Nelson Street's primary role is to be used by motorists travelling southbound on the Pacific Highway to access Mowbray Road westbound via Orchard Road. To maintain this movement, it is proposed to construct two right-turn lanes from the Pacific Highway southbound to Mowbray Road westbound. This would require the widening of the Pacific Highway to the north of the Mowbray Road intersection.

Other minor road modifications may be required near the construction sites to facilitate access and egress arrangements. These would be detailed in the environmental impact statement.

5.7.8 Construction sites

The majority of the construction sites would be contained within the operational station footprints and ancillary infrastructure sites. Additional construction sites would also be required to support tunnel excavation and fit-out work, as well as construction activities around Central Station.
The location and indicative footprint of the proposed main construction sites are shown in Figure 5.15 to Figure 5.23. Table 5.9 identifies the proposed main construction sites and associated uses.

Table 5.9 Construction site activities

Construction site	TBM launch and support	TBM retrieval	Roadheader works and support	Spoil removal	Station construction	Ancillary infrastructure construction	Rail systems fit-out support	Surface track works support	Staff facilities	Pre-cast concrete segment storage
Chatswood dive site (northern)	●			●			●	●	●	●
Artarmon substation				●		●			●	
Crows Nest			●	●	●				●	
Victoria Cross			●	●	●				●	
Barangaroo	●	●	●	●	●		●		●	●
Martin Place			●	●	●				●	
Pitt Street			●	●	●				●	
Central			●	●	●				●	
Marrickville dive site (southern)	●			●		●	●		●	●

Figure 5.15 Chatswood dive site (northern)

Figure 5.16 Artarmon substation

Figure 5.17 Crows Nest construction site

Figure 5.18 Victoria Cross construction sites

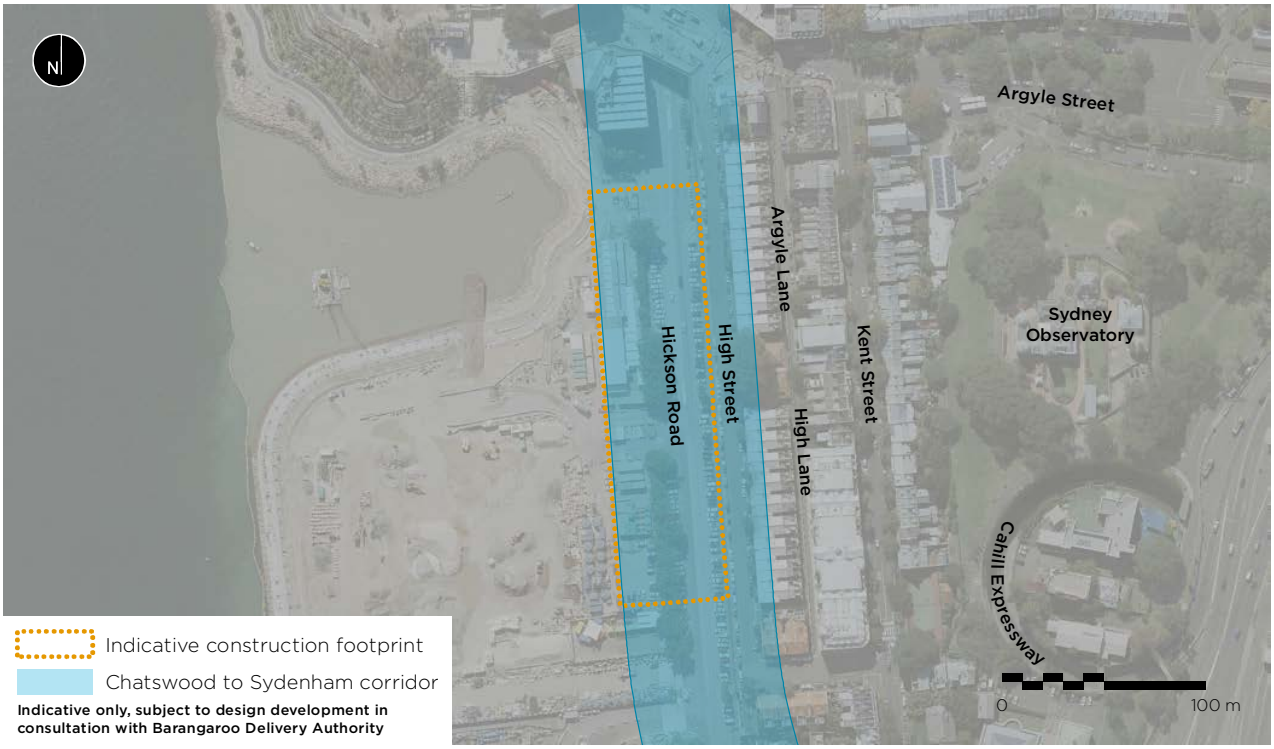


Figure 5.19 Barangaroo construction site

Figure 5.20 Martin Place construction sites

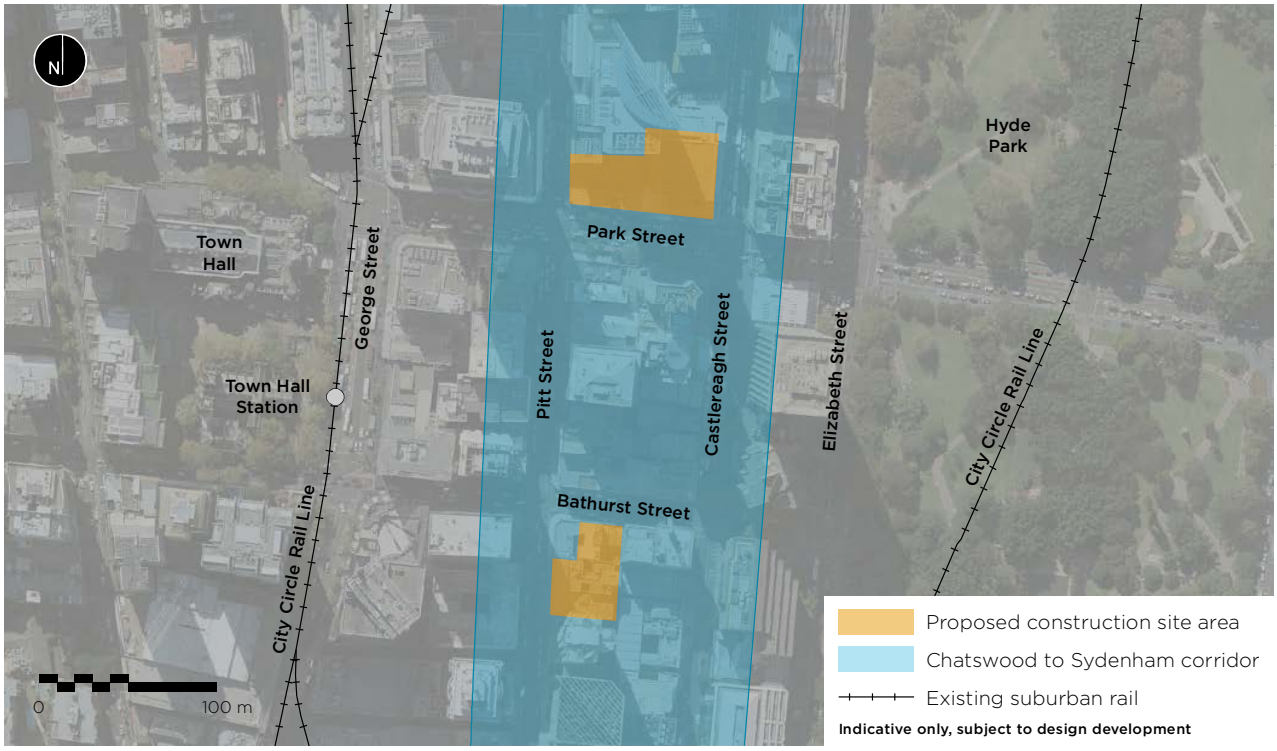


Figure 5.21 Pitt Street construction sites

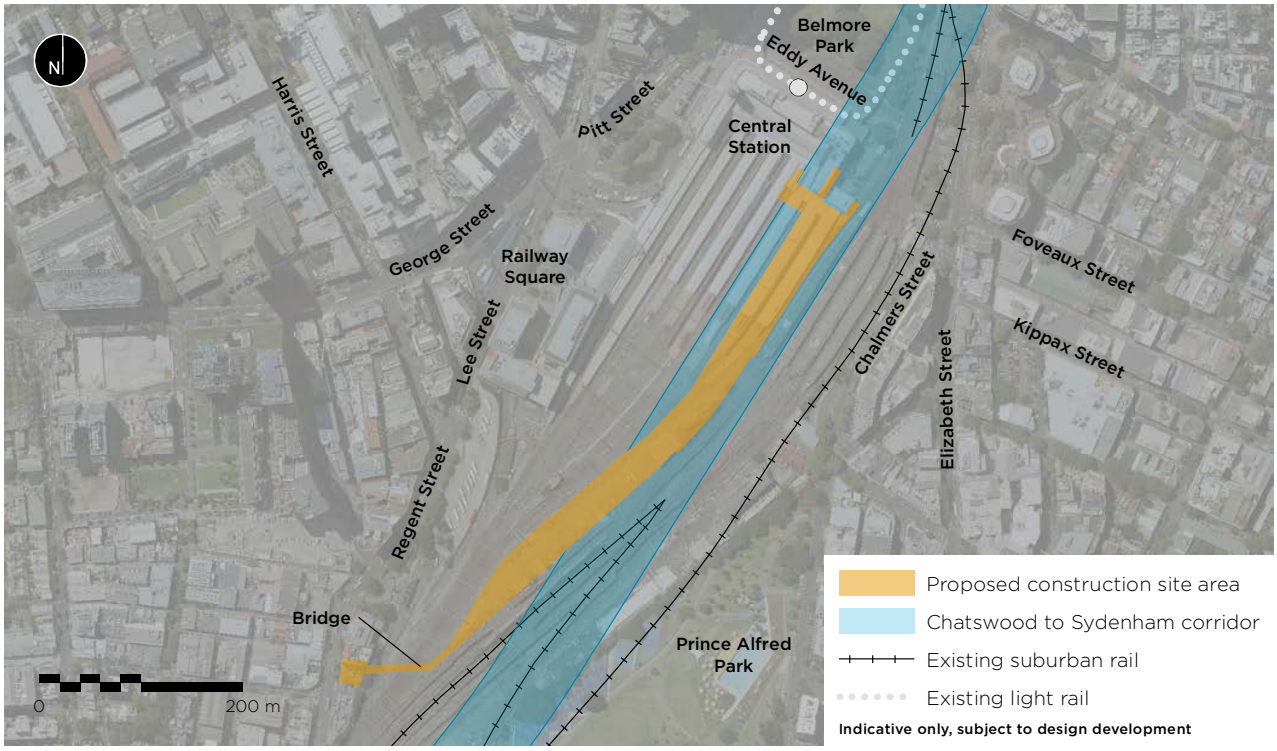


Figure 5.22 Central Station construction sites

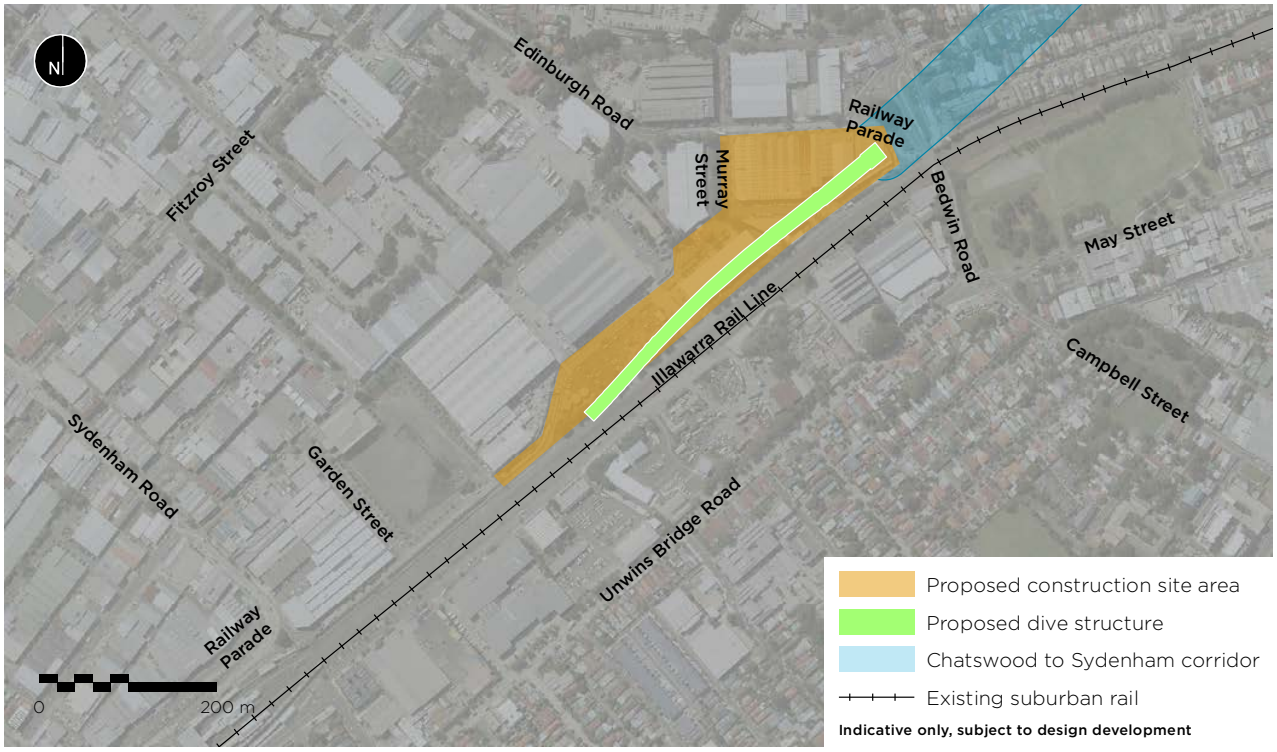


Figure 5.23 Marrickville dive site (southern)

5.7.9 Program

Pre-construction and enabling works (preliminary construction activities required to facilitate commencement of substantial construction) would be likely to begin prior to the commencement of major construction works. The total period for the major construction works would be around seven years, with the project likely to be opened to the public in late 2024. The major construction activities and durations include:

- Pre-construction and enabling works – around one year
- Tunnel excavation – around three years
- Station excavation and structural works – around four years
- Tunnel rail systems and station fit out – around two years
- Testing and commissioning – around two years.

5.8 Associated Sydney Metro projects

The Chatswood to Sydenham project forms part of a suite of related Sydney Metro projects, including the Sydney Metro Northwest (formerly known as North West Rail Link) and the Sydenham to Bankstown upgrade. The status of these associated projects is described in Table 5.10.

Table 5.10 Associated Sydney Metro projects

Project	Location	Status
Sydney Metro Northwest	Cudgegong Road to Epping	Under construction
Epping to Chatswood conversion. The conversion of the existing Epping to Chatswood Rail Link to a metro line as part of Sydney Metro Northwest.	Epping to Chatswood	Construction to commence 2018
Sydney Metro City & Southwest – Chatswood to Sydenham	Chatswood to Sydenham	This project
Sydney Metro City and Southwest – Sydenham to Bankstown upgrade	Sydenham to Bankstown	Subject to separate planning process

6 Preliminary environmental risk analysis

This chapter provides a preliminary environmental risk analysis undertaken for the project in order to identify the key and other issues for the environmental impact statement.

6.1 Purpose of the environmental risk analysis

The purpose of this preliminary environmental risk analysis is to:

- Identify the potential environmental and community risks and issues to be considered in this report and then in detail in the environmental impact statement
- Categorise each issue as a 'key issue' or an 'other issue' based on the risk rating.

6.2 Environmental risk analysis methodology

The environmental risk analysis was undertaken in accordance with the principles of the Australian and New Zealand standard *AS / NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. This involved ranking the risks by identifying the consequence of the impact and the likelihood of each impact occurring.

A risk analysis workshop was held to identify the potential impacts and set appropriate consequence and likelihood levels. The workshop was attended by a cross-section of the project team including the environmental impact assessment team, Transport for NSW and the design technical advisor.

A subsequent risk workshop was held to refine the consequence and likelihood levels as the design has progressed and further information has become available.

As the purpose of the risk analysis at this stage of the project was to categorise issues as 'key' or 'other', the following rules guided the risk process:

- Risk ratings were considered at the broader issue level only (for example construction noise and vibration)
- Industry standard practice was considered in determining risk ratings, however project-specific mitigation (which would depend on the outcomes on the environmental impact statement) was not applied. A residual (post mitigation) risk rating will form part of the environmental impact statement.

The first step in the risk analysis involved the identification of the consequence, should an impact occur. The definitions of the consequences used are provided in Table 6.1 and the definitions of likelihood are provided in Table 6.2.

Table 6.1 Risk analysis consequence definitions

Consequence level	Definition
Catastrophic	• Long-term (greater than 12 months) and irreversible large-scale environmental, social or economic impacts • Extended substantial disruptions and impacts to stakeholder(s) or customers.
Severe	• Long-term (6 to 12 months) and potentially irreversible impacts • Extensive remediation required • Severe disruptions or long-term impacts to stakeholder(s) or customers.
Major	• Medium-term (between 3 and 6 months) and potentially irreversible impacts • Considerable remediation required • Major impacts or disruptions to stakeholder(s) or customers.
Moderate	• Medium-term (between 1 and 3 months), reversible and / or well-contained impacts • Minor remedial actions required • Moderate impacts or disruptions to stakeholder(s) or customers.
Minor	• Short-term (less than 1 month), reversible or minor impacts that are within environmental regulatory limits and within site boundaries • Minor or short-term impacts to stakeholder(s) or customers.
Insignificant	• No appreciable or noticeable changes to the environment • Negligible impact to environment, stakeholder(s) or customers.

Table 6.2 Risk analysis likelihood definitions

Likelihood	Definition	Probability
Almost certain	Expected to occur frequently during time of activity or project (10 or more times per year)	>90%
Likely	Expected to occur occasionally during time of activity or project (1 to 10 times per year)	75% to 90%
Possible	More likely to occur than not occur during time of activity or project (once per year)	50% to 75%
Unlikely	More likely not to occur than occur during time of activity or project (once every 1 to 10 years)	25% to 50%
Rare	Not expected to occur during the time of activity or project (once every 10 to 100 years)	10% to 25%
Almost unprecedented	Not expected to ever occur during time of activity or project (less than once every 100 years)	<10%

The risk rating was then determined by combining the consequence and likelihood to identify the level of risk as shown in the matrix in Table 6.3.

Table 6.3 Risk matrix

Likelihood	Consequence					
	Insignificant	Minor	Moderate	Major	Severe	Catastrophic
Almost unprecedented	Low	Low	Low	Low	Medium	Medium
Rare	Low	Low	Low	Medium	Medium	High
Unlikely	Low	Low	Medium	Medium	High	High
Possible	Low	Medium	Medium	High	High	Very high
Likely	Medium	Medium	High	High	Very high	Very high
Almost certain	Medium	High	High	Very high	Very high	Very high

6.3 Environmental risk analysis

Using the framework described above, a preliminary environmental risk analysis for the project is presented in Table 6.4. The risk analysis identifies an initial risk rating for each of the environmental issues and provides a description of how the risk ratings were derived. Further details regarding the existing environment and potential impacts associated with each environmental issue are provided in Chapter 7.

This risk analysis will be re-examined in preparing the environmental impact statement to consider any additional information available at that time and to consider the effectiveness of mitigation measures.

Table 6.4 Preliminary environmental risk analysis

Potential impact	Consequence	Likelihood	Risk rating	Discussion
Operational traffic, transport and access				
Deterioration of traffic performance on surrounding road network due to altered traffic arrangements Deterioration of traffic performance due to road or lane closures Loss of parking spaces or loading zones Traffic, pedestrian and cyclist safety Altered (poorer) pedestrian and cyclist arrangements	Minor	Unlikely	Low	The project would improve the transport system by providing a stand-alone railway network with the capacity to operate 30 trains an hour through the CBD in each direction. The project would integrate with the existing transport network. The project would help to relieve congestion on the existing rail network and stations, and reduce the number of cars on the surrounding road network. Any changes to the network are likely to be minor alterations to bus stop locations or the provision of a small number of kiss-and-ride and / or taxi spaces around the stations. The project would not involve the provision of any major traffic-generating features such as park-and-ride.

Potential impact	Consequence	Likelihood	Risk rating	Discussion
Construction traffic, transport and access				
Deterioration of traffic performance on surrounding road network due to construction vehicles Deterioration of traffic performance due to road or lane closures Loss of parking spaces or loading zones Reduced pedestrian and cyclist access or flows due to construction Impacts on access to private property Traffic, pedestrian and cyclist safety Impacts on marine traffic Impacts on reliability of public transport services (Sydney Trains and buses)	Major	Likely	High	Construction of the project would require the use of a significant number of heavy vehicles to transport material to and from the sites. Additionally, construction may require: • The temporary or permanent closure of some sections of roadway • Alterations to pedestrian and cyclist facilities • Alterations to existing public transport infrastructure or timetables.
Operational noise and vibration				
Unacceptable airborne noise impacts due to the number of trains and proximity to receivers Unacceptable airborne noise impacts at stations or other at-surface ancillary infrastructure from fresh air ventilation, mechanical and electrical equipment, substations, public address systems, etc Unacceptable vibration impacts resulting in exceedance of human comfort levels Unacceptable vibration impacts resulting in exceedance of building or structure damage levels Unacceptable ground-borne noise impacts	Major	Possible	High	The project would be mainly located underground within twin tunnels. Ground-borne noise and vibration levels from operating trains are anticipated to be minor with the implementation of standard environmental management measures.

Potential impact	Consequence	Likelihood	Risk rating	Discussion
Construction noise and vibration				
Unacceptable airborne noise impacts from surface construction sites during standard construction hours Unacceptable airborne noise impacts from surface construction sites outside standard construction hours Construction traffic results in an increase in traffic noise greater than 2 dB Vibration from tunneling works exceed human comfort or damage levels Vibration from surface works exceed human comfort or damage levels Ground-borne noise from tunneling exceed the criteria Long term construction noise impacting on human health Unacceptable noise impact from out of hours work	Major	Likely	High	Construction of the project would involve the use of multiple construction sites across the length of the project. Construction works are likely to exceed the relevant noise management levels. Additionally, the project is likely to require a significant amount of work outside of standard daytime construction hours.

Potential impact	Consequence	Likelihood	Risk rating	Discussion
Non-Aboriginal heritage				
Unsympathetic design that detracts from the heritage significance of a nearby item Change to the values of a heritage conservation area during operation Damage to heritage items from vibration during operation Direct impacts on local and s170 register listed items during construction Direct impacts on State Heritage Register listed items during construction Direct impacts on Commonwealth, National and world heritage during construction Change to the values of a heritage conservation area during construction Construction impacts of works within the curtilage of listed items, but with no direct impacts on the significant components Impacts on unknown heritage items (eg archaeological items) during construction Damage to heritage from vibration during construction	Major	Almost certain	Very high	The project would be located in areas adjacent to or within State significant heritage items. Various areas of the project site are also likely to contain archeological items of State significance.
Property and land use				
Potential change in land use and zoning provisions surrounding new station sites Residual land use and ability for appropriate reuse or development Potential restrictions on future development within defined corridor due to subsurface tunnels Permanent property acquisition Temporary property acquisition for construction. Potential issues regarding end use Direct impacts on other infrastructure during construction including utilities and Sydney Trains property	Major	Likely	High	The project would require the acquisition and demolition of properties for the proposed station sites and construction areas. The project may also precipitate future development and land use changes associated with the proposed stations.

Potential impact	Consequence	Likelihood	Risk rating	Discussion
Business impacts				
Altered access and visibility to businesses (deliveries, patrons, employees) during operation Impacts on businesses during operation (due to changes in amenity) Altered access and visibility to businesses (deliveries, patrons, employees) during construction Permanent loss of business due to acquisition Impacts on businesses during construction (due to loss of amenity)	Major	Almost certain	Very high	The project would require the acquisition of businesses for the proposed station sites and construction areas. Businesses adjacent to construction site may also be temporarily impacted by changes to amenity, access and visibility of the business.
Social impacts and community infrastructure				
Loss of community facilities / open space during operation Impacts on community facilities due to changes to access during operation Loss of community facilities / open space for construction purposes Impacts on community facilities due to changes to access during construction Electromagnetic fields from operational substations Health benefits associated with public transport	Major	Almost certain	Very high	The project may result in the temporary loss of community facilities such as public open space, during construction. Opportunities to minimise these impacts (such as replacement of facilities within the local area) would be explored during the development of the environmental impact statement. The project would facilitate transit oriented development (and associated increases in urban density) through the generation of new rail catchment areas. There are a number of health benefits that can be attributed to increased urban density, primarily associated with increased active transport opportunities around transit stops.

Potential impact	Consequence	Likelihood	Risk rating	Discussion
Landscape character and visual impacts				
Adverse visual impacts associated with the introduction of new stations Adverse visual impacts associated with the introduction of other surface infrastructure (tunnel portals, fresh air tunnel ventilation facilities, etc) Adverse impacts on landscape character during operation Light spill from stations at night Adverse visual impacts due to the presence of construction activities and compounds Adverse impacts on landscape character during construction Light spill from out-of-hours works during construction	Major	Likely	High	The project would demolish significant buildings within the Sydney CBD and North Shore resulting in a change to the current visual environment. The project would introduce new built elements for the stations, tunnel portals and ancillary infrastructure. Temporary visual changes would also occur from the introduction of construction sites across the project alignment.
Groundwater and geology				
Ongoing operational changes to groundwater flows and levels from underground stations and other drained structures Impacts on groundwater flows, quality and levels during tunnel construction and station excavation Ground movement / settlement due to tunnelling and other excavations	Major	Likely	High	The excavation of the tunnels and underground stations may result in changes to the hydrogeological environment associated with groundwater drawdown. The tunnels are proposed to be undrained, which would limit the potential impacts of this component of the project to the construction phase.
Aboriginal heritage				
Impacts on known Aboriginal heritage items Impacts on areas of known Aboriginal cultural sensitivity Impacts on unidentified Aboriginal heritage items	Major	Possible	High	Areas of the project site are considered to have a medium to high potential for Aboriginal items to be present based on the level of previous disturbance and the location in the landscape. If present, these items would be considered potentially significant considering the rarity of items within areas such as the Sydney CBD.

Potential impact	Consequence	Likelihood	Risk rating	Discussion
Ecology				
Impacts on threatened ecological communities within the construction footprint Impacts on groundwater dependent ecosystems Impacts on threatened ecological communities outside of the construction footprint Impact on native vegetation (non-threatened ecological communities) outside of the construction footprint Significant impacts on threatened flora species Significant impacts on threatened fauna species and endangered populations Impacts to aquatic ecology associated with Sydney Harbour crossing works Impacts on previously unidentified threatened flora species Indirect impacts such as light and noise impacts, sedimentation, spread of weeds	Moderate	Rare	Low	Initial inspections did not identify the presence of any threatened ecological communities or threatened species within the project area. Whilst the project may provide suitable habitat for some threatened fauna species and endangered populations, the potential removal of this habitat is considered to be minor and these species are likely to be highly mobile. Any species currently occurring with the project area are likely to be accustomed to impacts such as noise and light spill which are already occurring.
Hydrology and flooding				
Impacts on flood-prone areas (eg increase in flood risk outside the project site) during operation Flooding of the tunnels during operation Impacts on construction activities due to flooding Impacts on flood-prone areas (eg increase in flood risk outside the project site) during construction Flooding of the tunnels during construction	Moderate	Possible	Medium	A number of sites across the project are located within flood prone land. The protection of the infrastructure from floods and any potential impacts on offsite flood behaviour are anticipated to be manageable through appropriate project design.

Potential impact	Consequence	Likelihood	Risk rating	Discussion
Soils, contamination and water quality				
Contamination of groundwater due to spills and leaks during operation Contamination of land due to spills and leaks during operation Erosion of soils resulting in offsite sedimentation during construction Exposure of acid sulfate soils during construction Disturbance of contaminated land during construction Contamination of land due to spills and leaks during construction Exposure of soil salinity / saline soils during construction Contamination of groundwater due to spills and leaks during construction Water quality impacts due to spills and erosion from the project site during operation Water quality impacts due to discharge of captured groundwater during operation Water quality impacts on nearby watercourses due to runoff from the project site resulting in sedimentation to waterways during construction Water quality impacts on nearby watercourses due to contamination / spills from the project site during construction Water quality impacts associated with the Sydney Harbour ground improvement works Water quality impacts due to discharge of captured groundwater during construction	Major	Likely	High	Potential impacts such as erosion and sedimentation, and spill or leaks are anticipated to be manageable through the implementation of standard environmental management measures. The project is likely to encounter and disturb known contaminated sites around the Chatswood dive site, Barangaroo, Central and Sydenham.

Potential impact	Consequence	Likelihood	Risk rating	Discussion
Air quality				
Impacts on local air quality during operation Impacts on local air quality due to construction plant and equipment and increase in vehicle movements Impacts on local air quality due to dust generation from exposed surfaces, spoil stockpiles or spoil haulage	Minor	Likely	Medium	The potential air quality impacts during construction and operation are anticipated to be similar to other infrastructure projects of this nature and scale. These impacts would be manageable through the implementation of standard environmental management measures. The project is also likely to result in a long-term improvement in air quality associated with a potential mode shift by customers from road to rail.
Greenhouse gas and energy				
Emissions of greenhouse gases from operational energy use and embodied energy in materials Emissions of greenhouse gases from construction activities including energy use for tunnel boring machines	Minor	Possible	Medium	The generation of greenhouse gas emissions during construction and operation would be similar to other infrastructure projects of this nature and scale. These impacts would be manageable through the implementation of standard environmental management measures. The project is also likely to result in a long-term reduction in greenhouse gas emissions associated with a potential mode shift by customers from road to rail.
Climate change adaptation				
Impact of climate change on rail operations and infrastructure Impact of climate change on customer and staff comfort	Major	Unlikely	Medium	Potential climate change impacts on the project would be manageable through the implementation of appropriate design standards.
Hazard and risk				
Transport and storage of hazardous substances and dangerous goods during operation Transport and storage of hazardous substances and dangerous goods during construction Potential for tunnel collapse during construction	Major	Rare	Medium	Potential hazards and risks during construction and operation would be manageable through the implementation of appropriate design standards and construction methodologies.

Potential impact	Consequence	Likelihood	Risk rating	Discussion
Waste and resource use				
Impacts associated with the management of waste during operation Increased electricity use during operation Impacts associated with the management of waste during construction Increased demand on electricity and water supply during construction Increased demand on local and regional resources including sand and aggregate during construction Increased diesel use during construction Impacts associated with the management and disposal of excess spoil from tunnel construction	Minor	Likely	Medium	The generation of waste and the anticipated resource consumption during construction and operation would be similar to other infrastructure projects of this nature and scale. These impacts would be manageable through the implementation of standard environmental management measures (such as application of the waste management hierarchy). The project is not anticipated to result in any resource becoming scarce or in short supply.
Cumulative impacts				
Construction noise and traffic associated with CBD and South East Light Rail Construction noise and traffic associated with WestConnex Spoil management and disposal from multiple tunnelling projects in Sydney (ie WestConnex and NorthConnex) Other stages of Sydney Metro such as Sydney Metro Northwest and Sydenham to Bankstown upgrade	Major	Likely	High	The project is likely to be undertaken concurrently with a number of other major infrastructure projects in Sydney. This may result in cumulative impacts associated with noise and traffic during construction, especially within the Sydney CBD.

6.4 Issue categorisation

Based on the consequence and likelihood definitions, 'key' issues are identified as those with a risk rating of high or very high, and 'other' issues are those with a risk rating of low or medium.

6.4.1 Key issues

As presented in Table 6.4, the 'key' issues for the project are determined as:

- Construction traffic, transport and access
- Construction noise and vibration
- Operational noise and vibration
- Property and land use
- Business impacts
- Non-Aboriginal heritage
- Aboriginal heritage
- Landscape character and visual amenity
- Groundwater and geology
- Soils, contamination and water quality
- Community infrastructure
- Cumulative impacts.

Chapter 7 provides a preliminary assessment of the above issues and outlines the proposed scope of assessments to be undertaken as part of the environmental impact statement.

6.4.2 Other issues

As presented in Table 6.4, the 'other' issues for the project are determined as:

- Operational traffic, transport and access
- Ecology
- Hydrology and flooding
- Air quality
- Greenhouse gas and energy
- Climate change adaptation
- Hazard and risk
- Waste and resource use.

These issues are not expected to raise major environmental risks for the project and / or have well known and tested standard mitigation and management strategies.

Notwithstanding, the preliminary environmental assessment (Chapter 7) also considers these issues and identifies additional scope requirements for the environmental impact statement.

6.4.3 Potential stations at The University of Sydney and Waterloo

As identified in Chapter 5, options are still being investigated for stations at either The University of Sydney or Waterloo.

The likely station locations were considered in a separate risk analysis. It was found that these stations would not result in any issues being elevated from an 'other' issue to a 'key' issue (that is, building these stations would not lead to any additional environmental risks to those identified in Table 6.4.)

7 Preliminary assessment of environmental impacts

This chapter provides a preliminary assessment of the key and other issues identified for the project, including a description of the existing environment and the identification of potential impacts during construction of the project and during operation. The proposed scope of investigations and assessment to be undertaken as part of the environmental impact statement is also provided.

The environmental impacts identified in this section are categorised as either 'key' or 'other' issues, based on the outcomes of the preliminary environmental risk analysis undertaken for the project (refer to Chapter 6).

7.1 Key environmental issues

As outlined in Chapter 6, the 'key' environmental issues identified for the project are expected to be:

- Traffic, transport and access
- Noise and vibration
- Property and land use
- Business impacts
- Non-Aboriginal heritage
- Aboriginal heritage
- Landscape character and visual amenity
- Groundwater and geology
- Soils, contamination and water quality
- Social impacts and community infrastructure
- Cumulative impacts.

The following sections provide a preliminary assessment of the above issues and outline the proposed scope of assessments to be undertaken as part of the environmental impact statement.

7.1.1 Traffic, transport and access

The preliminary environmental risk analysis identified that construction traffic, transport and access is anticipated to be a 'key' issue for the project; whilst operational traffic, transport and access is anticipated to be an 'other' issue for the project. Notwithstanding, the potential impacts and proposed investigations for traffic, transport and access – during both construction and operation – are discussed in this section.

Existing environment

Overview of the existing transport network

Sydney's transport network around the project area is shown in Figure 7.1 and described below.

The existing transport network consists of the Sydney Trains suburban rail lines, the road network, bus services, light rail, ferry services, and pedestrian and cyclist facilities.

Suburban rail

North of Sydney Harbour, the Sydney Trains rail network consists of the T1 North Shore Line and T1 Northern Line. These lines form two key transport corridors connecting major and specialised centres both within Sydney's northern suburbs and south of Sydney Harbour. The T1 North Shore Line is currently constrained by the maximum number of services able to cross the Sydney Harbour Bridge. To the south of Sydney Harbour, the T1 North Shore Line continues through the Sydney CBD before connecting to the T1 Western Line.

South of the Sydney CBD, services operating on the T3 Bankstown Line merge with either the T2 South Line and T2 Inner West Line or the T2 Airport Line. These lines continue through the Sydney CBD using the City Circle. This merging of rail lines to the south of Central Station creates a bottleneck, forcing trains to queue and causing backlogs in the west and southwest.

The T4 Eastern Suburbs and Illawarra Line also operates through the Sydney CBD from Bondi Junction to Cronulla and Waterfall.

Sydney Metro Northwest is currently being built and is due to open in 2019, providing metro services between Chatswood Station and Cudgegong Road Station in Rouse Hill. When it is completed, customers will be able to interchange at either Chatswood or Epping between metro services and rail services operating on the T1 North Shore or T1 Northern Lines.

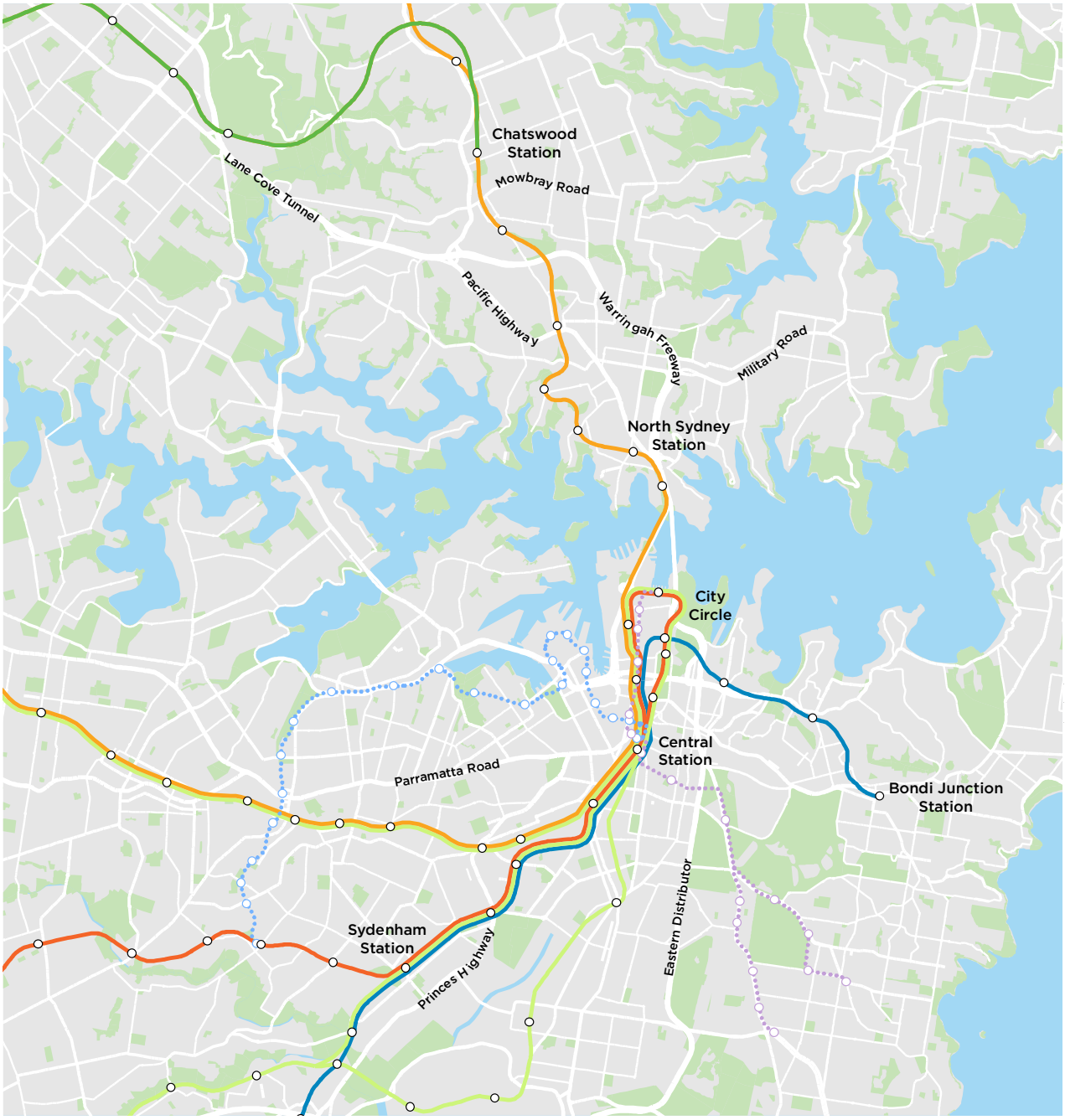


Figure 7.1 Overview of the existing and planned future transport network in the vicinity of the project

Road network

North of Sydney Harbour, the road network is dominated by the key motorways – the Warringah Freeway / Gore Hill Freeway, the Lane Cove Tunnel and the Hills M2 Motorway. The Warringah Freeway / Gore Hill Freeway, connects to the Sydney Harbour Bridge and the Sydney Harbour Tunnel. As the main route to and from the Sydney CBD from the north, it carries large volumes of traffic that progressively increase to the south and on the approaches to the crossing of Sydney Harbour.

The main arterials roads near the project are:

- The Pacific Highway, which is the key arterial road to the north. It passes through North Sydney, Crows Nest, St Leonards and Chatswood. Traffic volumes on the Pacific Highway generally increase to the north, especially between North Sydney and the connection to the Warringah Freeway around Artarmon
- Military Road, which runs east–west, connecting Mosman and Neutral Bay and intersecting with Spit Road at Spit Junction. The Military Road / Spit Road corridor connects to the Northern Beaches via the Spit Bridge
- Mowbray Road, which provides an important east–west connection between Lane Cove, Chatswood and Willoughby. It intersects with Epping Road, the Pacific Highway, Penshurst Street and Willoughby Road.

Numerous arterial and sub-arterial roads provide connections from the surrounding areas to the Pacific Highway and Military Road. North–south arterial roads such as Eastern Valley Way and Willoughby Road are also used as alternative routes to the Pacific Highway. The majority of the arterial and sub-arterial road network experiences significant traffic volumes and congestion, especially during the peak periods.

South of Sydney Harbour, the motorway network provides regional through routes primarily located on the periphery of the Sydney CBD or within tunnels beneath the Sydney CBD providing access for motorists whose origin or destination is not within the Sydney CBD. These roads include the Western Distributor, Eastern Distributor, Cahill Expressway and Cross City Tunnel.

The arterial road network within the Sydney CBD generally forms a grid pattern. Key north–south roads include Elizabeth, York and Clarence streets. Key east–west roads include Park, Market and King streets. Many roads within the Sydney CBD are one-way and experience high traffic volumes and congestion, especially during the peak periods. Pressure on key north–south roads is expected to increase following the pedestrianisation of George Street between Hunter and Bathurst streets as part of the CBD and South East Light Rail project.

South of the Sydney CBD, the road network is dominated by the Eastern Distributor (providing a connection to the M5 Motorway) and the key arterial roads of King Street, the Princes Highway and Regent Street.

Bus network

Buses generally perform a number of roles including cross-regional public transport and local services connecting residential areas to key transport interchanges.

North of Sydney Harbour, major bus routes operate along the Hills M2 Motorway providing express services to the Sydney CBD and North Sydney. The Pacific Highway and Military Road / Spit Road also provide key bus corridors. The Pacific Highway connects areas to the north with key centres including Chatswood, St Leonards, North Sydney and the Sydney CBD. The Military Road / Spit Road corridor provides services from the Northern Beaches to the Sydney CBD via the Warringah Freeway.

There are also a number of local and feeder services. These generally connect to rail stations, especially the key transport interchanges at Chatswood, St Leonards and North Sydney. These routes have frequent services both on and off peak.

Within the Sydney CBD, buses transport passengers from across Sydney into the CBD with many services running through the Sydney CBD in a north–south direction. A redesigned Sydney CBD bus network commenced operation on 4 October 2015. This new network improves connections, reduces the number of buses in the centre of the Sydney CBD, and enables the introduction of the CBD and South East Light Rail project on George Street. Key bus network changes that were implemented on 4 October 2015 include the establishment of new priority bus routes on Elizabeth Street, Castlereagh Street, Park Street, Druitt Street, Clarence Street, York Street and Hickson Road, and the removal of bus routes from George Street.

Key bus interchanges within the Sydney CBD are provided at Wynyard Station, Town Hall Station and Central Station. Buses within the Sydney CBD are constrained by low speeds and unreliability due to traffic congestion.

South of the Sydney CBD, key bus routes operate along the Princes Highway and King Street. There are also cross-regional services between Marrickville and Bondi Junction, and a number of local and feeder services that generally connect to rail stations to provide interchange opportunities. These routes have frequent services both on and off peak.

Light rail

The light rail network consists of one line between Dulwich Hill and Central via Lilyfield and Pyrmont (the Inner West Light Rail). It has frequent services over extended periods. Whilst its share of passengers to the Sydney CBD is limited, it plays an important role in connecting the areas it serves to the Sydney CBD.

Light rail's role and function will be significantly increased following the introduction of the CBD and South East Light Rail (anticipated to begin operations in 2019). This will establish a new light rail network between Circular Quay and Randwick / Kingsford. The route will be 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.

Ferry

Ferry services within Sydney perform two core functions – serving commuters and serving tourists / leisure customers. Most services connect to the Sydney CBD at Circular Quay. This includes services from the east (such as Watsons Bay), northeast (such as Manly), north (such as McMahons Point) and west (such as Parramatta River and Balmain). King Street Wharf on the western edge of the Sydney CBD is also served by Parramatta River services.

The proposed Barangaroo Ferry Hub will provide for new ferry services operating to and from the Barangaroo area, and will have connections to Wynyard Station via Wynyard Walk.

Pedestrian and cyclist network

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

Two key links in the cycle network are:

- The Sydney Harbour Bridge crossing, which is accessed from Alfred Street in Milsons Point (on the north) and Kent Street (in the south)
- The dedicated off-road Gore Hill Freeway cycleway, which provides a key regional link between Cammeray, Chatswood, Lane Cove, Macquarie Park and Epping.

Changes to cycle routes within the Sydney CBD are occurring as a result of the CBD and South East Light Rail project. The key cycle routes within the Sydney CBD will be Castlereagh (south of King Street), Kent, Liverpool, King, Park, and Pitt (north of King Street) streets.

South of the Sydney CBD, the major cycle routes operate through Waterloo and Alexandria, particularly along Bourke Street.

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.

Potential construction impacts

Potential traffic, transport and access impacts anticipated to occur during construction include:

- Deterioration of traffic performance on the surrounding road network due to construction vehicles. These impacts are likely to be greatest at construction sites within the Sydney CBD (given the substantial capacity constraints and constrained bus network) and the road network near the proposed Chatswood and Marrickville dive sites (due to the large numbers of vehicle movements to support the delivery of construction materials and removal of spoil)
- Deterioration of traffic performance due to road or lane closures, loss of on-street parking or removal of loading zones. Based on the current understanding of the project, it is anticipated that the following road or lane closures would be required:
  - Closure of Nelson Street overbridge at Chatswood. Two right-turn lanes would be provided from the Pacific Highway southbound to Mowbray Road westbound
  - Temporary closure of Hume Street at Crows Nest
  - Partial, staged lane closures of Hickson Road at Barangaroo.

- Removal or relocation of existing bus stops
- Delays or other impacts on the reliability of existing bus services due to potential diversions of bus services on an already constrained bus network, an increase in heavy vehicle movements on the road network, and heavy vehicles entering and exiting work sites
- Reduced pedestrian and cyclist access or flows due to impacts on existing footpaths and other construction activities. Based on the current understanding of the project and likely construction sites, this could include:
  - Diversions for pedestrians and cyclists through Martin Place
  - Temporary removal of subsurface pedestrian connections around Martin Place and Central stations
  - Diversion of pedestrians and cyclists near construction sites and access / egress points.
- Impacts on access to private properties
- Impacts on the safety of motorists, pedestrians and cyclists due to potential conflicts with construction vehicles, particularly in the Sydney CBD
- Impacts on the reliability of suburban and intercity rail services to allow for construction activities to safely occur within the rail corridor. This could include some temporary changes to the Sydney Trains timetable and a need for extended rail possessions in order to safely and efficiently complete certain construction activities
- Impacts on maritime traffic (such as ferries, cruise ships, fuel and cargo vessels) due the presence of barges within Sydney Harbour and / or activities around Barangaroo.

The Sydney CBD traffic and transport environment is complex and characterised by generally high volumes of traffic, high levels of congestion, numerous one-way streets and significant pedestrian volumes especially at peak travel times. This environment will be further complicated by the concurrent construction of other major projects such as the CBD and South East Light Rail, the pedestrianisation of George Street between Hunter Street and Bathurst Street, and the new CBD Bus Strategy. Consultation is occurring with Roads and Maritime Services and the CBD Coordination Office to provide a coordinated approach to the management of potential construction related traffic impacts within the Sydney CBD.

The project will aim to provide access and egress to and from the sites directly from arterial roads wherever possible. Notwithstanding, there is likely to be a need to use the local road network for short distances to access construction sites. This requirement will be identified in the environmental impact statement.

Potential operational impacts

The design of the project will aim to avoid or reduce impacts associated with operational traffic, transport and access. Notwithstanding, impacts that could occur during the operation of the project include:

- Changes to traffic arrangements on the surrounding road network (for example, changes to traffic light phasing)
- Permanent closure of the Nelson Street overbridge at Chatswood impacting local traffic movements and pedestrian and cyclist connectivity. Right-turn lanes would be provided from the Pacific Highway southbound to Mowbray Road westbound
- Changes to loading zones or loss of parking spaces
- Altered pedestrian and cyclist arrangements.

Notwithstanding the above impacts, the project would also deliver a number of significant traffic, transport and access benefits. These benefits are described in Chapter 3 and include:

- Increased capacity and reliability of Sydney's rail network
- Improved travel times between key destination within Sydney's Global Economic Corridor
- Reduced crowding on trains and stations on the existing Sydney rail network
- Improved journey times for bus customers and other road users
- Improved connectivity and interchange opportunities between public transport modes.

Proposed investigations and assessment for the environmental impact statement

A detailed traffic and transport impact assessment will be undertaken as part of the environmental impact statement to determine the project's potential to adversely affect traffic, transport and access and, where such potential exists, the likely significance of those impacts. The following government guidelines will be considered as relevant during the preparation of the traffic and transport impact assessment:

- *Guide to Traffic Management – Part 3 Traffic Studies and Analysis* (Austroads, 2013)
- *NSW Bicycle Guidelines* (RTA, 2003)
- *Guide to Traffic Generating Developments Version 2.2* (RTA, 2002).

The assessment will include the construction and operational traffic impacts on the local and regional traffic network, including public transport, cyclists and pedestrians and will include:

- Identification of haulage routes, site access and egress points
- Daily and peak traffic movements likely to be generated by each component of the project and the cumulative impacts of this traffic on the local and regional traffic network including nearby intersections
- Impacts on the overall efficiency, ease, comfort, reliability and convenience of the public transport system (rail and bus), and interchange opportunities
- Impacts on vehicular, pedestrian, cyclist and public transport access
- Impacts on emergency services
- Impacts on parking supply

- Impacts on Sydney Harbour maritime traffic
- Arrangements to ensure continuity of residential and business access
- Operation of and modifications to intersections, and any changes to travel times for public transport services and private motorists
- Opportunities for the integration of rail and bus services including modal interchange facilities, local bus services, strategic corridors and external network connections, access and mobility considerations
- Measures to minimise or mitigate identified impacts, including an assessment of available options and the expected effect of the measures proposed, in accordance with relevant best practice guidelines.

Consultation will be undertaken with Roads and Maritime Services, the CBD Transport Taskforce and the relevant local councils as part of the traffic and transport impact assessment.

7.1.2 Noise and vibration

Existing environment

The project would cross a well-established urban environment that contains a wide range of commercial, residential and industrial land uses of varying densities interspersed with recreational areas and community facilities (such as schools, childcare centres, places of worship and medical facilities).

Existing noise sources

The existing noise environment varies considerably along the length of the project. The dominant noise sources that are likely to influence background noise levels would include:

- Road traffic noise
- Suburban rail line operations and associated station activities
- Industrial activities occurring within existing industrial areas (such as at Artarmon and Marrickville)
- Construction activities (such as the CBD and South East Light Rail, building redevelopments, road and housing construction)
- Sydney Harbour maritime traffic
- Aircraft noise.

Further discussion on the existing acoustic environment (including the results of unattended and attended noise monitoring) will be provided in the environmental impact statement.

Potential construction impacts

Construction of the project would result in noise and vibration impacts on surrounding land uses and sensitive receivers. There are residential buildings within the Sydney CBD and there may be receivers sensitive to particular activities, such as medical facilities, which are sensitive to vibration. These sensitive receivers would be identified within the environmental impact statement.

Construction activities with the greatest potential to result in significant noise and vibration impacts would include:

- Activities occurring at the tunnelling sites (Chatswood and Marrickville dive sites and Barangaroo), including fresh air tunnel ventilation and high voltage power supply (which may involve diesel generation), grout batching plants, delivery of construction materials (such as pre-cast tunnel wall segments) and the extraction, stockpiling and removal of spoil via road trucks
- Activities associated with the manufacture of concrete pre-cast segments including concrete batching; and delivery of raw materials and transport of manufactured segments via road trucks
- Excavation of tunnels using tunnel boring machines, roadheaders and rockbreakers. Tunnel excavation and associated aboveground support activities are likely to be undertaken 24 hours per day, seven days per week
- Excavation, construction and fit-out of stations. Underground station excavation and associated aboveground support activities are likely to be undertaken 24 hours per day, seven days per week
- Construction of tunnel dive and portal structures
- Adjustments to the T1 North Shore Line including structural works and earthworks, track slewing, signalling and overhead wiring
- Construction of operational ancillary infrastructure including:
  - Artarmon substation
  - Southern services facility
- Construction road traffic associated with the delivery of plant, equipment and materials and spoil removal.

The extent of construction noise and vibration impacts on any individual receiver would be dependent on the construction sequencing adopted, plant and equipment used, working hours (that is, standard working hours or out-of-hours works) and the distance to surrounding receivers.

Generally, those sensitive receivers located close to the Chatswood and Marrickville dive sites, station sites and along construction haulage routes are anticipated to experience the greatest noise and vibration impacts. This would be due to the nature of activities proposed and / or the duration that these activities would occur.

Sensitive receivers located above the proposed tunnels are generally anticipated to be less adversely affected by the construction of the project due to the depth of the tunnels and the overall transient nature of the proposed works.

Various components of work would be required to be undertaken outside of standard daytime construction hours (that is, during the evening and night-time), which would increase the potential for adverse noise impacts on surrounding sensitive receivers due to lower background noise levels and the potential for sleep disturbance. However, this approach could also result in an overall reduction in the total duration of exposure to construction for some receivers. Given the proposed during of the project, and the need to undertake works outside of standard daytime construction hours, there may also be potential impacts to human health related to exposure to long term construction noise.

Given the nature of the proposed works and the proximity of sensitive receivers, construction noise and vibration impacts may exceed the noise management levels derived in the *Interim Construction Noise Guideline* (Department of Environment and Climate Change, 2009) at some locations. There is also the potential for vibration impacts on receivers, buildings and structures along the route (including listed heritage buildings, performance venues and those buildings containing sensitive medical equipment).

Potential operational impacts

Operation of the project has the potential to increase noise and vibration levels at surrounding receivers and land uses due to the generation of:

- Ground-borne and structure-borne noise and vibration from trains operating within the tunnels and associated dive structures
- Airborne noise from trains operating within the northern and southern dive structures and from tunnel portal breakout
- Airborne noise from surface tracks between Chatswood Station and the northern dive structure, and from the realigned T1 North Shore Line
- Airborne noise from stations (such as station announcements)
- Airborne noise from tunnel and station fresh air ventilation systems
- Airborne noise from traction substations and other ancillary facilities, including Artarmon substation and southern services facility
- Cumulative noise associated with the increased frequency of trains operating near the southern dive structure (that is, operation of metro trains close to the existing suburban rail network).

Proposed investigations and assessment for the environmental impact statement

A detailed construction and operational noise and vibration impact assessment will be undertaken as part of the environmental impact statement to determine the project's potential to adversely affect surrounding sensitive receivers and land uses.

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

- *Construction Noise Strategy* (Transport for NSW, 2012)
- *Interim Construction Noise Guideline* (Department of Environment, Climate Change and Water, 2009)
- *NSW Industrial Noise Policy* (Environment Protection Authority, 2000)

- *Rail Infrastructure Noise Guideline* (Environment Protection Authority, 2013)
- *NSW Road Noise Policy* (Environment Protection Authority, 2011)
- *Assessing Vibration: A Technical Guideline* (Department of Environment and Conservation, 2006)
- *German Standard DIN 4150-3: Structural Vibration – Effects of Vibration on Structures*
- *Environmental Noise Management Assessing Vibration: A Technical Guideline* (Department of Environment and Conservation, 2006)
- *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (Australian and New Zealand Environment Council, 1990).

The noise and vibration impact assessment will consider:

- The nature of construction activities
- The intensity and duration of noise and vibration impacts
- The nature, sensitivity and impact on potentially affected receivers
- Impacts associated with any works proposed to be undertaken outside standard daytime construction hours
- The potential human health impacts associated with long term construction noise
- The need to balance potential impacts on sensitive receivers and the mitigation of these impacts considering the overall project delivery program
- Other factors that may influence the timing and duration of construction activities (such as traffic management)
- Feasible and reasonable mitigation and management measures to address identified construction noise impacts.

In relation to operational noise and vibration, the assessment will consider:

- Airborne noise, ground-borne noise and vibration impacts
- Impacts on sensitive receivers (such as schools, hospitals, and aged care facilities) and sensitive structures (particularly heritage structures and key utilities / infrastructure)
- Appropriate mitigation and management measures to address identified operational noise impacts.

7.1.3 Property and land use

Existing environment

The project would traverse well-established areas of commercial, residential and industrial land uses of varying densities interspersed with recreational areas (such as public open space) and community facilities (such as schools, childcare centres, places of worship and medical facilities). Existing land use patterns are described in Table 7.1.

Table 7.1 Existing land use patterns

Land use	Pattern / key features
Residential	There are a number of lower density residential areas near the project. These are characterised by single houses and semi-detached houses. Lower density residential areas are located only on the Lower North Shore, generally away from key local or commercial centres. There is also higher density housing characterised by townhouses, multi-dwelling buildings, and multi-storey apartment buildings. Areas of higher density housing are located around local and commercial centres such as Chatswood, Artarmon Village, Crows Nest, Neutral Bay, North Sydney, Milsons Point, Chippendale, and Surry Hills.
Commercial cores	Commercial cores within the project area are those areas predominantly characterised by multi-storey office towers, such as Chatswood, St Leonards, North Sydney, and the Sydney CBD.
Mixed use	Mixed use sub-precincts generally comprise a combination of uses and activities including commercial, residential, retail, civic, cultural, education, health, special use and recreation. Mixed use precincts generally comprise the Chatswood – St Leonards – Crows Nest corridor, and the western and southern areas of Sydney CBD. Once completed, Barangaroo will provide a new mixed use zone on the western edge of the Sydney CBD.
Education	A number of educational institutions near the project are of regional significance and serve a much larger area than their immediate residential catchment. These educational institutions include North Sydney Institute of TAFE St Leonards, Crows Nest and Bradfield Campuses; North Sydney Boys High School; Australian Catholic University; University of Technology Sydney; University of Notre Dame; and The University of Sydney. The area also contains a number of other educational institutions, such as public and private primary schools.
Health	There are a number of hospitals located near the project, such as Royal North Shore Public Hospital, Royal North Shore Private Hospital, Mater Hospital, Sydney Hospital and Royal Prince Alfred Hospital.
Industrial	Industrial areas near the project include a large concentration of light industry, manufacturing, logistics, warehousing, urban services and bulky goods retailing, including the Artarmon Industrial Area and the Marrickville Industrial Area. These two areas perform a critical local and regional economic role.
Midtown Retail (Sydney CBD)	The Midtown Retail precinct is a concentration of a large number of malls, arcades and street-front shops in the Sydney CBD. It is one of the largest retail precincts in Australia in terms of floor space and specialty stores. It includes Westfield Sydney City Centre, MidCity, The Strand, Glasshouse and Sydney Arcade. Anchored by Pitt Street Mall, the Midtown Retail precinct affords retailing opportunities for workers of the Sydney CBD, residents and visitors from Greater Metropolitan Sydney.
Recreational	Major recreational facilities near the project include Chatswood Oval, Artarmon Reserve, Naremburn Park, Gore Hill Park, North Sydney Oval / St Leonards Park, the Sydney Harbour Foreshore including Barangaroo Reserve, Observatory Park, the Royal Botanic Gardens, Hyde Park, Belmore Park, Prince Alfred Park, Victoria Park and Sydney Park. In addition, there are numerous local parks around the project. These recreational facilities provide important parkland for residents and workers, with opportunities for informal recreation and sporting use.
Special uses	Special uses near the project are mainly associated with major roads and railway infrastructure. Other special uses include utilities, electricity transmission and distribution, and the Sydney Water stormwater channel at Sydenham.

Potential construction impacts

Potential property and land use impacts anticipated to occur during construction include:

- The leasing or temporary acquisition of property to enable the establishment of construction compounds and / or the construction work
- The potential temporary loss of public open space for construction sites
- Disruption to services, utilities and other transport assets / infrastructure to enable the construction of the project. This would include utility relocations, and changes to rail infrastructure to enable the integration of the project within shared parts of Sydney Trains' network.

Potential operational impacts

Potential property and land use impacts anticipated to occur during operation of the project include:

- The permanent acquisition of property to enable the establishment and operation of project infrastructure
- Potential restrictions on future development within a defined corridor due to subsurface tunnels or the presence of aboveground rail infrastructure
- Potential land use changes and indirect positive impacts associated with opportunities for urban renewal near the metro stations
- Facilitation of changes associated with future above station development.

Proposed investigations and assessment for the environmental impact statement

The environmental impact statement will identify potential impacts on property and land use, including the following issues:

- Existing property and land use ownership along the proposed route
- Likely future land use based on zoning and consultation with local councils, the Department of Planning and Environment, and the Barangaroo Delivery Authority
- Direct impacts on property and land use
- Indirect positive and negative impacts on property and land use, including potential land use integration issues, potential opportunities and / or benefits for urban renewal / development at metro stations.

Relevant government guidelines that will be considered include *Environmental Planning and Impact Assessment Practice Note: Socio-economic Assessment* (Roads and Maritime Services, 2013).

7.1.4 Business impacts

Existing environment

The project would be generally located within Sydney's Global Economic Corridor, which is an arc of extensive economic activity and a connection of key and specialised centres. This corridor extends between North Sydney, Macquarie Park, the City, Sydney Airport and Port Botany.

The key characteristics of local businesses around each of the proposed station sites and construction sites are provided below.

Chatswood dive site (northern) and surface track works

The proposed Chatswood dive site is located on land currently owned by Ausgrid and predominately used as a depot. A number of businesses are also located within the site fronting the Pacific Highway. Further north, Chatswood is an important area within the regional economy and contains substantial commercial and retail precincts.

Artarmon substation

The Artarmon substation is located on land bounded by the Gore Hill Freeway, Butchers Lane and Barton Road, Artarmon. There are no businesses located directly adjacent to the site; however, a number of commercial and industrial businesses are located nearby within the Artarmon industrial area.

Crows Nest Station

Local businesses are generally focused along two core linear retail strips – the Pacific Highway and Willoughby Road. Willoughby Road is a thriving retail sub-precinct which has low vacancy rates and a diverse mixture of businesses including restaurants, cafes, smaller clothes shop, health clubs, specialty stores and multiple offices on the second and third levels of buildings. The majority of business premises are in two-storey buildings along Willoughby Road with taller, three to four-storey office buildings behind the main retail strip.

The retail strip along the Pacific Highway through St Leonards and south into Crows Nest is heavily oriented towards activated ground floor retail with larger commercial operations and / or residential apartments in upper floors generally behind the primary retail strips. This retail strip is not experiencing the same level of retail business activity as Willoughby Road.

Victoria Cross Station

Victoria Cross Station would be located within the major business hub of the North Sydney commercial area. (Victoria Cross is the official name for the open space in front of the North Sydney Post Office, where a number of roads converge.)

The commercial area is an extension of Global Sydney. The majority of businesses in the precinct are housed in office buildings; however, there is a considerable retail presence as well as a number of health and education uses, many of which are commercial operations.

The core activity area has some large shopping centres as well a considerable retail presence on the Pacific Highway, Miller Street and Berry Street. There are many vacancies on the street front and in the shopping centre; however, the geographic spread is uneven and some areas are performing better than others.

North Sydney has been undergoing a period of change over the last decade with an influx of new residential apartments that have broadened the activity beyond business hours.

Barangaroo Station

Barangaroo is one of the largest urban renewal projects in Australia, comprising 22 hectares of waterfront redevelopment in three defined sub-precincts. Barangaroo is planned to provide over 24,000 permanent jobs once fully developed with 33,000 people expected to visit each day.

Barangaroo South will be a mixed use precinct consisting of commercial office buildings, residential apartments, an international hotel, shops, cafes, restaurants, and cultural facilities. The first tenants began moving into Barangaroo South in July 2015.

Central Barangaroo will combine civic and cultural attractions with recreational, residential, retail and commercial uses. Construction work on Central Barangaroo is anticipated to be completed around 2019.

Martin Place and Pitt Street stations

The Sydney CBD (as defined by the City of Sydney Floorspace and Employment Survey 2011–2012) contains 11,287 individual businesses. Whilst this covers an area broader than the Pitt Street and Martin Place station precincts, it is a good indicator of different business sectors within the Sydney CBD. The City of Sydney Floorspace and Employment Survey states that "the predominant sectors in terms of business numbers in the Sydney CBD Precinct are Professional and Business Services, Retail and Personal Services, Food and Drink and Finance and Financial Services". These are the market sectors with over 1000 commercial businesses.

The local business area around the proposed Martin Place Station at ground level is dominated by higher end retail and extensive food and beverage retail. There are extensive underground connected shopping arcades within this precinct. The proposed Martin Place Station is also located at the southern end of the financial core of the Sydney CBD.

The proposed Pitt Street Station is comparable to Martin Place in terms of the distribution and type of businesses, and located almost in the very centre of the Sydney CBD. This means it is likely to significantly impact the local businesses, especially those at ground floor and operating sub-stratum of which there are many retail businesses.

Central Station

Central is Sydney's most important station due to its role as a multi-modal hub and centrepiece of Sydney's public transport network.

The Central Station precinct has been undergoing significant revitalisation over the past decade with the redevelopment of the Carlton and United Breweries site into Central Park Sydney, and multiple new buildings at UTS.

Surry Hills, on the eastern side of Central Station, has also experienced recent urban gentrification and ongoing property price increases, with considerable conversion of older industrial buildings and warehouses into apartments. This has driven a marked increase in the number of small businesses in the precinct, generating increased foot traffic, destination retail and small business trade.

The Haymarket / Chinatown / Chippendale sub-precinct, on the western side of Central Station, is renowned for its considerable number of Asian restaurants, convenience stores, street markets, grocery shops and small fashion outlets. The sub-precinct is very popular for the younger demographic due to the proximity to education centres (such as UTS and NSW TAFE).

The local businesses benefit from this highly connected inner city suburb which features Central Station, three light rail stations (Paddy's Markets, Central and Capitol Square Stations) and bus links along George Street. The local businesses perform strongly due to adjoining suburbs such as Darling Harbour, Ultimo, Surry Hills and Sydney CBD, which are well connected for pedestrians.

Marrickville dive site (southern) and surface track works

The proposed Marrickville dive site is located within the Marrickville Industrial Area and currently contains a number of industrial businesses. To the north is Marrickville Metro Shopping Centre, providing an important local retail function.

Potential construction impacts

Potential adverse business impacts that could occur during construction include:

- Disruptions to servicing, deliveries and access – temporary street closures, the relocation / removal of car parking along the street frontage and the location of construction sites could collectively restrict and hinder servicing, delivery and customer access opportunities, resulting in time and vehicle related costs as well as lost revenue for businesses
- Increased traffic congestion and / or travel times – impacts on businesses as a result of traffic delays and congestion may be both direct and indirect. Businesses may be directly affected by delayed or hindered access to work places or servicing areas owing to local traffic constraints and congestion. A business may be indirectly affected by increased traffic and therefore travel times for staff or deliveries on major thoroughfares owing to construction works. Service and delivery based businesses may also be impacted by higher vehicle operating costs
- Loss of power and utilities – businesses may be disrupted by accidental or planned shutdowns of electricity or other utilities to enable construction works. Whilst significant advance notice would be given to all businesses of a power or utility shutdown, accidental events would be more difficult to manage
- Visibility – the presence of construction works, hoardings and other structure may reduce the visibility of certain businesses. For businesses which rely on passing trade, such as cafes and convenience stores, this could result in a loss of customers and turnover
- Amenity – Deterioration of amenity (particularly due to noise, vibration, and visual and air quality impacts) may result in a reduction in customers for certain business types such as cafes
- Property acquisition – Some businesses may not be able to as easily relocate as others (for example, those businesses requiring particular machinery / operating conditions).

Notwithstanding the above negative impacts, some businesses in the project area may also experience positive impacts during the construction, including:

- Increase in passing trade – depending on their location, some businesses may benefit from a net gain in passing trade during construction owing to changes to pedestrian traffic and vehicle access
- Trade increase – trade could increase for businesses located close to construction sites or en-route to construction sites, which sell goods to construction workers; related industries, such as service stations, take-away food shops and hotels, could also benefit
- Demand for services – the project could benefit construction related businesses, such as construction recruitment agencies, construction companies and resource suppliers.

Potential operational impacts

Potential adverse business impacts that could occur during the operation of the project include:

- Increased commercial rent – as a result of the likely enhanced attraction of locating a business close to the project corridor, competition for space and thereby commercial rents could increase across the project area. Where this occurs, there would be some negative impacts on smaller businesses that are not able to quickly absorb higher rents or businesses that are presently experiencing challenges to viability. Conversely the ability to command higher rents would be a positive benefit for property owners
- Changed behaviour during construction – a forced change in consumer behaviour (such as travel route or diversion) may have longer term effects. For example, an alternative pedestrian route provided during construction (that moves passing trade away from a given business) may result in a permanent change in behaviour or travel direction even when no longer enforced. This can negatively affect businesses from which trade was diverted and conversely may benefit others
- Altered traffic, access and parking conditions – changed traffic arrangements could collectively restrict and hinder servicing, delivery and customer access opportunities, resulting in time and vehicle related costs as well as lost revenue for businesses
- Amenity – Deterioration of amenity (particularly due to noise, vibration, and visual and air quality impacts) may result in a reduction in customers for certain business types such as cafes.

Notwithstanding the above negative impacts, the project would also result in a number of positive business impacts due to improved public transport facilities, improved travel times for staff, and greater connectivity between key centres of the Global Economic Corridor. These benefits may include:

- Increased business activity
- Increased trade generation
- Increased residential development opportunities
- Improved staff access, recruitment and retention
- Improved business viability.

Proposed investigations and assessment for the environmental impact statement

A local business impact assessment will be prepared as part of the environmental impact statement. The assessment will:

- Identify businesses that would be directly impacted by the project
- Identify local businesses near the project that may be indirectly impacted by the construction and / or operation of the project
- Undertake a local business survey to understand the nature of businesses and the local economy
- Assess the potential impacts of the project on local businesses, and on the local economy from the potential loss of businesses
- Identify measures to avoid or mitigate the potential impacts.

Relevant government guidelines that will be considered include *Environmental Planning and Impact Assessment Practice Note: Socio-economic Assessment* (Roads and Maritime Services, 2013).

7.1.5 Non-Aboriginal heritage

This section provides a description of non-Aboriginal heritage items, conservation areas and areas of archaeological potential located near the proposed site-based components of the project (the tunnel portals, stations and Artarmon substation).

Existing environment

Heritage listed items

Non-Aboriginal listed heritage items likely to be directly impacted by the project include:

- Mowbray House and / or its associated 10 metre curtilage (local heritage significance and Ausgrid section 170 register). This item is located within the Chatswood dive site and may be demolished as part of the works
- Shop, 187 Miller Street, North Sydney (local heritage significance). This item is located within the Victoria Cross Station site and would be demolished as part of the works
- Martin Place (local heritage significance). This item would be temporarily impacted during cut-and-cover excavation works through Martin Place between Castlereagh and Elizabeth streets
- Flat building including interior (local heritage significance). This building is likely to be demolished as part of the development of the new Martin Place Station
- Sydney Terminal and Central Railway Stations Group (State heritage significance). The proposed Central Station metro platforms would be located within this heritage item. Construction works may also temporarily impact this item, including through the provision of a bridge from Regent Street to Sydney Yard and potentially during the construction of the east–west underground concourse

While the Hickson Road cutting is not a listed heritage item it may be of local heritage significance. The Hickson Road cutting may be impacted as part of the proposed Barangaroo Station works.

A number of local and State listed heritage items are also located close to the proposed station sites or above the tunnels. Potential indirect impacts on these items, such as vibration and visual impacts, will be considered as part of the environmental impact statement.

No properties on the World Heritage or National Heritage lists are located within the vicinity of the proposed permanent aboveground elements of the project. However, project activities associated with the construction of the harbour crossing may occur within the buffer zone for the World Heritage listed Sydney Opera House. The intent of the buffer zone is to protect views of the Opera House from public places on the foreshores that contribute to its World Heritage significance. The presence of barges within Sydney Harbour has the potential to temporarily impact views to the Opera House. These potential impacts would be further considered as part of the environmental impact statement.

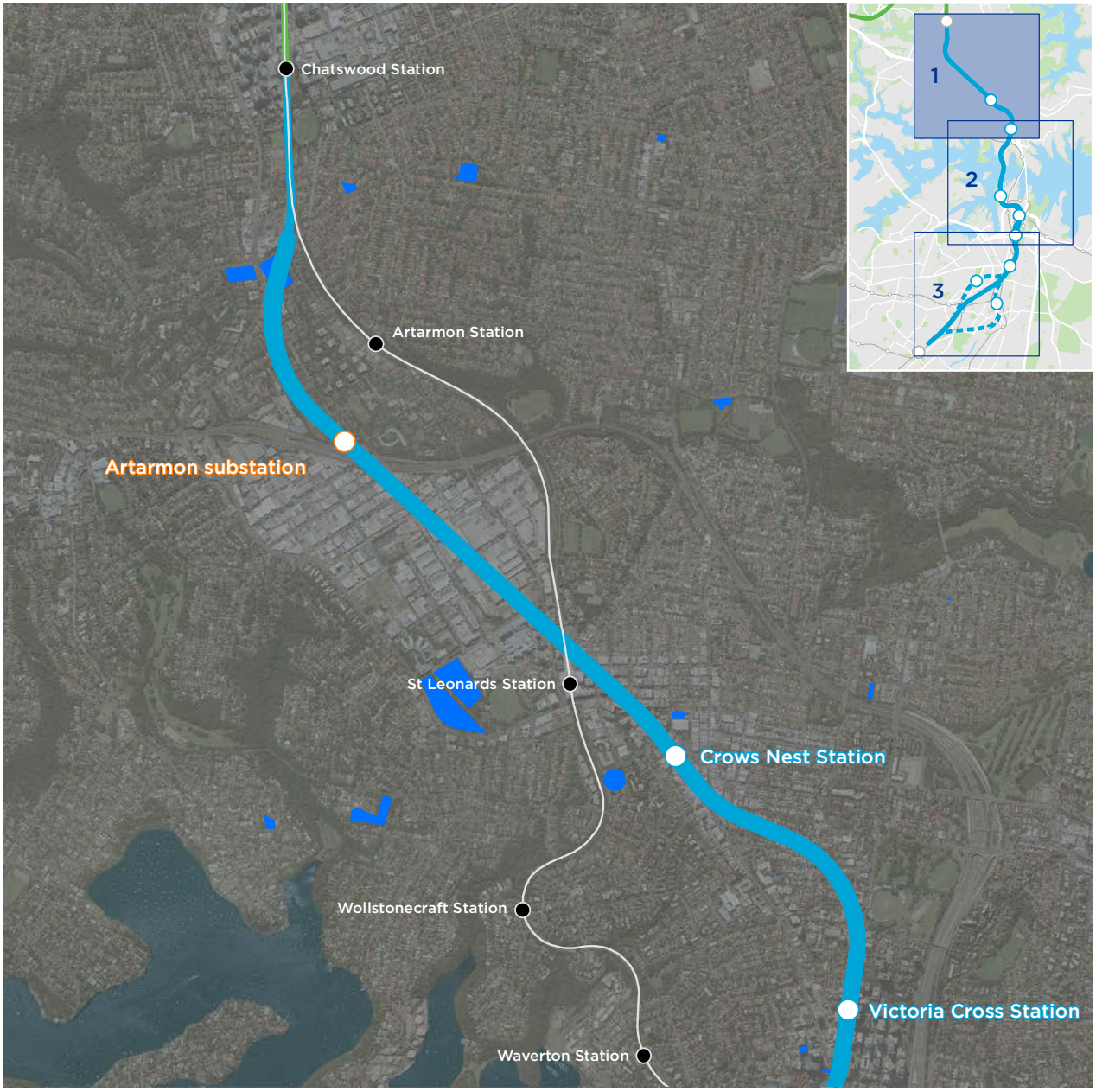


Figure 7.2 State heritage listed items – Map 1

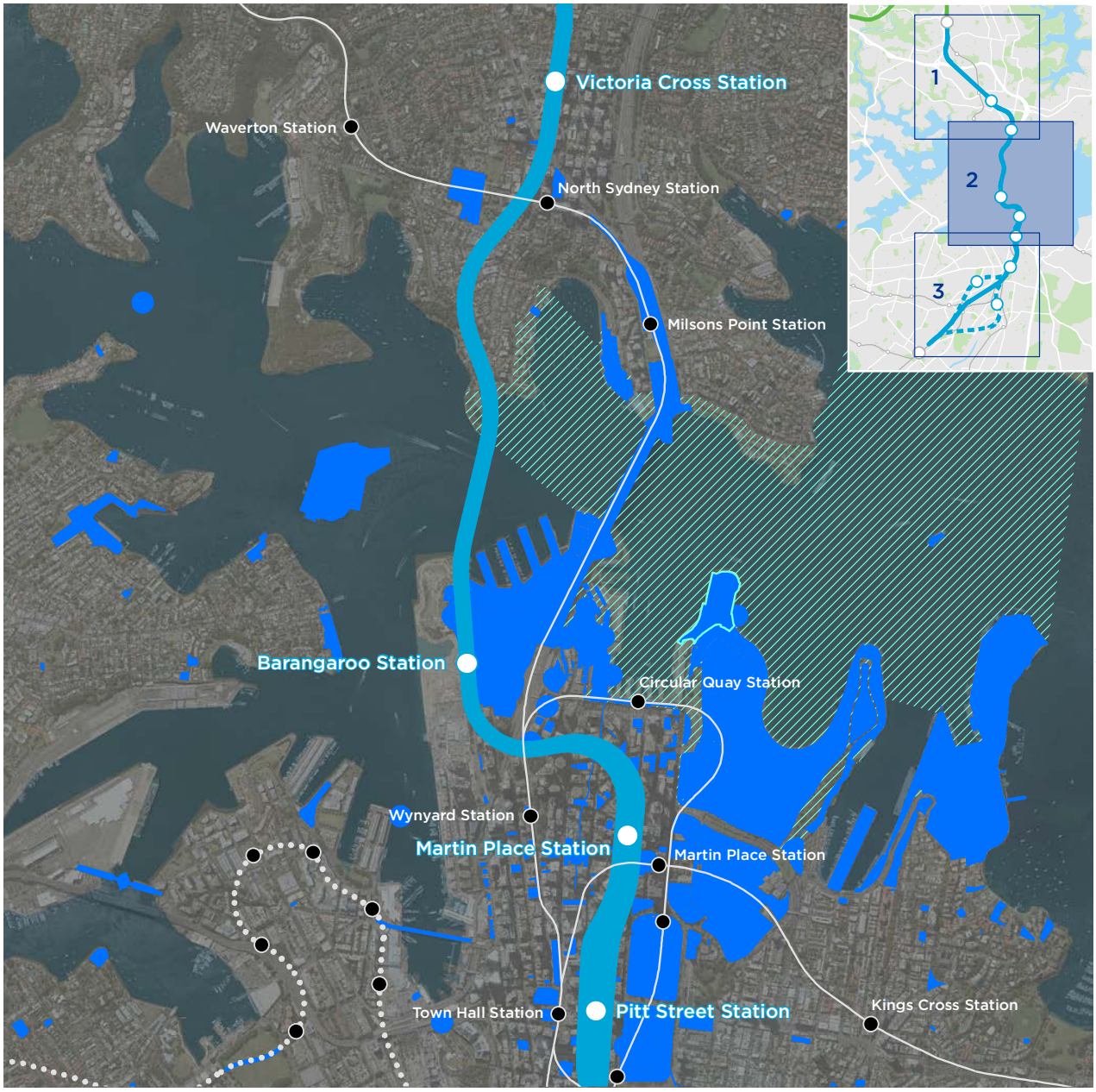


Figure 7.3 State heritage listed items – Map 2

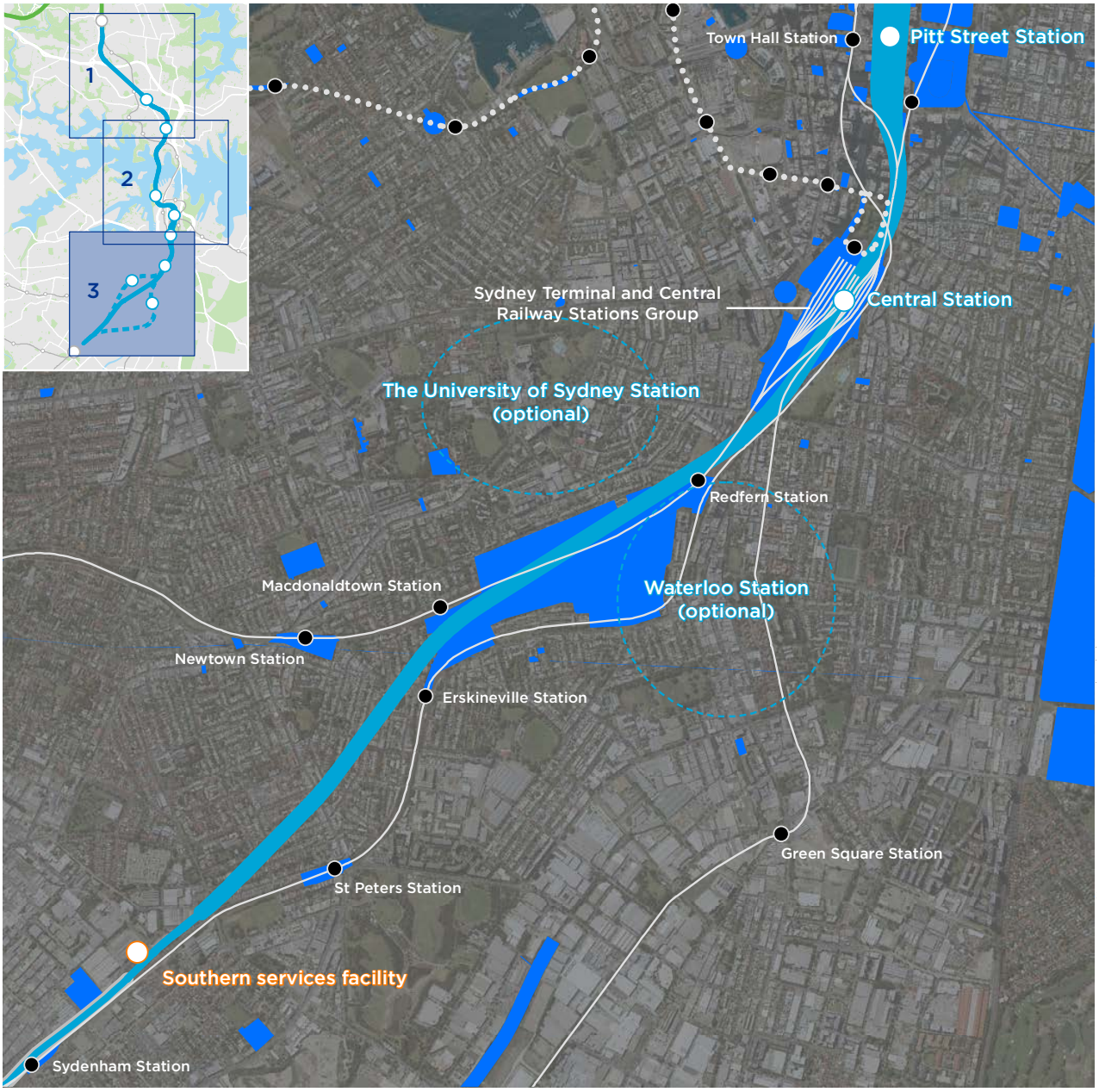


Figure 7.4 State heritage listed items – Map 3

Heritage conservation areas

The project is located within or adjacent to four heritage conservation areas. These are listed in Table 7.2.

Table 7.2 Listed heritage conservation areas

Heritage conservation area	Register listings (Item no.)[1]	Heritage significance
Chatswood dive site (northern)		
South Chatswood Conservation Area	Willoughby LEP 2012 (C11)	Local
Barangaroo Station		
Millers Point Conservation Area	State Heritage Register (00884); Department of Housing S170 Register; Sydney LEP 2012 (C35); Register of the National Estate	State
Central Station		
Chippendale Heritage Conservation Area	Sydney LEP 2012 (C9)	Local
Cleveland Gardens Heritage Conservation Area	Sydney LEP 2012 (C62)	Local

Note 1: S170 Register = Section 170 Register under the NSW Heritage Act 1977*; Sydney LEP 2012 =* Sydney Local Environmental Plan 2012.

Archaeological potential and significance

The project area has been subjected to a range of land uses following European colonisation and, therefore, has the potential to contain a variety of archaeological resources. A preliminary assessment of the anticipated archaeological potential and significance of the project area is provided in Table 7.3.

Table 7.3 Preliminary assessment of archaeological potential and significance

Location	Preliminary assessment of archaeological potential and significance
Chatswood dive site (northern)	As the project area currently contains low-rise commercial development and open space (car parking), and appears to have done throughout much of the twentieth century (according to historical aerial photographs of the project area), it can be assumed that the site would have some archaeological potential to contain remains associated with early 19th to early 20th century occupation, which may be of local heritage significance.
Artarmon substation	In the mid twentieth century the project area was occupied by small-scale residential subdivision. It is likely that most of these residences were associated with the later nineteenth century expansion of the surrounding area. These residences appear to have been demolished for construction of the Gore Hill Freeway, which is likely to have resulted in substantial modification to the surrounding landscape. It is unlikely that the Artarmon project area contains a substantial or significant archaeological resource. If any items are present they are unlikely to reach the local significance threshold.
Crows Nest Station	This site has the potential to contain an archaeological resource associated with late 19th and early 20th century residential subdivision. Archaeological remains of this type, if found to be substantially intact and containing a substantial artefactual resource, may be of local heritage significance.
Victoria Cross Station	There is some potential that archaeological remains (associated with residences and gardens) dating from the mid-19th to early 20th century may be located within this site, which may be of local heritage significance.

Location	Preliminary assessment of archaeological potential and significance
Barangaroo Station	This site has potential to contain a range of archaeological resources spanning the 19th century. These could be associated with early shipbuilding activities, fishing, foraging, brick making or lime burning. Archaeological items at the Barangaroo site may be of State significance.
Martin Place Station	Preliminary analysis suggest that the archaeological resource, if it survives within this site, would be associated with early to late 19th century residences, shopfronts and small-scale industrial workshops. Archaeological remains within the City of Sydney can be substantially intact, and date from early phases of the development of the colony. Therefore, an intact and early archaeological resource in the project area has the potential to be of State heritage significance.
Pitt Street Station	The *Archaeological Zoning Plan of Sydney* identifies many properties in Park Street (30-40 Park Street) and Bathurst Street (107-109, 131-135 and 137-139) as Areas of Archaeological Potential. This designation refers to an allotment of land or feature that has been identified as being an area of high archaeological potential due to limited physical disturbance (usually due to the most recent building development). Preliminary analysis suggests that the archaeological resource, if it survives within this site, would be associated with early to late 19th century residences, shopfronts and small-scale industrial workshops. An intact and early archaeological resource in the project area has the potential to be of State heritage significance.
Central Station	The *2013 Conservation Management Plan for Central Railway Station* states that the key archaeological research value of the Central Station site is associated with the sites of the former charitable institution and government buildings. These archaeological remains are stated as having potential State significance, and the ability to respond to a number of important research questions. The area proposed for the station excavation is unlikely to encounter State significant remains. The section of the potential east–west concourse within the western forecourt may be within an area with high potential for archeology associated with the Benevolent Asylum, Christ Church Parsonage and Government Cottage. These items are considered to be of State significance.
Marrickville dive site (southern)	There is the potential that this site contains archaeology associated with the development of Marrickville / Sydenham, which could date back to the mid-19th century (or later). However, the potential for such remains to be present within the site is likely to be reduced due to subsequent ground disturbance associated with a late 19th, or early 20th century brickmaking pit on the site. Remains associated with pre-1850 development of the Marrickville / Sydenham area are likely to have significance at a local level, and may require further archaeological mitigation. Archaeological remains of late 19th and early 20th century brickworks are unlikely to reach the local significance threshold.

Potential construction impacts

The project has been, and will continue to be, designed to minimise potential impacts on non-Aboriginal heritage. Notwithstanding, construction of the project has potential to impact non-Aboriginal heritage through:

- Undertaking construction within the State listed Sydney Terminal and Central Railway Stations Group to establish the proposed Central Station metro platforms and concourses
- Undertaking construction within the locally listed Martin Place to establish the proposed new Martin Place Station and the underground connections to the existing Martin Place Station
- Establishing the Chatswood dive site, which has the potential to directly impact on the locally listed Mowbray House and / or associated 10 metre heritage curtilage
- Construction within the buffer zone for the World Heritage listed Sydney Opera House
- The Hickson Road cutting may be impacted as part of the proposed Barangaroo Station works
- Demolition of a local heritage items – Shop, 187 Miller Street, North Sydney for the construction of Victoria Cross Station, and flat building including interior for the construction of Martin Place Station
- Undertaking vibration-intensive construction (such as demolition of nearby buildings, rock breaking and tunnelling) beside or close to a large number of heritage listed items, which could result in damage to the fabric and / or structural integrity of these items
- Establishing construction compounds and / or work sites within the curtilages of heritage listed items
- Establishing construction compounds and / or work sites within, or close to, a heritage conservation area
- Undertaking excavations and other land-disturbing works in areas of potential archaeological significance, which could result in damaging previously unrecorded archaeological relics, including archaeological material and deposits.

Potential operational impacts

The following potential non-Aboriginal heritage impacts are anticipated to occur during operation of the project:

- Adverse impacts on the heritage significance of listed heritage items and conservation areas due to 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
- Ground-borne vibration impacts on heritage listed items, which may result in damage to the structural integrity and / or fabric of such items.

Proposed investigations and assessment for the environmental impact statement

A non-Aboriginal heritage assessment will be undertaken as part of the environmental impact statement.

The following government guidelines will be considered as relevant during the preparation of the non-Aboriginal heritage assessment:

- *Commonwealth EPBC 1.1 Significant Impact Guidelines – Matters of National Environmental Significance* (Commonwealth of Australia, 2013)
- *Commonwealth EPBC 1.2 Significant Impact Guidelines – Actions on, or Impacting upon, Commonwealth Land and Actions by Commonwealth Agencies* (Commonwealth of Australia, 2013)
- *NSW Skeletal Remains: Guidelines for Management of Human Remains* (Heritage Office, 1998)
- *Criteria for the Assessment of Excavation Directors* (NSW Heritage Council, 2011).

The non-Aboriginal heritage assessment will:

- Identify items and areas of heritage significance 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
- Consider 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, where such potential exists, the likely significance of those impacts
- 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 best practice guidelines.

7.1.6 Aboriginal heritage

Existing environment

Historical background

Evidence of Aboriginal occupation within NSW dates back around 50,000 to 60,000 years at Lake Mungo (in NSW's southwestern region, about 110 kilometres northeast of Mildura) and up to 30,000 years at Parramatta. Prior to the appropriation of their land by Europeans, Aboriginal people lived in small family or clan groups that were associated with particular territories or places.

The language group spoken across Sydney was known as Darug. The Darug language group is thought to have covered the area south from Port Jackson, north from Botany Bay, and west from Parramatta (Attenbrow, 2010).

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 Port Jackson area. 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).

Subsidence resources known to occur within the project area at the time of Aboriginal occupation include tidally influenced mud flats associated with the mouth of the Tank Stream (situated roughly within Circular Quay), as well as fresh water from the Tank Stream itself (which flowed through the Sydney CBD, generally in the vicinity of Pitt Street).

There is potential for Aboriginal objects to occur across the landscape. The underlying geology and proximity of water sources indicate the potential for the occurrence of artefact sites and / or midden sites.

Previously registered Aboriginal heritage sites

Extensive searches of the NSW Office of Environment and Heritage's Aboriginal Heritage Information System (AHIMS) identified one previously recorded Aboriginal heritage site within 100 metres of the project. This site comprises a sub-surface archaeological deposit associated with Angel Place. The recorded location of the site is 75 metres to the north of the proposed Martin Place Station. However, it is likely that the AHIMS coordinates for the site are incorrect and that the site is 200 metres west at Angel Place.

A number of previously recorded Aboriginal heritage sites were identified within the broader area (at distances greater than 100 metres from the project). The closest sites include:

- An open camp site at Moore's Wharf recorded about 300 metres north of the proposed Barangaroo Station
- A rock engraving near the site of the Maritime Services Board tower recorded about 180 metres north of the proposed Barangaroo Station
- A potential archaeological deposit (PAD) recorded about 380 metres northwest of the proposed Pitt Street Station
- A sub-surface archaeological deposit recorded about 380 metres southwest of the proposed Pitt Street Station
- An artefact site recorded about 330 metres northwest of Central Station
- A surface artefact(s) recorded about 240 metres south of the proposed southern portal site.

Archaeological potential and significance

Due to the rich resources in the area, there is a possibility for remains of Aboriginal campsites to be located within the vicinity of the project area. As a result, there is a potential for artefact scatters and midden sites to be buried within the vicinity of the project area. However, this would depend on the level of modern impacts that have occurred at a given location, with the excavation of building basements or car parks substantially lowering the potential of intact archaeological deposit.

The likelihood of Aboriginal heritage sites surviving to the present is influenced by a range of factors, including the durability of the material evidence and the subsequent impacts that have occurred at that location. While large portions of the project area have been significantly altered by previous land developments (particularly within the Sydney CBD), significant archaeological resources have been identified in discrete areas that have been preserved beneath areas of historical development.

For example, a previously recorded Aboriginal heritage site (a sub-surface archaeological deposit) at Angel Place (within the Sydney CBD) had been preserved to a certain extent by the large deposits of fill placed over the site prior to subsequent phases of building construction. The sub-surface archaeological deposit was identified in those parts of the Angel Place site that had survived the building construction.

Given the varying extent to which the project sites have been impacted by previous developments, archaeological potential for Aboriginal objects is likely to be present in sub-surface contexts in those parts that have not been extensively disturbed by sub-surface impacts.

The research significance of any intact Aboriginal archaeological deposit identified within the Sydney CBD would be high, given the rarity of such deposits in this area. Notwithstanding, such artefacts are not considered likely to demonstrate high archaeological significance as they would be unlikely to provide accurate information or answers to relevant research questions.

A preliminary assessment of the anticipated archaeological potential and significance of the project is provided in Table 7.4.

Table 7.4 Preliminary archaeological potential and significance

Location	Preliminary archaeological potential	Preliminary archaeological significance
Chatswood dive site	**Low –** The site is located on a crest landform away from major watercourses and is likely to contain shallow soils (associated with Ashfield Shale). Construction of commercial buildings and roads is likely to have impacted upon or removed archaeological deposits.	**Low –** The archaeological significance of the site is currently assessed as being low due to the high levels of disturbance resulting from historical activities and the preliminary assessment of the site as having low archaeological potential.
Artarmon substation	**Low –** The site is located in an area that was previously the site of a residential dwelling that was demolished during construction of the Gore Hill Freeway.	**Low –** The archaeological significance of the site is currently assessed as being low due to the high levels of disturbance resulting from historical activities and the preliminary assessment of the site as having low archaeological potential.
Crows Nest Station	**Low –** The site is located on a crest landform away from major watercourses and is likely to contain shallow soils (associated with Ashfield Shale). Construction of commercial buildings and roads is likely to have impacted upon or removed archaeological deposits.	**Low –** The archaeological significance of the site is currently assessed as being low due to the high levels of disturbance resulting from historical activities and the preliminary assessment of the site as having low archaeological potential.
Victoria Cross Station	**Low –** The site is located on a crest landform away from major watercourses and is likely to contain shallow soils (associated with Ashfield Shale and crest landscapes of Hawkesbury Sandstone). Construction of commercial buildings, roads and underground services is likely to have impacted upon or removed archaeological deposits.	**Low –** The archaeological significance of the site is currently assessed as being low due to the high levels of disturbance resulting from historical activities and the preliminary assessment of the site as having low archaeological potential.
Barangaroo Station	**Moderate to high –** Archaeological potential has been identified within the western portion of the Barangaroo Station footprint. This archaeological potential relates to the possible survivability of buried shell midden deposits associated with the original shoreline of Darling Harbour.	**Potentially high –** Intact Aboriginal archaeological deposits within the Sydney CBD are extremely rare and would be of high research significance. It is also possible that out of context Aboriginal artefacts may be present in the layers of fill used in the area. Any such artefacts would not likely demonstrate high archaeological significance, as they would not have potential to provide accurate information or answers to relevant research questions.
Martin Place Station	**Moderate to high –** Discrete portions of surviving archaeological deposit containing Aboriginal objects may occur in very small areas. The location of Martin Place Station within the Tank Stream catchment and within 250 metres of that watercourse suggests potential for Aboriginal objects below the ground surface in areas that have not been significantly impacted by the construction of building basements and / or underground car parks.	**Potentially high –** Intact Aboriginal archaeological deposits within the Sydney CBD are extremely rare and would be of high research significance. It is also possible that out of context Aboriginal artefacts may be present in the layers of fill used in the area. Any such artefacts would not likely demonstrate high archaeological significance, as they would not have potential to provide accurate information or answers to relevant research questions.

Location	Preliminary archaeological potential	Preliminary archaeological significance
Pitt Street Station	**Moderate to high –** The location of Pitt Street Station in a low-lying and gently sloping area around the headwaters of the Tank Stream suggests potential for Aboriginal objects beneath the ground surface in areas that have not been significantly impacted by the construction of building basements and / or underground car parks.	**Potentially high –** Intact Aboriginal archaeological deposits within the Sydney CBD are extremely rare and would be of high research significance. It is also possible that out of context Aboriginal artefacts may be present in the layers of fill used in the area. Any such artefacts would not likely demonstrate high archaeological significance, as they would not have potential to provide accurate information or answers to relevant research questions.
Central Station	**Moderate to high –** The location of Central Station on a raised, well-drained area close to estuarine resources at Cockle Bay suggests potential for Aboriginal objects beneath the ground surface in areas that have not been significantly impacted or excavated.	**Potentially high –** Intact Aboriginal archaeological deposits within the Sydney CBD are extremely rare and would be of high research significance. It is also possible that out of context Aboriginal artefacts may be present in the layers of fill used in the area. Any such artefacts would not likely demonstrate high archaeological significance, as they would not have potential to provide accurate information or answers to relevant research questions.
Marrickville dive site (southern)	**Moderate to high –** The site has been significantly modified by previous developments, including channelisation of the natural watercourse through the area to Cooks River, construction of large industrial estates, and the large-scale use of the area for brick making (including the extraction of clay soil). However, the identification of Dugong bones and hatchet heads in the vicinity of Shea Creek demonstrates the potential for highly significant archaeological deposits to remain in the vicinity of the former estuarine areas adjoining the Cooks River. Although it is likely that modification of the area and industrial development has significantly reduced the survivability of sub-surface archaeological deposits, any intact areas that do remain will have archaeological potential.	**Potentially high –** The survival of Aboriginal objects in sub-surface contexts in those areas that have not been impacted by earlier developments is extremely rare. Intact Aboriginal archaeological deposits are extremely rare and would be of high research significance. It is also possible that out of context Aboriginal artefacts may be present in the layers of fill used in the area. However, any such artefacts would not likely demonstrate high archaeological significance as they would not have potential to provide accurate information or answers to relevant research questions.

Potential construction impacts

Construction of the project is not anticipated to impact on any previously recorded Aboriginal heritage sites. As outlined previously, the closest previously recorded Aboriginal heritage site comprises a sub-surface archaeological deposit likely to be located near Angel Place.

Notwithstanding the above, there is potential for previously unrecorded items of Aboriginal heritage significance to be present within the project area, including artefact scatters and midden sites. Therefore, construction has the potential to inadvertently impact on unrecorded Aboriginal heritage items and / or areas of Aboriginal cultural sensitivity.

There is likely to be an elevated risk of uncovering previously unrecorded items of Aboriginal heritage significance in the following areas:

- The western portion of the Barangaroo Station footprint, where there is the potential to uncover buried shell midden deposits associated with the original shoreline of Darling Harbour
- Discrete locations around the proposed Martin Place and Pitt Street stations and Central Station metro platforms, where there is the potential to uncover archaeological deposits containing Aboriginal objects in areas that have not been significantly impacted by the construction of building basements and / or underground car parks
- The southern portal site, where there is the potential for highly significant archaeological deposits to remain near the former estuarine areas adjoining the Cooks River.

The overall guiding principle for cultural heritage management for the project would be to conserve Aboriginal sites in situ, where possible. In situations where the conservation of an Aboriginal heritage site is not practical, management measures will be developed during the preparation of the environmental impact statement (in consultation with the Metropolitan Local Aboriginal Land Council) and implemented to reduce the project's Aboriginal heritage impact. These measures would include:

- Consultation with the Metropolitan Local Aboriginal Land Council in accordance with the NSW Office of Environment and Heritage's *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation 2005* (Department of Environment and Conservation, 2005)
- Archaeological test excavation
- Preparation and implementation of an Aboriginal heritage management plan as part of the construction environmental management plan.

It is anticipated that the above management measures would reduce the risk of impacting on previously unrecorded items of Aboriginal heritage significance and / or areas of Aboriginal cultural sensitivity.

Potential operational impacts

Aboriginal heritage would not be impacted during the operation of the project as widespread ground disturbance / excavation would be restricted to the construction phase. Therefore, Aboriginal heritage is not considered to be a key issue during operation of the project.

Proposed investigations and assessment for the environmental impact statement

An Aboriginal heritage assessment will be prepared as part of the environmental impact statement. The Aboriginal heritage assessment for the environmental impact statement will further consider the archaeological potential of the project sites. It will also document environmental management measures that would be implemented to minimise the risk of impacting on previously unrecorded items of Aboriginal heritage significance and / or areas of Aboriginal cultural sensitivity during construction.

The following government guidelines will be considered as relevant during the preparation of the Aboriginal heritage assessment:

- *Guide to investigating, assessing and reporting on Aboriginal Cultural Heritage in NSW* (Department of Environment, Climate Change and Water, 2011)
- *Aboriginal Cultural Heritage Consultation requirements for proponents* (Department of Environment and Climate Change, 2010)
- *NSW Skeletal Remains: Guidelines for Management of Human Remains* (Heritage Office, 1998)
- *Criteria for the assessment of excavation directors* (NSW Heritage Council, 2011).

The Aboriginal heritage assessment will:

- Identify the potential for the project to disturb Aboriginal heritage (sites, objects, remains, values, features or places) and, where this is the case, to:
  - Determine, in consultation with relevant stakeholders, the significance of the heritage resources to the Aboriginal community
  - Determine the extent and significance of impact to those resources as a result of construction and / or operation of the project
- Identify any requirements for in situ conservation of items and / or areas (as appropriate), the need for further archaeological testing and / or detailed archaeological excavations
- Identify appropriate measures to avoid, minimise and / or mitigate potential impacts.

7.1.7 Landscape character and visual amenity

Existing environment

The project traverses an environment of varying landscape character and visual sensitivity. An overview of the existing landscape character and visual amenity is provided in Table 7.5.

Table 7.5 Overview of the existing landscape character and visual amenity

Location	Existing landscape character and visual amenity
Chatswood dive site and surface track works	The site comprises a length of railway corridor extending from in the vicinity of Brand Street at Artarmon to Albert Avenue in Chatswood. The high-rise skyline of Chatswood is prominent in northerly views along the corridor, framed by the steep embankments and surrounding vegetation in some parts. The corridor is a predominantly residential precinct with a mix of brick detached houses and two to three storey unit blocks. A television tower sits prominently on an elevated location at the Hampden Road near Mowbray Road. This tower is a local visual landmark, and seen from surrounding residential and commercial areas. Between Mowbray Road and Nelson Street, and west of the rail corridor towards the Pacific Highway, is an Ausgrid compound with a larger grain of built form including a mix of light industrial buildings and institutional style office buildings. The Chatswood Bowls Club and a wide multiuse footpath, 'Frank Channon Walk' runs alongside the railway corridor, connecting the Chatswood Station Precinct at Albert Avenue with Nelson Road. Chatswood Park and Oval, is located within the setting of multistorey residential and highrise commercial buildings at the Chatswood Centre. This parkland includes a mature framework of trees and a manicured sports oval with formal gardens and a number of small scale recreational buildings. Chatswood Station, and bridge over Albert Avenue, and adjacent formal parkland, create a gateway into the Chatswood CBD precinct.
Artarmon substation	The site includes grassland and scrubby vegetation around its eastern perimeter and along Butchers Lane. Residential areas are located to the north, east and south and include a mix of low scale residential (including early 20th century single storey brick houses) and 2-4 storey brick unit blocks. The Gore Hill Freeway forms the south western boundary of the site, is about 13 lanes wide in this area and is about 10 metres lower than the site. Views of the Freeway are protected somewhat due to the level changes and noise walls. Trees lining Butchers Lane filter views from the rear of properties on the southern side of Milner Street, which have rear gardens directly opposite the project site.
Crows Nest Station	There is a mixture of tall, medium and low building heights of varying ages, including office developments, apartments, retail and food outlets at ground level. Low-scale highway-oriented, showroom developments are located along the Pacific Highway, including a concentration of 19th century two-storey shopfront parapets south of Hume Street. Willoughby Road is a retail and restaurant precinct, and the heart of Crows Nest. The mature London Plane trees along Oxley Street, Clarke Street and the Pacific Highway soften views and provide a unifying element along an otherwise eclectic and architecturally disjointed urban streetscape.

Location	Existing landscape character and visual amenity
Victoria Cross Station	The built character of this area is mainly high rise interspersed with schools, tertiary education facilities and several heritage buildings and conservations areas. Key heritage sites include the MLC building, the jewellery shop, North Sydney Post Office, Rag and Famish hotel, Monte St Angelo Convent and Girls School, and 'Don Bank' museum and gardens, which offer an insight to the scale and character of this area during the 19th and early 20th century.
Barangaroo Station	Barangaroo is divided into three precincts: Barangaroo Point Reserve, Central Barangaroo and Barangaroo South. The proposed station is located in Central Barangaroo. Barangaroo Point Reserve is located at the northern end of Barangaroo where it meets Millers Point. It is a 6 hectare harbour foreshore park, designed as a contemporary interpretation of the pre-1836 headland, with bush walks, grassed areas, lookouts, walking and cycle paths. South of the Barangaroo Point Reserve, the 5.2 hectare Central Barangaroo precinct is currently being planned. It will be the cultural heart of Barangaroo. The development is expected to include civic and cultural attractions with recreational, residential, retail and commercial uses. Located on the southern portion of the peninsula, Barangaroo South will be a major extension of the Sydney CBD. A mixed use precinct, it will have office buildings, residential apartments, a landmark international hotel, shops, cafes and restaurants, and a waterfront promenade. Transport for NSW has recently gained planning approval for a ferry hub at Barangaroo, which is expected to open to customers in 2016. Hickson Road forms the eastern boundary of the Barangaroo development site. Hickson Road is located at the base of a distinctive cliff, which rises about four storeys high. The cliff is a local visual feature, with its exposed sandstone rock face and masonry, heritage railings and staircase cut into the stone. The cliff also creates a strong spatial 'edge' to the Barangaroo peninsular between Munn Street and the High Street stairs in the south, and a physical barrier to east–west movement. South of the High Street stairs are a mixture of contemporary and heritage buildings which align with the line of the wall, addressing the road with a mix of commercial, offices and service entries.
Martin Place Station	The station precinct is influenced by two of central Sydney's most prominent urban plazas, Chifley Square and Martin Place. The precinct is traversed by several important civic streets, including Elizabeth, Castlereagh and Hunter streets, which are lined by office towers, with intermittent mature trees, creating important streetscape vistas. The setting of the proposed northern station building is characterised by the unique and historic semi-circular urban form of nearby Chifley Square, including Qantas House and Chifley Tower, which follow the curved alignment of Chifley Square. These buildings create a distinct sense of enclosure for Chifley Square and this corner of the Sydney CBD. The proposed southern station building site is located on the southern side of Martin Place, between Castlereagh and Elizabeth streets, opposite the historic Commonwealth Bank building. There is an office tower (of about 20 storeys) on the site with an entry-level plaza, stairs and retail space. The character of this site is influenced by the verticality of buildings flanking the southern edge of Martin Place. The built form of Martin Place is marked by iconic and identifiable buildings that both attract attention and channel views along surrounding streets.

Location	Existing landscape character and visual amenity
Pitt Street Station	The proposed station is located in the heart of the Sydney CBD, in one of the busiest parts of the city for vehicular and pedestrian movement. The site is a short walk, and in view of, some of Sydney's most prominent landmarks and attractions. The nearby streets are lined by a mixture of low and high-rise office, commercial and apartment buildings of varying ages and styles. They mainly include retail space, restaurants and cafés at street level. Near the corner of Pitt and Park streets, and extending somewhat up Pitt Street, are a number of four to six-storey buildings with decorative historic facades, a number of them in stone, brick and masonry, and in Victorian and Art Deco styles. These streets are flanked by paved footpaths, from building to kerb, with intermittent awnings, which are heavily used by pedestrians throughout the day.
Central Station	The western forecourt, known as Railway Square, is the major visual and functional gateway to the city from west and south. The intersection of George and Pitt streets is one of Sydney's busiest and largest intersections, which has traditionally dispersed traffic and pedestrians into and out of the city. The area is typified by a concentration of low to medium scale heritage buildings (of three to seven storeys) and streetscapes, a series of varied interrelated open spaces and a rich mix of uses and activities, including commercial, industrial, institutional, residential and hotel. The predominant built form is multi-storey warehouse (as opposed to the tower form), which prevails in the city centre to the north of the area. The platforms within Central Station are seen as part of the overall platform complex. The platforms are characterised by their Victorian corrugated iron roof canopies. From the platforms to the south are views to the main Central Station clock tower, associated sandstone buildings and the city skyline. The central rail yard is surrounded by several railway lines entering Central Station from the south and west, giving it an open, industrial character. This area of the station merges visually with the surrounding railway lines, characterised by corridors of ballast, and overhead wiring equipment. Prince Alfred Park is a historic parkland south of Central Station, within the suburb of Surry Hills. The park is bounded by Chalmers Street, Cleveland Street and the railway. Trees and elements of the layout from the original 1870 plan of the park still exist on the site today including Moreton Bay fig trees arranged as an informal row along the boundaries. Regent Street is a wide, heavily trafficked five-lane road, located along the western side of Central Station, connecting Chippendale to the Pitt and George Street intersection. Adjacent to Central Station, Regent Street incorporates five terrace style houses, a two-storey petrol station, a Masonic Temple, a three-storey contemporary residential building and the heritage Mortuary Station. The visual character around Central Station (including areas along Eddy Avenue and Chalmers Street) is expected to change following the introduction of the CBD and South East Light Rail. This project will introduce new transport infrastructure into this area, including a new light rail stop on Chalmers Street, light rail tracks and associated infrastructure. Further consideration of the visual changes likely to occur at this location as a result of the CBD and South East Light Rail and this project will be provided in the environmental impact statement.

Location	Existing landscape character and visual amenity
Southern construction site	The character of this area is strongly influenced by its industrial history and transport network including the railway, busy main roads and Sydney Airport. The area includes heritage items dating back to its time as an industrial and manufacturing hub during the 19th and early 20th centuries when activities included steel works, mills, brick making and pottery. In particular, this includes a local heritage listed brick-lined drainage pit on Garden Street. Buildings in this area are mainly single and double storey industrial buildings. There are also some three and four-storey commercial / industrial buildings.

Potential construction impacts

The construction of the project may cause temporary adverse impacts on landscape character and visual amenity for those who work, study, reside, visit, or access businesses / community services within the project area. These impacts may result from:

- The establishment of construction compounds, work sites, a pre-cast concrete facility and stockpiles, particularly at the proposed station locations
- Light spill from construction sites during out-of-hours construction
- Aboveground construction works including dive structures and tunnel portals, and surface track works
- The erection of fencing, barricades, gates and security lighting to provide safe and secure work sites
- The erection of acoustic sheds and hoarding to mitigate construction noise impacts
- Construction vehicle movements both within construction work sites and along haulage routes
- Traffic disruptions associated with traffic management measures (road diversions / closures) and / or construction traffic
- The removal of some street trees
- The parking and use of construction plant and equipment.

The impact of the project on individual sensitive receivers would be dependent on the stage of construction, their location and severity of the impact. Visual amenity impacts during construction would be greatest where residential / sensitive receivers have unscreened views of the construction work site.

Potential operational impacts

Potential landscape character and visual amenity impacts that could occur during the operation of the project include:

- Adverse visual impacts associated with the introduction of new stations and other rail related infrastructure (such as tunnel portals)
- Adverse impacts on landscape character due to the establishment of new infrastructure (such as station buildings and Artarmon substation)
- Changes to landscape character (both negative and positive) due to potential future above station development and associated changes to the existing traffic / pedestrian environment and streetscape
- Light spill from station lighting.

Proposed investigations and assessment for the environmental impact statement

A visual and urban design impact assessment will be undertaken as part of the environmental impact statement. The assessment will:

- Describe the visual character and unique qualities of the project area
- Interpret the design to identify the visual character and urban design of the project
- Assess the compatibility of the project with its context
- Identify the visual impacts of the project during daytime and night-time conditions (including lighting), and throughout construction and operation
- Consider land use changes where they may influence the character of the existing site
- Consider the heritage and other social values of the site to establish the potential sensitivity of receptors and visual absorption capacity
- Consider potential cumulative impacts associated with the construction / operation of other major projects near the project site
- Identify measures to avoid, minimise and / or mitigate potential impacts.

7.1.8 Groundwater and geology

Existing environment

Geology

The project is located within the Sydney Basin, a large depositional geological feature that spans from Batemans Bay to the south, Newcastle to the north and Lithgow to the west. The *Sydney 1:100,000 Geological Series Sheet 9130* (NSW Department of Mineral Resources, 1983) indicates that the project is underlain by:

- Wianamatta Ashfield Shale – generally consisting of black to dark grey shale and laminate
- Hawkesbury Sandstone – generally consisting of medium to coarse-grained quartz sandstone, very minor shale and laminate lenses
- Mittagong Formation – comprising interbedded shale and fine-grained sandstone.

Aquifer systems

The project would be primarily constructed through rock, consisting of medium to coarse-grained quartz sandstone (associated with Hawkesbury Sandstone); interbedded shale and fine-grained sandstone (associated with the Mittagong Formation); and siltstone and fine-grained lithic sandstone (associated with the Wianamatta group).

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.

If a station at Waterloo is pursued, it is likely that the station excavation would interface with the Botany Sands Aquifer system. In this case, the environmental impact statement would include additional consideration of the potential impacts on this aquifer and any groundwater dependent ecosystems associated with it (as part of the ecological assessment).

Groundwater levels

Groundwater levels in the deeper groundwater system are expected to range between 15 and 35 metres below ground level, with the top of the rock formations expected to be unsaturated. Groundwater levels in the surface groundwater system are expected to range between two and five metres below ground level.

Groundwater flows

Groundwater yield throughout the project area is expected to be low to very low. A review of the NSW Office of Water's PINNEENA database indicates that typical groundwater flows through the Mittagong Formation and Hawkesbury Sandstone are about 0.2 to 0.3 litres per second, while flows through the Ashfield Shale are likely to be less than 0.01 litres per second.

Groundwater users

There is limited groundwater use along the project alignment due to the geological environment generally consisting of low permeability shale, siltstone and sandstone. A review of the NSW Office of Water's PINNEENA database identified the following groundwater users in the vicinity of the alignment as detailed in the indicative alignment drawings in this report:

- A recreation water supply well (GW107757) located about 100 metres east of the surface track works in the suburb of Chatswood
- A recreation water supply well (GW029731) located about 95 metres east of the surface track works in the suburb of Chatswood
- A domestic water supply well (GW072478) located about 300 metres south west of the tunnel corridor in the Artarmon Industrial Area
- A domestic water supply well (GW108224) located about 370 metres north east of the tunnel corridor in the suburb of Naremburn
- A domestic water supply well (GW107764) located about 80 metres west of the tunnel corridor in the suburb of North Sydney
- A recreation water supply well (GW071907) located about 700 metres south east of the tunnel corridor in the suburb of Redfern
- A domestic water supply well (GW106192) located about 680 metres south east of the tunnel corridor in the suburb of Alexandria
- A domestic water supply well (GW110247) located about 500 metres north west of the tunnel corridor in the suburb of Newtown
- A domestic water supply well (GW105938) located about 400 metres east of the tunnel corridor in the suburb of Erskineville
- A recreation water supply well (GW110351) located about 580 metres south east of the tunnel corridor in the suburb of Erskineville
- A domestic water supply well (GW111164) located about 820 metres south east of the tunnel corridor in the suburb of Erskineville

Potential construction impacts

Potential groundwater and geology impacts that could arise during construction include:

- Groundwater drawdown / lowering of the water table due to dewatering during tunnel and station excavations and / or drawdown incurred by bed cracking or interference with geological features beneath surface-water bodies and drainage lines
- Ground movement and settlement due to tunnelling, excavation and / or groundwater drawdown
- Impacts on groundwater users due to reduced groundwater yields, reduced groundwater quality and / or direct impacts and damage to existing groundwater bores.

Potential impacts on groundwater dependent ecosystems would also be considered as part of the ecological assessment.

The tunnels would be lined to prevent significant volumes of groundwater ingress. Therefore, tunnel construction is anticipated to cause only a short-term disruption to groundwater levels as the system should adjust back to its natural state once excavation has passed and the permanent tunnel lining is installed.

Whilst yet to be determined, station excavations, if undrained, would result in drawdown during construction depending on site-specific conditions, and the interaction of recharge sources and drainage measures. The generally low hydraulic conductivity of the Mittagong Formation, Hawkesbury Sandstone and Ashfield Shale geological units indicates that the extent of groundwater drawdown may be limited by relatively low discharge rates compared to recharge sources.

Potential operational impacts

Potential hydrogeological impacts that could arise during operation of the project include:

- Groundwater drawdown / lowering of the water table due to station excavations, if undrained stations are progressed (as discussed previously, the low hydraulic conductivity of geological units in the project area indicates that the extent of groundwater drawdown may be limited by relatively low discharge rates compared to recharge sources)
- Potential for groundwater levels to rise during unusually wet seasons, resulting in groundwater ingress into the previously dry sections of the tunnels and / or stations
- Impacts on groundwater users due to reduced groundwater yields as a result of groundwater drawdown.

Proposed investigations and assessment for the environmental impact statement

A desktop-based hydrogeological assessment will be undertaken as part of the environmental impact statement. The following government guidelines will be considered as relevant during the preparation of the hydrogeology assessment:

- *NSW Aquifer Interference Policy* (Department of Primary Industries, 2012).

The hydrogeological assessment will:

- Describe the aquifer system(s) traversed by the project
- Identify existing groundwater levels along the alignment and near the stations and portals
- Identify sensitive groundwater receptors (registered groundwater bores)
- Discuss the nature and extent of potential impacts on groundwater associated with construction and the presence of end-state project infrastructure including tunnels, portals and station excavations. This would take into account existing groundwater levels, the geological context, the extent to which the infrastructure is 'tanked' (with sealed walls) and experience on other projects (including groundwater inflow rates)
- Propose monitoring / management measures to address identified impacts.

7.1.9 Soils, contamination and water quality

Existing environment

Geology

A description of the geology underlying the project area is provided in Section 7.1.8.

Soils

Based on the *Sydney 1:100,000 Soil Landscape Series Sheet 9130* (Soil Conservation of NSW, 1966) the project is located within the following soil landscapes:

- Birrong – generally associated with localised flooding, high soil erosion hazard, saline subsoils, seasonal waterlogging, and very low soil fertility
- Blacktown – are generally moderately reactive, highly plastic subsoil, with low fertility and poor drainage
- Deep Creek – generally exhibit flooding, extreme soil erosion hazard, sedimentation hazard, localised very low fertility and permanently high water tables
- Lucas Heights – generally exhibit stony soil, low soil fertility and low available water capacity
- Gymea – generally exhibit high soil erosion, rock outcrop, shallow highly permeable soil, and very low soil fertility
- Glenorie – generally exhibit high soil erosion hazard
- Hawkesbury – generally exhibit extreme soil erosion hazard, mass movement (rockfall) steep slopes, rock outcrop, shallow, stony, highly permeable soils with low fertility
- Disturbed – soils generally depend on nature of fill material and include subsidence resulting in a mass movement hazard, soil impermeability leading to poor drainage and low fertility.

Acid sulfate soils

Acid sulfate soils risk varies across the project. There is a high probability of acid sulfate soils occurring at the following locations:

- Areas located opposite Erskine Street, Barangaroo
- Areas of the Sydney Harbour foreshore
- Sydenham
- Sydney Harbour sediments.

There is also the potential for acid sulfate soils to be present at all other aboveground project elements (the stations, southern dive structure and tunnel portal); however, the risk of acid sulfate soils in these areas is likely to be low, given their general topography and locations relative to estuarine environments.

Contamination

A search of the NSW EPA Contaminated Sites Register and Record of Notices (under Section 58 of the *Contaminated Land Management Act 1997*) identified 13 registered sites within 500 metres of the project area. Of these, the project may interface with the following sites:

- Former Caltex service station within Ausgrid site – 607 Pacific Highway, Chatswood
- Former AGL Gasworks, 30–34 Hickson Road, Barangaroo
- Former AGL Gasworks, 36 Hickson Road, Barangaroo
- Former AGL Gasworks, 38 Hickson Road, Barangaroo
- Former AGL Gasworks, berths 5, 6 and 7 (already demolished) and part Hickson Road, Barangaroo
- Former AGL Gasworks, road reserve fronting 30–38 Hickson Road, Barangaroo.

An inspection of the project sites also identified potential areas of environmental interest that have the potential to be contaminated. These areas comprise:

- A service station on Regent Street adjacent to Central Station
- Reclaimed land within Barangaroo
- Industrial land uses at Artarmon and Marrickville
- Channel 7 and 10 transmission tower at Chatswood
- Sydney Water reservoirs at Chatswood
- Industrial land uses in the vicinity of the southern tunnel portal
- The existing rail corridor.

The risk of contamination will be further considered during the preparation of the environmental impact statement.

Surface water quality

Watercourses near the project corridor (as outlined in Table 7.6) are heavily urbanised and, in some locations, piped underground or concrete lined. Water quality along the project alignment is largely 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.

Marine water quality

The NSW Office of Environment and Heritage measures the recreational water quality of Sydney's harbours and surrounding beaches through the Beachwatch programs. Rainfall data is used to predict the likelihood of bacterial contamination at sample sites. Relevant samples have been taken at various locations in Middle Harbour, Sydney Harbour and Botany Bay. The closest monitoring sites to the project are Hayes Street Beach at North Sydney in Middle Harbour and Kyeemagh Baths at the mouth of Cooks River at Port Botany. According to the *Central Sydney State of the Beaches 2013-2014* report (Beachwatch, 2014), the water quality at Hayes Street Beach and Kyeemagh Baths over this 12 month period was considered to be good.

Groundwater quality

The expected groundwater quality derived from the geological units is as follows:

- Ashfield Shale – brackish groundwater, with salinity ranging from 5000 to 20,000 milligrams per litre and a neutral pH. The concentration of dissolved metals and nutrients is expected to be low. Organic compounds are not naturally associated with this geological unit
- Hawkesbury Sandstone – fresh to brackish groundwater, with salinity ranging from 500 to 10,000 milligrams per litre and a neutral pH. The concentration of trace ions (such as iron and manganese) and dissolved metals and nutrients is expected to be low. Organic compounds are not naturally associated with this geological unit
- Mittagong Formation – Water quality is expected to range between fresh (<1000 milligrams per litre as total dissolved solids) to brackish (1000 to 20,000 milligrams per litre as total dissolved solids) with a neutral pH, reflecting its depositional history as interbedded shale and medium-grained quartz sandstone.

Potential construction impacts

Soil erosion

Construction of the project would expose the natural ground surface and sub-surface through the removal of vegetation, overlying structures (such as buildings and footpaths) and excavation of construction footprints for stations, structures and foundations. The exposure of soil to water runoff and wind could increase soil erosion potential, particularly where construction is undertaken in soil landscapes characterised by a high and extreme erosion hazard. There is the potential that exposed soils and other unconsolidated materials (such as spoil, sand and other aggregates) could be transported from the construction sites into surrounding waterways via stormwater runoff.

Given the relatively small areas of surface disturbance anticipated during construction and the overall topography of those parts of the project (generally slightly undulating), soil erosion would be adequately managed with standard management measures (which would be developed as part of the environmental impact statement).

Acid sulfate soils

The exposure of acid sulfate soils during excavation could result in the release of acid sulfates, which would damage surrounding vegetation and drainage lines. Given the risk of encountering acid sulfate soils during construction, management measures will be developed as part of the environmental impact statement to identify, contain and monitor acid sulfate soils (if encountered) throughout construction. Potential risks associated with encountering acid sulfate soils will be further considered as part of the environmental impact statement.

Contamination

There is the potential for contamination to be encountered at a number of locations throughout the project. Contaminants that could be encountered during excavation and other ground disturbing activities include:

- Contamination associated with leaks and spills from fuel storage infrastructure (hydrocarbons and heavy metals)
- Contamination associated with processing of heavy end hydrocarbons, heavy metals and metalloids
- Contamination associated with land reclamation and other uncontrolled fill material (metals, hydrocarbons, pesticides, PCB and asbestos)
- Contamination associated with former and current industrial land uses (hydrocarbons, heavy metals and metalloids, solvents, phenolics, pesticides, heavy metals and metalloids and asbestos in soil)
- Contamination associated with existing railways and associated activities (metals, hydrocarbons, pesticides, nutrients, phenols, carbamates, pesticides, herbicides and asbestos in soils).

The exposure of any contaminated materials during construction may increase the potential for contaminant mobilisation and may create additional exposure pathways to sensitive receptors including workers, the general public, surface water bodies, groundwater bodies and terrestrial ecosystems. Potential risks associated with encountering contaminated soils and groundwater will be considered as part of the environmental impact statement.

Construction also has the potential to result in contamination of soils and / or groundwater due to spills and leaks of fuel, oils and other hazardous materials. These impacts are anticipated to be readily manageable through standard environmental management measures.

Surface water quality

Construction has the potential to adversely affect water quality in nearby watercourses and receiving catchments through the pollution of stormwater runoff with sediments, fuel and other hazardous materials from construction sites. These impacts would be adequately managed with standard environmental management measures. These measures would be consistent with the principles and practices detailed in *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004).

Given that potential impacts could be readily manageable through standard mitigation measures, surface water quality is not considered to be a key issue for the project.

Marine water quality

There may be the potential for water quality impacts associated disturbance of the seabed during the ground improvements works within Sydney Harbour. At this stage a number of different methods are being investigated with a focus on those that would have minimal environmental impacts. Regardless of the final methods adopted, environmental management measures would be used to ensure minimal impacts on the existing water quality of Sydney Harbour.

Groundwater quality

Potential impacts on groundwater quality from the construction of the project would be associated with:

- The generation of turbid, saline or contaminated water collected from within the tunnels and station excavations, which would require disposal
- Contaminants such as oils and chemicals from construction activities leaking to the water table.

Potential operational impacts

Contamination

Operation of the project has the potential to result in contamination of soils and / or groundwater due to spills and leaks of fuel, oils and other hazardous materials from trains, maintenance vehicles and other project infrastructure. These impacts are anticipated to be readily manageable through standard environmental management measures.

Water quality

Operation of the project is not anticipated to result in significant adverse impacts on surface water quality. All groundwater and surface water runoff from the proposed tunnels would be captured and pumped to the water treatment plants (located adjacent to the southern dive structure) prior to reuse and / or disposal.

Runoff from above ground project elements (such as station buildings) have the potential to be contaminated with sediments, fuel / oils (for example, from maintenance vehicles) and / or other pollutants (such as litter), which could enter the surrounding stormwater system.

During operation, there may also be the generation of turbid, saline or contaminated groundwater collected from within the tunnels and station excavations, which would require disposal.

Such water quality risks would be relatively minor and could be adequately managed with standard management measures.

Proposed investigations and assessment for the environmental impact statement

A soils, contamination and water quality assessment will be undertaken as part of the environmental impact statement. The following government guidelines will be considered as relevant during the preparation of the soils, contamination and water quality assessment:

- *Acid Sulfate Soils Assessment Guidelines* (Department of Planning, 2008)
- *Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land* (Department of Urban Affairs and Planning and Environment Protection Authority, 1998)
- *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004)
- *Managing Urban Stormwater: Soils and Construction Volume 2* (Department of Environment and Climate Change, 2008)
- *Guidelines for Consultants Reporting on Contaminated Sites* (Office of Environment and Heritage, 2000)
- *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* (Department of Environment and Climate Change, 2009)
- *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (Department of Environment and Climate Change, 2008)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC / ARMCANZ, 2000)
- *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (Department of Environment and Conservation, 2006).

The soils, contamination and water quality assessment will include:

- A review of previous contamination assessments (where available)
- A review of historical aerial photography of the project area (to identify potential contamination sources along and / or adjacent to the project)
- A review of publicly available data (web-based information searches)
- A site inspection to identify potential contamination sources and verify those potential areas of concern identified in the review of historical and available information
- Recommendations for additional investigations and / or management of potentially contaminated sites which could be encountered during construction.

The environmental impact statement will also:

- Identify potential impacts on surface water quality and groundwater quality
- Identify the potential to disturb acid sulfate soils and the associated impacts
- Consider the potential impacts associated with erosion and sedimentation.

7.1.10 Social impacts and community infrastructure

Existing environment

Community infrastructure includes the services that help individuals, families, groups and communities meet their social needs, maximise their potential for development and enhance community wellbeing. Community infrastructure includes schools, childcare centres, places of worship, medical / healthcare infrastructure and recreational areas (such as public open space). A variety of community infrastructure is located within and adjacent to the project.

Potential construction impacts

Potential social and community impacts that could occur during construction include:

- Loss of community infrastructure – direct impacts would occur where a community facility exists within the footprint of the construction area. For example it is anticipated that the project would directly impact parts of Martin Place. In some instances, alternative facilities may be available in the local area, or the facilities may be easily replaceable in the local area
- Amenity impacts – community facilities are potentially more sensitive to amenity impacts such as noise, vibration, air quality and visual changes. The ability of certain community facilities to function, or the community's enjoyment of them, may be reduced where they are located close to construction sites
- Temporary disruptions to access – construction sites and activities may result in loss of access or restricted access to and from community facilities
- The potential human health impacts associated with long term construction noise (refer to Section 7.1.2)

Potential operational impacts

Potential social and community impacts that could occur during the operation of the project include:

- Loss of community facilities – direct impacts would occur where a community facility exists within the footprint of the operating project. In some instances, alternative facilities may be available in the local area, or the facilities may be easily replaceable in the local area
- Amenity impacts – community facilities are potentially more sensitive to amenity impacts such as noise, vibration, air quality and visual changes. The ability of certain community facilities to function, or the community's enjoyment of them, may be reduced where they are located close to operational infrastructure
- Electric and magnetic fields – the project would require a number of substations to provide traction power to the metro trains. These substations have the potential to introduce risks associated with electric and magnetic fields. To manage this risk, the design of the project would comply with the requirements of the *Draft Radiation Standard – Exposure Limits for Magnetic Fields* (Australian Radiation Protection and Nuclear Safety Agency, 2006).

The project would facilitate transit oriented development (and associated increases in urban density) through the generation of new rail catchment areas. There are a number of health benefits that can be attributed to increased urban density, primarily associated with increased active transport opportunities around transit stops. For example, key health benefits associated with the project could include:

- Less reliance on the motor vehicle including private cars and taxis by trip substitution
- Increased walking trips from changes in density in the various areas
- Increase in walking trips due to less reliance on motor vehicles such as private cars and taxis
- Increased walking trips due to population movements from areas with lower walking trips per person per day to areas with higher walking trips per person per day
- Improvements to local air quality with less motor vehicle movements
- Improvements to safety and reduced accidents due to reduction in vehicle kilometres travelled.

Proposed investigations and assessment for the environmental impact statement

An assessment of potential social and community impacts will be undertaken as part of the environmental impact statement. This assessment will:

- Identify any community facilities that would be lost as a result of construction or operation of the project. In this instance, the assessment will identify if alternative facilities are available or if the facilities can be replaced in the local area
- Identify community facilities adjacent to construction sites and operational infrastructure that may be impacted by reduced amenity
- Identify where access may be lost or restricted as a result of construction of the project. In this instance, the assessment will identify if suitable alternative access can be provided to the facility
- Consideration of electric and magnetic fields in accordance with the *Draft Radiation Standard – Exposure Limits for Magnetic Fields* (Australian Radiation Protection and Nuclear Safety Agency, 2006)
- Consider the potential health benefits associated with public transport.

A formal Health Impact Assessment (HIA) is not considered to be required, based on a preliminary screening which indicates:

- The potential negative health issue would primarily relate to impacts of construction – particularly noise and potentially associated amenity impacts. These issues would be comprehensively addressed in the respective technical assessments.
- Any negative impacts are expected to be very localised and would be more appropriately addressed on the specifics of the case
- Potential negative impacts are common, well documented, measurable and there are well known applied and effective strategies for management and mitigation
- There are no unique populations potentially affected by the project
- There would be opportunities for refinements and improvements to management and mitigation strategies at an individual construction site basis. These strategies would be tailored to the uniqueness of the construction site and programme and to the specific sensitive receivers
- There is well-documented evidence of the potential impacts of similar proposals within similar contexts.

7.1.11 Cumulative impacts

Overview of cumulative impacts

Cumulative impacts that may occur during the construction and operation of the project can generally be categorised as either:

- Type 1: Different impacts upon the same receiver – these may arise as the result of an accumulation of impacts of a different nature at the same location. For example, the combined effect of construction noise and visual impacts may give rise to an overall significant impact on business viability, whereas individually these impacts may not be as significant
- Type 2: Cumulative impacts generated by the project – these may arise as a result of the accumulation of impacts of the same type at a number of different locations. For example, a small number of truck movements generated at different construction sites associated with the project may collectively give rise to an overall significant impact
- Type 3: Cumulative impacts with other projects – these may arise as a result of the combination of similar impacts from multiple projects. For example, the noise-related impacts of the project may be magnified by their association with other major noise-emitting projects nearby.

The extent to which another development or activity could interact with the construction and / or operation of the Chatswood to Sydenham project would be dependent on its scale, location and / or timing of construction. Generally, the largest adverse cumulative impacts would be expected to occur in situations where multiple long-duration construction activities are undertaken close to, and over a similar timescale of, construction activities for the Chatswood to Sydenham project.

Other known developments

Publicly announced projects that have the potential to adversely interact with either the construction and / or operation of the Chatswood to Sydenham project are:

- CBD and South East Light Rail
- WestConnex – New M5 and Stage 3
- Barangaroo
- Sydney Metro Northwest (formerly known as North West Rail Link)
- Sydney Metro Sydenham to Bankstown upgrade.

Potential construction impacts

Potential cumulative impacts that could arise in situations where the construction of the project occurs concurrently with other known developments include:

- Construction traffic – cumulative impacts may occur where multiple construction projects use the same construction traffic routes at the same time. Cumulative impacts could include traffic congestion (particularly if truck movements occur during peak hour and if truck queuing occurs), and amenity impacts (such as noise, visual and air quality) on sensitive receivers near these construction traffic routes
- Loss of on-street parking and / or other kerbside uses (such as loading zones) – construction of the project has the potential to affect the supply of some on-street parking and other kerbside uses (such as loading zones). Parking availability could be further affected by a number of other projects, particularly within the Sydney CBD, where the CBD and South East Light Rail project (and other strategies proposed as part of the City Centre Access Strategy) could affect the location and / or number of parking spaces
- Disruptions to the reliability of public transport – the presence of multiple construction sites could result in longer commuter travel times due to multiple disruptions to bus and / or rail services, which may require some customers to use multiple modes of transport (due to the need to switch to rail replacement buses) to reach their destinations
- Construction noise, vibration and visual amenity – there is potential for impacts from the project to be exacerbated by other nearby construction sites operating either simultaneously with the project or very shortly before or after the project. Cumulative impacts could include construction fatigue due to longer periods of construction noise on a daily basis and an overall basis, increased overall noise levels, night works that persist for longer at night or persist for more consecutive nights, and increased extent and / or duration of visual amenity impacts
- Loss of public open space – the availability of public open space could be temporarily reduced due to the establishment of multiple construction compounds and / or work sites. This would particularly be likely to occur within the city, where the CBD and South East Light Rail is expected to require the use of multiple CBD parks. The community's enjoyment of nearby public open spaces (that are not directly affected by construction) could be affected by increased construction noise and visual amenity impacts

- Business impacts – businesses could be affected by the effects of various cumulative impacts, such as the loss of on-street parking for customers, disruptions to loading zones and deliveries and / or the loss of and disruption to ground-floor retail spaces
- Spoil management – concurrent tunnelling projects, particularly WestConnex and NorthConnex, will increase the volume of spoil being generated within the Sydney metropolitan region, which has the potential to affect spoil reuse opportunities and the disposal strategy of the project.

Potential operational impacts

Potential cumulative impacts that could arise due to the concurrent operation of the project and other known developments include:

- Non-Aboriginal heritage impacts – project infrastructure (such as station buildings) in the vicinity of other surrounding developments could impact on the setting or heritage significance of heritage listed items and / or heritage conservation areas. This impact could particularly occur within the Sydney CBD, where a large number of State and locally listed heritage items are situated close to the project and other known developments (such as the CBD and South East Light Rail).

Proposed investigations and assessment for the environmental impact statement

Details of known surrounding developments with the potential to interact with the construction and / or operation of the project will be identified through consultation with stakeholders and a review of relevant local environmental plans, the Department of Planning and Environment's major projects database and local council development application registers. Potential cumulative impacts arising from the interaction of these projects will be identified and assessed in a qualitative manner. Management and mitigation measures will be proposed, where appropriate.

7.2 Other environmental issues

As outlined in Chapter 6, the 'other' environmental issues identified for the project are:

- Ecology
- Hydrology and flooding
- Air quality
- Greenhouse gas and energy
- Climate change adaptation
- Hazard and risks
- Waste and resource use.

The following sections provide a preliminary assessment of these issues and outline the proposed scope of assessment to be undertaken as part of the environmental impact statement.

7.2.1 Ecology

Existing environment

A site inspection was carried out on 25 May 2015 to identify the presence (or otherwise) of threatened ecological communities, threatened flora and fauna, fauna habitat values and noxious weed species.

The project would be located in a highly urbanised environment that is characterised by intensive residential, commercial and industrial land uses. Open space is largely dedicated to recreational use in parks such as Prince Alfred Park, and most watercourses in the project area have been channelised.

Almost all of the original vegetation and other natural features of the project area have been removed or modified, and biodiversity values have been greatly reduced as a result of former developments.

Terrestrial vegetation communities

The area is highly modified and has been historically cleared of native vegetation. No naturally occurring vegetation communities were observed during site inspections, and none of the vegetation meets the criteria for any threatened ecological community listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or the *NSW Threatened Species Conservation Act 1995* (TSC Act).

Vegetation occurring within the project area generally consists of native and exotic street trees, landscape plantings (in parks), exotic grassland / lawns and an isolated area of native grassland (generally restricted to an area running parallel to Cleveland Street, Redfern).

Terrestrial threatened and migratory species

No threatened flora species were recorded during site inspections. Given the low native flora habitat values of the project site, there is a low likelihood of any threatened flora occurring, with the exception of planted specimens.

The following four fauna species listed under the EPBC Act and / or TSC Act are considered to have a high or moderate likelihood of occurrence at one or more locations in the area:

- Grey-headed Flying-fox – listed as vulnerable under the TSC Act and EPBC Act. Fig trees in the Barangaroo road reserve would provide a foraging resource for this species
- Eastern Freetail-bat – listed as vulnerable under the TSC Act. Buildings around Central Station and the southern portal site could provide potential roosting habitat for this species.
- Eastern Bentwing-bat – listed as vulnerable under the TSC Act. Buildings around Central Station and the southern portal site could provide potential roosting habitat for this species.
- Black-faced Monarch – listed as a migratory species under the EPBC Act. There is potential for this species to occur in suburban parks.

Potential micro bat habitat may also exist under jetties and wharves around Sydney Harbour.

Groundwater dependent ecosystems

A search of the National Atlas of Groundwater Dependent Ecosystems (Bureau of Meteorology, 2015) did not identify any groundwater dependent ecosystems within or surrounding the project area. However, one high priority groundwater dependent ecosystem – the Botany Wetlands – is located about three to four kilometres to the east (it is listed on Schedule 4 of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*). The Botany Wetlands are associated with the Botany Sands Groundwater Source. The project would not intersect this groundwater source. However, if a station at Waterloo is pursued, the station excavation is likely to intersect this groundwater source. In this event, the ecological assessment will consider the potential impacts on this groundwater dependent ecosystem.

Noxious weeds

Noxious weed species are likely to be present within the project area, particularly at project sites which are within existing rail corridors.

Marine flora species

Threatened species of seagrasses are known to occur within Sydney Harbour. A review of the Department of Primary Industries estuarine habitat maps identified that the closest areas of seagrass habitat to the harbour crossing works are located to the west at Balls Head Reserve and the northeast, within Lavender Bay.

Further investigations will be undertaken as part of the environmental impact statement to identify the potential for threatened species of seagrasses (or their habitat) to be present within the project area.

Marine fauna species

According to the Sydney Institute of Marine Sciences, Sydney Harbour has over 570 species of fish, 3,600 invertebrates and many thousands of species of often unique marine microbes (2011). Based on Australian Museum records, 308 species of worms, 118 echinoderms, 1,375 molluscs and 672 crustaceans have been recorded in Sydney Harbour. However, no comprehensive surveys of soft-bottom benthic communities of Sydney Harbour have been undertaken (Sydney Institute of Marine Sciences, 2011).

Notwithstanding, general public knowledge of the history and current state of Sydney Harbour indicates the industrialised nature of the harbour, with past industrial practices in the harbour leading to known contaminated sediments and a deterioration in water quality (Department of Environment Climate Change and Water, 2006).

The open water, where the potential harbour ground improvement works would be undertaken, provides for the transport, dilution and transformation of dissolved and particulate materials that impact harbour ecology. The open water also provides habitat for planktonic foodwebs, facilitates life-stage transitions for meroplankton and fishes, and functions as a corridor for movements of higher trophic levels such as fishes, sharks and mammals (Sydney Institute of Marine Sciences, 2014).

The Threatened and Protected Species Records Viewer published by the Department of Primary Industries showed no threatened and aquatic species within the project area. It is possible, however, that some marine or estuarine species, protected under the *Fisheries Management Act 1994* and EPBC Act may occur in the project area, particularly members of the *Syngnathiformes* order (seahorses, seadragons, pipefish, pipehorses and seamoths).

Two threatened species of fish were returned from a query of the EPBC Act Protected Matters Search Tool – Australian Grayling and Black Rock Cod. Due to a lack of suitable habitat, the Australian Grayling is unlikely to occur in the project area. However, there may be habitat within the marine environment of the project area for the Black Rock Cod. Due to the historical and ongoing disturbance of the marine environment in the site, important habitat for the species is not likely to be present. The search also identified the potential for migratory marine species to be present within Sydney Harbour including various species of turtles, Indo-Pacific Humpback Dolphin, Giant Manta Ray, Mackerel Shark and Great White Shark. Numerous migratory bird species may also fly over the site or use Sydney Harbour as foraging habitat.

Port Jackson is deemed key fish habitat according to maps published by the Department of Primary Industries.

Potential construction impacts

Construction has the potential to result in the following ecological impacts:

- Loss of terrestrial and marine fauna habitat and impacts on threatened and migratory species – clearing of terrestrial and marine vegetation and demolition of existing buildings and structures has the potential to result in the removal of fauna habitat. In particular, the potential removal of fig trees at Barangaroo could impact foraging habitat for the threatened Grey-headed Flying-fox, while the removal of buildings / structures at Central Station and the southern portal site could result in the loss of roosting habitat for microbats, including the threatened Eastern Freetail-bat and Eastern Bentwing-bat. In addition, construction activities in Sydney Harbour, including potential impacts to wharves and jetties, have the potential to impact on habitat for marine and micro bat species (particularly where existing underwater structures are disturbed)
- Injury and mortality of fauna species – fauna injury or mortality could occur during vegetation clearing and / or as a result of collisions with construction plant and vehicles. The majority of fauna species anticipated to occur are likely to be highly mobile bird species. These species are likely to be able to readily move away from vegetation clearing activities. However, there is potential for hollow-dependent birds and mammals and less mobile fauna species to also be present
- Mobilisation of contaminants due to disturbance of sediment within Sydney Harbour – construction activities within Sydney Harbour (including ground improvement works) could result in the mobilisation of contamination within marine sediments. This could impact on marine flora and fauna species within Sydney Harbour
- Indirect impacts such as light and noise, sedimentation, spread of weeds – these risks would generally occur uniformly across the project area
- Cumulative loss of fauna habitat across the project area – a number of other planned projects have the potential to further reduce fauna habitat. In particular, the CBD and South East Light Rail will remove a number of street trees from the Sydney CBD, which may further increase the significance of vegetation clearing from this project if they provide suitable habitat for the same species.

The above impacts are anticipated to be relatively minor and could be adequately managed with standard management measures, such as:

- Retaining vegetation and other fauna habitat resources, wherever possible
- Developing and implementing pre-clearing surveys and fauna handling / relocation procedures prior to the clearing of vegetation and demolition of buildings / structures
- Developing and implementing weed management procedures to prevent the introduction and / or spread of weed species.

With the application of standard environmental management measures, construction of the project is not anticipated to result in a significant adverse ecological impact. Therefore, ecological impacts are not considered to be a key issue during construction.

Potential operational impacts

Ecological impacts during operation of the project would primarily be restricted to:

- The injury / mortality of fauna species, which could result from collisions with trains and / or maintenance vehicles
- Disturbance of fauna species due to indirect impacts such as light and noise.

As the project would be predominantly located underground, within an urban environment, the potential for the above impacts to occur would be relatively minor. Furthermore, fauna species likely to be occupying the area are anticipated to be accustomed to noise and light impacts that are already occurring. For these reasons, ecological impacts are not considered to be a key issue during operation of the project.

Proposed investigations and assessment for the environmental impact statement

An ecology assessment will be prepared as part of the environmental impact statement. The following government guidelines will be considered as relevant during preparation of the ecology assessment:

- *Commonwealth EPBC 1.1 Significant Impact Guidelines – Matters of National Environmental Significance* (Commonwealth of Australia, 2013)
- *Commonwealth EPBC 1.2 Significant Impact Guidelines – Actions on, or Impacting upon, Commonwealth Land and Actions by Commonwealth Agencies* (Commonwealth of Australia, 2013)
- *Commonwealth Department of the Environment – Nationally Threatened Ecological Communities and Threatened Species Guidelines* (various)
- *Commonwealth Department of the Environment – Survey Guidelines for Nationally Threatened Species* (various)
- *Threatened Species Survey and Assessment Guidelines* at http://www.environment.nsw.gov.au/threatenedspecies/surveyassessmentgdlns.htm
- *NSW Biodiversity Offsets Policy for Major Projects* (Office and Environment and Heritage, 2014)
- *Framework for Biodiversity Assessment* (Office and Environment and Heritage, 2014).

The ecology assessment will be based on a desktop review of database searches, regional biodiversity mapping and any relevant existing site-specific reports, as well as site inspection and detailed targeted field surveys, if necessary. The ecology assessment will:

- Identify and describe the flora and fauna species, habitat, populations and ecological communities (including groundwater dependent ecosystems) that occur or are considered likely to occur
- Assess the direct and indirect impacts of the project on terrestrial and aquatic flora and fauna species, populations, ecological communities and their habitats, and groundwater dependent ecosystems
- Assess the significance of the impacts of the project on species, ecological communities and populations, and groundwater dependent ecosystems listed under the EPBC Act, the TSC Act and *Fisheries Management Act 1994* that occur or are considered likely to occur
- Identify and describe mitigation measures using the principles of 'avoid, minimise, mitigate', and propose offsets where residual impacts occur. Offsets would be determined in accordance with the *NSW Biodiversity Offsets Policy for Major Projects* (Office and Environment and Heritage, 2014).

7.2.2 Hydrology and flooding

Existing environment

This section provides a description of the existing hydrology and flooding environment around those elements of the project that would have the greatest potential to interact with surface hydrology and flooding – namely the proposed tunnel portals and metro stations.

Drainage catchments and infrastructure

The project would be located within drainage catchments which ultimately drain to Middle Harbour, Sydney Harbour and Botany Bay. These catchments and receiving waters are summarised in Table 7.6.

All drainage catchments across the project are highly urbanised, with large impervious surfaces created by roads, footpaths and buildings. These impermeable surfaces are interspersed with permeable surfaces associated with parkland areas and other unsealed surfaces (such as vacant land and landscaped areas).

All natural watercourses have generally been replaced with constructed drainage systems (such as lined and unlined drainage channels, and sub-surface pit and pipe networks), which ultimately discharge into the downstream receiving environments (as listed in Table 7.6).

Surface water is generally collected by developed stormwater networks that consist of road kerb and guttering, lined and unlined drainage channels, and sub-surface pit and pipe networks. The majority of the drainage systems are owned and maintained by the local council, while a number of the larger trunk drainage systems are assets of Sydney Water. Descriptions of the drainage systems around the proposed tunnel portals and stations are provided in Table 7.6.

Table 7.6 Drainage catchments and infrastructure

Location	Surface water catchment	Receiving waters	Drainage infrastructure
Chatswood dive site (northern)	Scotts Creek	Middle Harbour	Rail corridor runoff is collected by the rail drainage system and discharged into surrounding Council stormwater systems. Runoff from the Chatswood dive site located between the rail corridor and the Pacific Highway is drained by a stormwater pipe that runs north down Hammond Lane and crosses under the rail corridor at Chapman Avenue.
Artarmon substation	Flat Rock Creek	Middle Harbour	Runoff from the site is collected by the drainage networks on Reserve Road and the Gore Hill Freeway.
Crows Nest Station	Flat Rock Creek	Middle Harbour	Runoff collected by road kerb and gutter systems and discharged into stormwater pits at the intersection of Oxley Street and Clarke Lane.
Victoria Cross Station	Milson Park, Kirribilli	Sydney Harbour	Runoff collected by road kerb and gutter systems and discharged east towards Kirribilli.
Barangaroo Station	Sydney City	Sydney Harbour	Runoff collected by a number of drainage pits and pipes on Hickson Road. The pipes discharge west directly into Sydney Harbour.
Martin Place Station	Sydney City	Sydney Harbour	Runoff collected by the drainage system in Castlereagh Street, which discharges north toward Circular Quay and Sydney Harbour.
Pitt Street Station	Sydney City	Sydney Harbour	Runoff collected by the road drainage systems, which drains north down Pitt Street and eventually discharges directly into Sydney Harbour.
Central Station	Sydney City	Sydney Harbour	Runoff collected by the rail corridor drainage system that then connects to larger pipe systems draining around and under the site. Rail corridor drainage in the northern half of the site connects to drainage in Eddy Avenue or a trunk drain under the site near Devonshire Street, both of which are part of the Darling Harbour catchment. Rail drainage in the southern half of the site connects to trunk mains under the site from Prince Alfred Park that are part of the Blackwattle Bay catchment.

Location	Surface water catchment	Receiving waters	Drainage infrastructure
Marrickville dive site (southern)	Eastern Channel	Botany Bay via the Cooks River	Runoff is collected by the rail corridor drainage system or council stormwater system and discharged into the surrounding street and trunk drainage systems. The main drainage features comprise the Eastern Channel and the Sydenham Storage Pit located immediately north of the rail corridor. The Eastern Channel collects runoff from the areas of Enmore, Newtown and St Peters and discharges it south to the Cooks River and ultimately Botany Bay. A number of rail culverts between Sydenham Station and the Bedwin Road overbridge drain areas south of the rail line into the Eastern Channel. The Sydenham Storage Pit is a large detention basin that collects urban runoff from areas of Marrickville that is then pumped into Eastern Channel. The Eastern Channel and Sydenham Storage Pit are both assets of Sydney Water.

Existing flood behaviour

Due to the highly urbanised drainage catchments surrounding the project area, flooding behaviour is expected to be largely controlled by the capacity of stormwater drainage systems and roadways that form overland flow paths.

Local councils have investigated flood behaviour to varying degrees. Relevant flood studies are:

- *Scotts Creek Flood Study* (Lyall and Associates Consulting Engineers, 2008)
- *Flat Rock Creek Flood Study* (Lyall and Associates Consulting Engineers, 2006)
- *Flat Rock Creek Updated Flood Study* (Lyall and Associates Consulting Engineers, 2011)
- *City Area Catchment Flood Study Final Report* (BMT WBM Pty Ltd, 2014a)
- *Darling Harbour Catchment Flood Study Final Report* (BMT WBM Pty Ltd, 2014b)
- *EC East Subcatchment Management Plan Volume 2 – Flood Study* (Golder Associates Pty Ltd, 2010)
- *Marrickville Valley Flood Study Draft Report* (WMAwater, 2011)
- *Blackwattle Bay Catchment Flood Study Draft Report* (WMAwater, 2014)
- *Alexandra Canal Flood Study – Final* (Cardno Pty Ltd, 2014).

A description of flood behaviour around the proposed tunnel portals and stations (based on the above flood studies) is provided in Table 7.7.

North Sydney Council is currently undertaking an overland flood study for the entire local government area. Flood modelling results from this study were not available at the time of writing this document and will be reviewed (if available) during the preparation of the environmental impact statement.

Table 7.7 Description of existing flood behaviour

Location	Description of flood behaviour
Chatswood dive site (northern)	The Chatswood dive site is located near the top of the Scotts Creek catchment. Localised flooding of the construction site and in the rail corridor has the potential to occur during high intensity rainfall events. However, the proposed works are expected to have minimal external impacts on flooding
Artarmon substation	The site is located near the ridge between sub-catchments and therefore the site would not be affected by flooding. The main overland flow path near the site is on Reserve Road that drains south before turning east along the northern side of the Gore Hill Freeway.
Crows Nest Station	Crows Nest Station would be located at the top of the Flat Rock Creek catchment. During high intensity rainfall events, flows would be carried by the surrounding roads. Flooding is expected to have limited impact on the proposed station site.
Victoria Cross Station	Urbanised areas of North Sydney drain towards the proposed Victoria Cross Station. The main overland flow paths around the site are down Berry Street and Miller Street and there is a low point in Miller Street immediately north of the Pacific Highway intersection. The catchment upstream of the Miller Street low point covers about 17 hectares. The proposed station location would potentially be impacted by overland flooding down Berry Street and Miller Street. The proposed site is not expected to be impacted by flooding at the Miller Street low point as ponding depths would be limited by level at the Pacific Highway.
Barangaroo Station	Barangaroo Station would be located along the low-lying area of Hickson Road. The catchment draining toward Hickson Road extends about 200 metres east to Observatory Hill. When the stormwater system capacity is exceeded, floodwaters would flow onto Hickson Road from the low point on High Street near Lance Lane. Ponding occurs on Hickson Road at the Barangaroo Station site in events as frequent as the two year average recurrence interval. Significant ponding depths of between 0.5 and 0.75 metres would occur in the probable maximum flood.
Martin Place Station	The catchment falling towards the proposed Martin Place Station extends about 200 metres east to Macquarie Street. The overland flow paths around the site are down Elizabeth, Castlereagh and Hunter streets. Overland flooding occurs during a five year average recurrence interval event and flood depths of between 0.25 to 0.5 metres would occur in the probable maximum flood. High hazard flooding occurs in Hunter Street in the 20 year average recurrence interval flood event and larger.
Pitt Street Station	Pitt Street Station would be located near the top of the Sydney City catchment. During high intensity rainfall events, flows would be carried by the surrounding roads. Flooding is expected to have limited impact on the proposed station site.
Central Station	Urbanised areas of Surry Hills drain towards Central Station from the east. The main overland flow paths that approach Central Station are from: ○ Foveaux Street where floodwaters continue west down Eddy Avenue toward George Street ○ Devonshire Street and Prince Alfred Park where floodwaters enter the Central Station site and pond in low-lying sections of the rail track next to Prince Alfred Park in events as frequent as the two year average recurrence interval.

Location	Description of flood behaviour
Marrickville dive site (southern)	Areas to the north and south of the rail line drain towards the construction site and Eastern Channel. The main overland flow path from the north is down Murray Street before floodwaters enter the upstream end of the Eastern Channel. Catchments from south of the rail corridor drain via a number of culverts under the rail line into Eastern Channel. These culverts flow full in flood events with an Average Recurrence Interval of two years or more, causing floodwaters to flow over the rail line near the Bedwin Road overbridge and Sydenham Station. Flood modelling for the *Marrickville Valley Flood Study* (WMAwater, 2011) estimated a Probable Maximum Flood level of 4.7 metres Australian Height Datum in Eastern Channel adjacent the construction site.

Potential construction impacts

Surface hydrology and drainage infrastructure

Construction has the potential to alter existing stormwater flows and the existing stormwater drainage infrastructure due to the establishment of erosion and sediment control measures (such as redirecting stormwater runoff around the work site and / or establishment of detention basins). Best practice stormwater management measures would be developed during preparation of the environmental impact statement to minimise the potential impacts on downstream receiving environments.

Flooding

As outlined in Table 7.7, land surrounding the southern portal site and the proposed stations at Barangaroo and Martin Place are anticipated to be at risk of flooding. Flooding of the construction work site could result in stockpiles of construction materials (such as aggregate, fuels and other hazardous materials) and spoil being washed into nearby waterways, or floodwater entering the tunnels and excavations.

Construction also has the potential to locally alter existing flood behaviour due to the loss of flood plain storage (due to stockpiling construction materials and spoil, etc) and in situations where alterations to existing stormwater drainage infrastructure are required. Flooding risks arising during construction would be further considered during the preparation of the environmental impact statement.

Potential operational impacts

Surface hydrology and drainage infrastructure

The project has the potential to alter existing stormwater catchment flows and the operation of existing stormwater drainage networks due to a minor increase in impervious areas (such as at the southern portal site) and rerouting of drainage infrastructure (such as in situations where such infrastructure needs to be relocated and / or augmented to accommodate the project). Best practice stormwater management measures would be developed and incorporated into the project design to minimise the project's impact on the existing surface hydrology and stormwater drainage environment.

Flooding

As outlined in Table 7.7, land surrounding the southern portal site and the proposed stations at Barangaroo and Martin Place are anticipated to be at risk of flooding. However, the tunnel portals would be designed to protect the tunnels from the probable maximum flood level.

The establishment of project infrastructure within flood-prone areas has the potential to affect flood behaviour surrounding the sites due to the loss of floodplain storage and alteration of local catchment boundaries (which could change the distribution of stormwater between drainage networks). These impacts are anticipated to be readily manageable through suitable project design. Potential flooding impacts during the operation of the project will be considered in the environmental impact statement.

Proposed investigations and assessment for the environmental impact statement

The environmental impact statement will include an assessment of potential hydrology and flooding impacts during construction and operation of the project. The following government guidelines will be considered as relevant during the preparation of the hydrology and flooding assessment:

- *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom 2004) and *Volume 2 (A. Installation of Services; B. Waste Landfills; C. Unsealed Roads; D. Main Roads; E. Mines and Quarries)* (DECC 2008)
- NSW Government's *Floodplain Development Manual* (2005).

The assessment of potential hydrology and flooding impacts will include:

- Identification of potential impacts on stormwater quantity
- Broad assessment of the potential change in stormwater runoff (increase or decrease)
- 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
- An assessment of the potential impact on surface water quantity
- Identification of any potential changes to flood levels, discharges, velocities, duration of flood inundation and flood hazards for the 20 and, 100 year average recurrence interval flood event, and the probable maximum flood
- Identification of appropriate mitigation and management measures.

7.2.3 Air quality

Existing environment

Ambient air quality throughout the Sydney Basin is influenced by a number of factors, including topography, prevailing meteorological conditions (such as wind and temperature, which vary seasonally) and local and regional air pollution sources (such as motor vehicles, industrial facilities and bushfires). Consequently, regional air quality can be highly variable and impacted by events occurring a significant distance away.

A search of the Commonwealth Department of the Environment's National Pollutant Inventory (2015) and general site observations identified a number of air pollution sources close to the project which are likely to influence local air quality. These sources include:

- Industrial facilities at Artarmon, St Leonards, North Sydney, Greenwich, Alexandria, Sydenham and Mascot that reported air emissions (under the National Pollutant Inventory reporting program) during the 2013 – 2014 reporting period. These facilities include basic ferrous and other fabricated metal product manufacturing (at Artarmon and Alexandria); waste treatment, disposal and remediation services (at Artarmon and North Sydney); hospitals (at St Leonards); mineral, metal and chemical wholesaling (at Greenwich and Mascot); and airport operations and other air transport support services (at Mascot)
- Vehicle exhaust emissions from the road and rail networks
- Commercial businesses, such as service stations and smash repairs
- Domestic activities, such as wood-fired home heaters and lawn mowing
- Other construction projects.

The NSW Office of Environment and Heritage operates air quality monitoring stations within the Sydney Basin. Data recorded at these monitoring stations is considered to be indicative of air quality in the overall Sydney Basin. Data sourced from monitoring stations at Lindfield, Rozelle, Randwick and Earlwood (the closest stations to the project) show that concentrations of air pollutants were below the applicable air quality criteria during the 2013 and 2014 reporting periods.

Potential construction impacts

During construction, local air quality may be temporarily affected by particulate (dust) and gaseous emissions (such as emissions from the combustion of fuels and storage of volatile organic compounds). These impacts are described in the following sections.

Dust

The main potential air quality impacts during construction of the project would be associated with the generation of dust, which would include pollutants such as deposited dust, total suspended solids (TSP) and particulate matter with an aerodynamic diameter less than 10 microns (PM_{10}) and 2.5 microns ($PM_{2.5}$). Owing to the urban setting, there is also potential for dust emissions to contain contaminants (mobilised through the disturbance of contaminated soils) and other hazardous materials (such as asbestos fibres mobilised through the demolition of buildings and other structures).

Construction activities with the greatest potential to generate dust would include:

- Excavation, handling, stockpiling, loading / unloading and transport of spoil
- Demolition of buildings and other structures, and the handling, stockpiling and transport of demolition material

- Transport, loading / unloading, stockpiling and handling of imported construction materials such as imported fill
- Creation of exposed surfaces through the clearing of vegetation, stripping of topsoil and other overlying structures (such as road and footpath pavements), which would increase the potential for dust emissions to be generated by wind erosion
- Concrete batching and pre-cast activities
- Movement of construction plant, vehicles and equipment along unsealed haulage routes and surfaces.

Without the implementation of adequate management measures, dust emissions from the above activities could result in reduced local air quality and dust deposition at the nearest potentially affected receivers due to the small distance between these receivers and the construction sites.

The volume of dust generated during a typical work day would vary depending on the types of activities occurring at each work site and prevailing weather conditions (for example, dry windy conditions increase the potential for wind erosion).

Locations where dust emissions are anticipated to have the greatest potential to affect sensitive receivers (due to the location of sensitive receivers and / or the magnitude / extent of dust-generating activities) are outlined in Table 7.8.

Table 7.8 Locations potentially most affected by dust emissions

Location	Indicative construction activities at location
Tunnel construction sites (northern, Barangaroo and southern)	• Demolition of existing industrial buildings • Excavation and earthworks for the tunnel dive and portal structures • Handling, stockpiling, loading / unloading and transport of spoil from tunnel boring activities • Air extraction and fresh air ventilation to the tunnels • Concrete batching and pre-cast activities
Artarmon substation	• Topsoil stripping and earthworks • Vehicle, equipment and machinery movements
Station construction sites	• Building demolition • Excavation for the establishment of the station • Air extraction and fresh air ventilation to the tunnels

Overall, the volume of dust emissions would be comparable to volumes generated by other similar infrastructure projects and the impacts readily manageable through standard environmental management measures, such as wetting stockpiles and exposed surfaces and minimising dust-generating works during adverse weather conditions. Therefore, dust emissions are not considered to be a key issue during construction.

Gaseous emissions

Gaseous emissions would generally be restricted to minor localised emissions of carbon monoxide, oxides of nitrogen, sulfur dioxide and volatile organic compounds. These pollutants would be generated during the combustion of fuel in construction plant, machinery and equipment, as well as from the handling and / or onsite storage of fuel and other chemicals.

Because gaseous emissions during construction would be relatively minor and would be adequately managed with standard environmental management measures, they are not considered to be a key issue.

Potential operational impacts

As the project would be powered by electricity, regional emissions generated during operation are expected to be minimal and dispersed.

The project would include a fresh air ventilation system to circulate fresh air through the tunnels and underground stations and prevent the build-up of heat. Fresh air would be drawn into the tunnels and air would be extracted from the tunnels through the portals by the piston effect of the trains, and by mechanical ventilation at the stations. Air would be discharged from the tunnels at each station. The stations would also provide separate fresh air ventilation systems to draw fresh air in and extract air from the station environment. Air discharged from the tunnels and stations would be well diluted and dispersed into the outdoor air.

Minor quantities of particulate matter (PM_{10}) emissions would be generated in underground tunnels, mainly due to train brake pad wear, vaporisation of metals due to sparking, wear of steel due to friction between wheels and rail, and recirculation of particulates from tunnel walls. Most of these emissions would be vented through the fresh air ventilation system in very low concentrations.

Vented air is also likely to comprise minor concentrations of carbon dioxide, volatile organic compounds and oxides of nitrogen as well as ash and soot particulates generated during maintenance. The ventilation outlet air would contain small quantities of particulates at low concentrations due to the large volumes of exhaust air. Given the low concentrations of particulates, the project is very unlikely to have air quality impacts on the surrounding environment, including sensitive receivers.

The fresh air ventilation system would also respond to emergency conditions such as fire incidents where smoke-laden air would be discharged through the emergency ventilation system to prevent smoke entering stations or recirculating through fresh air ventilation shafts or tunnel portals. The design and location of the fresh air ventilation shafts at stations would ensure sensitive receivers were not unnecessarily affected; suitable emergency plans would be in place for these circumstances.

Although air quality may be impacted at the source of power generation, the overall impact from increased power generation to run the trains is expected to be minor.

The project is also expected to benefit local air quality by delivering an attractive alternative mode of public transport, which could result in a mode shift from road to rail. This has the potential to reduce air pollution emissions from road transport and congestion within the Global Economic Corridor (when compared to the emissions that would otherwise occur if the project were not delivered).

Overall, air quality is not considered to be a key issue during operation of the project.

Proposed investigations and assessment for the environmental impact statement

The environmental impact statement will include an air quality impact assessment. This assessment will:

- Identify and describe the background air quality environment based on a desktop assessment
- Identify potential sources of air emissions during both construction and operation of the project
- Identify potential sensitive receivers likely to be impacted by emissions to air from the project
- Identify and describe mitigation measures using the principles of avoid, minimise, mitigate.

7.2.4 Greenhouse gas and energy

Potential construction impacts

Construction would result in the generation of greenhouse gas emissions. The volume of greenhouse gas emissions generated would largely depend on the type and quantity of construction materials used, construction methodologies and equipment used, and the overall design (for example, station and tunnel depths). Activities that are anticipated to result in the largest quantities of greenhouse gas emissions include:

- Use of electricity for the tunnel boring machines and roadheaders
- Combustion of fuel in construction plant, equipment and vehicles
- Disposal of construction waste (indirect emissions would be generated by the decomposition of the waste material at waste handling facilities)
- Use of construction materials with a high embodied energy. For example, construction materials (such as steel and concrete) require a considerable amount of energy to manufacture and transport.

It would not be possible to completely avoid the generation of greenhouse gas emissions during construction. However, opportunities to reduce the volume of greenhouse gas emissions would be identified in the environmental impact statement and could include:

- Minimising the quantity of fuel and electricity used by construction plant and equipment through the use of biofuels, electricity derived from renewable sources, and energy-efficient work practices (such as using fuel-efficient equipment and avoiding unnecessary idling of construction plant and equipment)
- Minimising the quantity of fuel used in the transport of construction materials and spoil through sourcing such materials from local suppliers and disposing of spoil at nearby waste handling facilities
- Minimising the embodied energy of materials used by substituting materials with high embodied energy for a suitable material with a lower embodied energy (for example, using recycled concrete to reduce the volume of 'new' concrete required)
- Minimising onsite electricity consumption by using electricity derived from renewable sources
- Offsetting a proportion of the project's electricity needs through the generation or purchase of 'green power'.

Overall, the emission of greenhouse gas during construction is not considered to be a key issue.

Potential operational impacts

Greenhouse gas emissions would be primarily associated with the consumption of electricity to power the metro trains, signalling, lighting, fresh air ventilation, closed-circuits television and communications systems, station facilities (including lighting, lifts and escalators), and other rail infrastructure and systems.

There would also be emissions from the disposal of waste and use of materials during rail maintenance activities (such as fuel, concrete and replacement of steel rails and structures).

Overall, however, the project would provide an attractive alternative mode of public transport that would result in a mode shift from road to rail. Such a mode shift has the potential to reduce greenhouse gas emissions associated with road transport when compared to the emissions that would otherwise occur if the project were not delivered.

Opportunities to reduce the project's demand on electricity (and, therefore, greenhouse gas emissions) would be identified in the project's sustainability strategy and could include purchasing electricity derived from a renewable energy source (where available), using regenerative braking on rolling stock, selecting energy-efficient rolling stock, using photovoltaic lighting at stations and other rail infrastructure facilities (such as water treatment plants), offsetting the project's power requirements and undertaking a traction power assessment during detailed design.

Because greenhouse gas emissions during operation of the project would be manageable through design and standard mitigation measures, they are not considered to be a key issue.

Proposed investigations and assessment for the environmental impact statement

A greenhouse gas and energy assessment will be included in the environmental impact statement. The following government guidelines will be considered as relevant during the preparation of the greenhouse gas and energy assessment:

- *NSW's Sustainable Design Guidelines (Version 3.0)* (Transport for NSW, 2013)
- *Greenhouse Gas Inventory Guide for Construction Projects* (Transport for NSW, 2012).

The environmental impact statement will:

- Identify the potential greenhouse gas emissions from the project during construction and operation
- Consider the potential savings of greenhouse gas that would result from the project encouraging a mode shift from road to rail
- Identify mitigation and management measures to reduce potential emissions of greenhouse gas.

7.2.5 Climate change adaptation

Potential construction impacts

Climate change risks during construction would primarily be associated with the occurrence of severe weather events, such as the increased frequency and severity of rainfall events placing increased pressure on erosion and sediment control measures and / or resulting in the flooding of the tunnels and / or work sites.

These risks are anticipated to be adequately managed with standard management measures, such as increasing the capacity of erosion and sediment controls and minimising construction impacts on the capacity of existing stormwater drainage systems. Therefore, climate change is not considered to be a key issue during construction.

Potential operational impacts

Climate change risks during operation of the project are anticipated to include:

- Increased average temperatures and the frequency of heatwaves, which may affect the integrity of project infrastructure (this could include sagging of overhead wires, overheating of trains, etc) and affect customer and staff comfort (due to the difficulty in regulating temperatures in tunnels and at stations)
- Increased frequency and severity of extreme rainfall events, which may exceed the design capacity of the drainage system and lead to flooding of project infrastructure, particularly the tunnels and stations
- Changes in seasonality and the amount of precipitation, which may affect project infrastructure (due to changes in soil moisture content and groundwater flows), project landscaping (such as the viability of plantings at stations) and limit opportunities to capture, treat and reuse stormwater or groundwater as an alternative water source for various components of the project (such as station toilets).

Possible measures to address the effects of climate change on the project would be considered during detailed design, and could include designing project infrastructure to be resilient to the predicted changes in extreme weather events, based on the latest industry standards.

Proposed investigations and assessment for the environmental impact statement

The environmental impact statement will include a climate change adaptation assessment. The following government guidelines will be considered as relevant during the preparation of the climate change adaptation assessment:

- Commonwealth Scientific and Industrial Research Organisation's *Climate Change in Australia Technical Report 2007* (this is based on the Intergovernmental Panel on Climate Change's *Fourth Assessment Report, 2007*)
- *ISO 31000-2009; Risk Management – Principles and Guidelines*
- *AS 5334 – Climate Change Adaptation for Settlements and Infrastructure*
- *Flood Risk Management Guide: Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments* (DECCW, 2011).

The climate change adaptation assessment will:

- Identify possible climate related impacts with an emphasis on any that are projected to undergo a substantial change
- Identify project components that may be vulnerable to the climate change impacts such as increased bushfires
- Identify possible current and future controls that may increase the resilience of particular project components to climate impacts
- Recommend what should be considered, and how to establish if further information is needed, to adequately assess climate change risk.

7.2.6 Hazard and risks

Potential construction impacts

The following hazards have the potential to occur during construction:

- The onsite storage, use and transport of chemicals, fuels and materials. To manage this risk, all hazardous substances that may be required for construction would be stored and managed in accordance with the *Work Health and Safety Act 2011* and the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW, 2005)
- The rupture of, or interference with, underground services. To manage this risk, dial before you dig searches would be undertaken and non-destructive digging used to identify the presence of services at the start of construction
- Tunnel collapse. To manage this risk, best-practice tunnelling methods and processes would be employed to ensure the structural integrity of the tunnels and excavations.

Because construction hazards and risks would be adequately managed with standard management measures, they are not considered to be a key issue.

Potential operational impacts

The main hazard likely to be encountered during operation of the project is the storage, use and transport of chemicals, fuels and materials. To manage this risk, all hazardous substances that may be required during operation would be stored and managed in accordance with the *Work Health and Safety Act 2011* and the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW, 2005).

Because operational hazards and risks would be adequately managed with standard management measures, they are not considered to be a key issue.

Proposed investigations and assessment for the environmental impact statement

A high level, desktop hazard and risk assessment will be undertaken for the project and management measures will be proposed, where appropriate. The following government guidelines will be considered as relevant during the preparation of the hazard and risk assessment:

- *Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (DoP 2011)
- *International Standard (ISO / IEC 31010) Risk Management – Risk Assessment Technique*
- *Australian Code for the Transport of Dangerous Goods by Road and Rail (7th edition)* (National Transport Commission, 2007)
- *Code of Practice for the Safe Removal of Asbestos 2nd edition* (National Occupational Health and Safety Commission, 2005)
- *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover, 2005).

7.2.7 Waste and resource use

Potential construction impacts

Waste

A variety of solid and liquid wastes would be generated during construction. The main construction activities anticipated to generate waste are outlined in Table 7.9 along with the likely waste materials produced.

Table 7.9 Indicative types of waste generated during the construction of the project

Waste-generating activity	Waste materials produced
Tunneling, station excavations, cuttings and general earthworks	Spoil comprising virgin excavated natural material; tunnel boring machine cutter heads and associated equipment replacement (conveyer belts etc); tunnel boring machine lubricants (bentonite slurry or similar); contaminated materials and potential acid sulfate soils
Pre-cast concrete manufacture	Concrete slurry, concrete waste, timber formwork
Demolition of buildings and other structures	Concrete, bricks, tiles, timber (treated and untreated), metals, plasterboard, carpets, electrical and plumbing fittings and furnishings (such as doors and windows), hazardous waste (including asbestos)
Dust suppression, wash down of plant and equipment, and staff amenities at construction compounds (such as toilets)	Sediment-laden and / or potentially contaminated wastewater, sewage and grey water, including groundwater inflows to tunnels and station excavations
Tunnel and station fit-out and general construction activities and resource use	Concrete waste, timber formwork, scrap metal, steel, concrete, plasterboards, cable and packaging materials
Maintenance of construction plant, vehicles and equipment	Adhesives, lubricants, waste fuels and oils, engine coolant, batteries, hoses and tyres
Activities at offices and crib rooms	Putrescibles, paper, cardboard, plastics, glass and printer cartridges
Clearing and grubbing of vegetation, landscaped and / or turfed areas	Green waste

The quantity of construction waste likely to be generated by the project would be considered in the environmental impact statement. The largest volumes of construction waste would be generated during the excavation of tunnels and underground stations (spoil and wastewater) and the demolition of buildings and other structures (general construction wastes such as steel and concrete).

The quantity of waste would be comparable to similar infrastructure projects (including Sydney Metro Northwest, which is currently under construction) and would be adequately managed with standard waste management measures. The disposal of this waste is not anticipated to result in significant adverse environmental impacts and, as such, is not considered to be a key issue.

Resource use

Resources used during construction would include:

- Electricity
- Fuel
- Lubricating oil
- Concrete
- Steel
- Water
- Paving materials
- Glass
- Timber.

The quantity of resources required would be considered in the environmental impact statement. Environmental management measures would be developed to reduce the project's demand on resources. While the project would increase demand on local and regional resources, it is unlikely that the project would result in any resource becoming scarce or in short supply. Therefore, resource use is not considered to be a key issue during construction.

Potential operational impacts

Waste

The main types of activities anticipated to generate waste during operation of the project are outlined in Table 7.10 along with the likely waste materials produced.

Table 7.10 Indicative types of waste generated during the operation of the project

Waste-generating activity	Waste materials produced
Disposal of general litter in station bins and cleaning activities associated with trains, stations and other infrastructure	General non-recyclable and putrescible waste (such as food waste from station rubbish bins), recyclable wastes such as plastics and aluminium cans, office waste including paper and plastics
Infrastructure maintenance	Cable and conduit off-cuts from maintenance of track electrical infrastructure, solvents, paints, adhesives, cleaning fluids, greases, acids and alkali materials, and spent spill kit absorbent materials used to clean up accidental spills during maintenance
Groundwater and stormwater ingress into tunnel and stations	Sediment-laden and / or potentially contaminated wastewater
Use of station customer facilities (such as toilets)	Sewage and grey water

The quantity of waste generated during the operation of the project would be relatively minor. The disposal of this waste is not anticipated to result in significant adverse environmental impacts and, therefore, is not considered to be a key issue.

Resource use

Resources used during the operation of the project would include:

- Electricity
- Water
- Steel (during the maintenance of rail infrastructure)
- Concrete (during the maintenance of rail infrastructure)
- Fuel, lubricating oil and grease
- Cleaning chemicals.

Resource use during operation of the project would primarily be associated with electricity to power the metro trains, signalling, lighting, fresh air ventilation, closed-circuit television and communications systems, station facilities (including lifts and escalators), and other rail infrastructure and systems.

Opportunities to reduce the project's demand on electricity would be identified in the project's sustainability strategy and could include purchasing electricity derived from a renewable energy source (where available), using regenerative braking on rolling stock, selecting energy-efficient rolling stock, using photovoltaic lighting at stations and other rail infrastructure facilities (such as water treatment plants) and undertaking a traction power assessment during detailed design.

While the operation of the project would increase demand on local and regional resources (particularly electricity), it is unlikely that the project alone would result in any resource becoming scarce or in short supply. There is also the potential to reduce resource use due to the mode shift from road to rail, and from private to public transport. Therefore, resource use is not considered to be a key issue during operation of the project.

Proposed investigations and assessment for the environmental impact statement

A desktop waste and resource assessment will be undertaken as part of the environmental impact statement. This assessment will include:

- A review of the likely waste streams and volumes during construction and operation, including spoil, wastewater and demolition materials
- A review of the likely resources required during construction and operation, including energy, fuel and steel
- Development of management strategies to adequately address waste and resource use during construction and operation. Measures would likely include:
  - Managing construction waste through the waste hierarchy established under the *Waste Avoidance and Recovery Act 2001* (ie avoidance of waste, resource recovery, disposal of waste)
  - Establishing targets for the beneficial reuse of spoil, wastewater and other construction wastes in accordance with the project's sustainability strategy
  - Developing procedures for the assessment, handling, stockpiling and disposal of potentially contaminated materials and wastewater, in accordance with the NSW Office of Environment and Heritage's *Waste Classification Guidelines* (DECCW, 2009)
  - Identifying opportunities to reduce the project's demand on electricity and other resources
  - Developing a spoil management strategy identifying how spoil 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 route of transportation. This spoil management strategy would consider the cumulative effects of spoil haulage and disposal activities associated with other Sydney based tunnel projects, including NorthConnex and WestConnex.

8 Consultation

This chapter provides an outline of the consultation undertaken on the project to date and how this consultation has influenced the project and the scope of the environmental impact statement. A summary of the consultation proposed to be undertaken as part of the environmental impact statement and during construction of the project is also provided.

8.1 Overview

Stakeholder and community consultation for Sydney Metro City & Southwest forms an integral part of informing and scoping investigations for the Chatswood to Sydenham environmental impact statement.

In June 2014, the NSW Government announced that Sydney Metro City & Southwest would extend Sydney Metro Northwest (formally North West Rail Link) under Sydney Harbour, through the Sydney CBD and on to Bankstown.

Engagement with the community and stakeholders began in June 2014 and will continue during preparation of the environmental impact statement.

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

- State agencies (eg Department of Planning and Environment, Roads and Maritime Services, Environmental Protection Authority, NSW Office of Water and Office of Environment and Heritage)
- Local government (Willoughby, Lane Cove, North Sydney, City of Sydney and Marrickville councils)
- Public utilities, and business and industry groups near the project
- Directly impacted communities
- The broader community.

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

8.2 Communication objectives

The NSW Government is interested in community and stakeholder feedback on the project. The Sydney Metro communication objectives include to:

- Communicate the rationale for the project and the broader network benefits it will deliver, including how it fits into the NSW Government's plans to increase Sydney's rail capacity
- Communicate the Sydney Metro concept and timing
- Build community and key stakeholder relationships and maintain goodwill
- Provide information about the planning approvals process and encourage community participation
- Clearly communicate the corridor protection and property acquisition process.

The project team has developed a comprehensive community and stakeholder engagement program to proactively engage with local communities, key stakeholders and government agencies.

8.3 Consultation to date

Consultation to date has been undertaken over three phases:

- Stakeholder consultation following the announcement of the project in June 2014
- Project scope consultation and exhibition in June 2015
- Industry consultation commencing in June 2015.

Key activities undertaken in each of these phases are described in the following sections.

8.3.1 Stakeholder consultation

Since the announcement of the project in June 2014, consultation has consisted of briefings with key stakeholders including:

- Barangaroo Delivery Authority
- Urban Growth
- Department of Planning and Environment
- Sydney Harbour Foreshore Authority
- NSW Trains
- Roads and Maritime Services
- Sydney Trains
- Other sections of Transport for NSW
- Australian Rail Track Corporation Ltd
- Infrastructure Partnerships Australia
- Sydney Chamber of Commerce
- Tourism and Transport Forum
- Property Council
- Australasian Railway Association
- City of Sydney Council
- Lane Cove Council
- North Sydney Council
- Western Sydney University
- The University of Sydney
- Transport specialists.

This first round of consultation was accompanied by information distributed to the wider community through:

- Media releases
- Information available at the Sydney Metro Northwest community information centre
- Information available on the Sydney Metro Northwest website about Sydney Metro
- Fact sheet – 'More trains, faster services right across Sydney' (June 2014)
- Fact sheet – 'Transforming Sydney' (November 2014).

8.3.2 Project scope consultation and exhibition

On 4 June 2015, the Premier of NSW announced a change to the name of the Sydney Rapid Transit project and that funding had been secured to progress planning on Sydney Metro City & Southwest. The announcement also initiated a round of community consultation to collect stakeholder and community feedback on the project (and to help inform development of more detailed plans for the Chatswood to Sydenham environmental impact statement process). Consultation undertaken during this period was completed along the project alignment between Chatswood and Bankstown.

This consultation phase was not a statutory consultation process and was carried out to proactively engage with the community prior to the commencement of the Chatswood to Sydenham environmental impact statement process.

Public information and engagement

Table 8.1 identifies the activities used to provide up-to-date information to the community and stakeholders.

Table 8.1 Community contact and information points

Activity	Establishment date	Detail
Community Information Line (toll free)	4 June 2015	1800 171 386
Community email address	4 June 2015	sydneymetro@transport.nsw.gov.au
Website	4 June 2015	www.sydneymetro.info This website includes an online forum function to collect feedback on various aspects of the project including station locations along Sydney Metro City & Southwest
Postal address	4 June 2015	Sydney Metro City & Southwest PO Box K659, Haymarket, NSW 1240
Transport for NSW Community Information Centre	4 June 2015	388 George Street, Sydney
Sydney Metro Northwest Community Information Centre[1]	4 June 2011	Shop 490, Castle Towers Shopping Centre Old Castle Hill Road, Castle Hill
Place Managers	April 2015	Three Place Managers have been employed on the project to cover the following areas: - Chatswood to Sydney Harbour - Sydney CBD, Central to Sydenham - Bankstown Line.

1 *The Transport for NSW community information centre has been operating at this location for a number of years, providing information on the North West Rail Link, now known as Sydney Metro Northwest. From 4 June 2015, the centre began providing information on Sydney Metro City & Southwest.*

These activities were accompanied by:

- Community information sessions (attended by just under 800 people)
- Media releases
- Advertisements in local newspapers
- Booklet – 'Project Overview' (June 2015)
- Newsletter – 'Have your say, more choice, more opportunity with metro rail' (June 2015) (delivered to 220,000 properties)
- Booklet – 'Delivering Sydney Metro, Industry Briefing' (June 2015).

Stakeholder meetings

Key stakeholders were briefed via meetings, presentations and phone calls. The meetings were designed to ensure stakeholders were adequately briefed on the project (including the alignment and station locations); to ensure issues and concerns were understood, captured and addressed in the development of the project; and to receive feedback.

These meetings were held with:

- Action for Public Transport
- Australian Institute of Architects
- Bankstown Council
- Barangaroo Delivery Authority
- BusNSW
- Canterbury Council
- City of Sydney Council
- Committee for Economic Development of Australia
- Committee for Sydney
- Consult Australia
- NSW Trains
- Roads and Maritime Services
- Other sections of Transport for NSW
- Department of Planning and Environment
- Federal Member for Bradfield
- Friends of Greater Sydney
- Hills Shire Council
- Housing Industry Association
- Infrastructure Partnerships Australia
- Lane Cove Council
- Marrickville Council
- State Member for Sydney
- North Sydney Council
- Northern Sydney Regional Organisation of Councils
- NRMA
- NSW Business Chamber
- NSW Commuter Council
- Planning Institute of Australia
- Property Council
- South Sydney Regional Organisation of Councils
- Sydney Business Chamber
- Sydney Trains
- Tourism and Transport Forum
- The University of Sydney
- Western Sydney University
- Urban Growth
- Urban Taskforce
- Western Sydney Business Chamber
- Western Sydney Regional Organisation of Council.

The project team also presented at the Australian Financial Review National Infrastructure Summit in June 2015.

Table 8.2 provides is a summary of submissions received from local government and peak bodies.

Table 8.2 Submissions summary

Stakeholder	Submission summary
Lane Cove Council	• Sydney Metro is supported • The St Leonards / Crows Nest Station option should be located as close to St Leonards as possible.
North Sydney Council	• Sydney Metro is strongly supported • Barangaroo Station is strongly supported • Consultation and collaboration with Council is critical especially around station locations and access • Ensure that Miller Street is recognised as the main pedestrian spine of North Sydney • Connectivity with other transport modes and accessibility (for example, bike friendly) • Northern Beaches rail or bus rapid transit accommodated in Victoria Cross Station design • The St Leonards / Crows Nest Station option should be located as close to St Leonards as possible.
Willoughby Council	• Sydney Metro is strongly supported • Supports Crows Nest Station option • Supports Artarmon Industrial Station • Park and ride options at metro stations and extra car parking • Protection of Artarmon Reserve & Heritage Conservation Area.
Southern Sydney Region Organisation of Councils	• Sydney Metro is strongly supported • The metro network should be extended, including to Hurstville and Liverpool and to Parramatta • Collaboration regarding social infrastructure such as housing and connectivity with regional plans and other transport modes • Park and ride options at metro stations and extra car parking • Connectivity with other transport modes and accessibility (for example, bike friendly).
City of Sydney Council	• Sydney Metro is strongly supported • Barangaroo Station supported • Martin Place and Pitt Street stations supported • No preference on The University of Sydney or Waterloo station option.
Marrickville Station	• Broadly support Sydney Metro • Supports stations at both The University of Sydney and Waterloo • Supports a station before Sydenham and a station at Alexandria • Concern about increased urban density • Connectivity with other transport modes and accessibility (for example, bike friendly).

Stakeholder	Submission summary
Peak bodies including: • Action for Public Transport • Bicycle Network • BusNSW • Committee for Sydney • Friends of Greater Sydney • NRMA • Planning Institute of Australia • Sydney Chamber of Commerce (and NSW Business Chamber) • Tourism & Transport Forum • Urban Taskforce • Warren Centre for Advanced Engineering	• Overall strong support for Sydney Metro • Barangaroo Station supported • Most support extending the metro network, including to Hurstville and Liverpool and to Parramatta • Some support for an extension to areas like the Northern Beaches and the Bays precinct • Connectivity with other transport modes and accessibility (for example, bike friendly) • The need for a coordinated whole-of-government approach (that is, collaboration between government departments) • Acknowledgement that Sydney Metro will provide opportunities for urban renewal, better connectivity between communities and improved social and economic outcomes • Most support for The University of Sydney station option than a Waterloo station option.

Community information sessions

Table 8.3 provides a list of the community information sessions held during the project scope exhibition period. Just under 800 people attended these information sessions.

Table 8.3 Community information sessions

Date	Time	Location
Saturday 13 June 2015	10 am – 2 pm	Dougherty Community Centre (Auditorium)
Wednesday 17 June 2015	4 – 8 pm	North Sydney Harbour View Hotel
Thursday 18 June 2015	4 – 8 pm	Marrickville Metro
Thursday 18 June 201	4 – 8 pm	Transport for NSW City Information Centre
Saturday 20 June 2015	9 am – 1 pm	Crows Nest Markets
Saturday 20 June 2015	10 am – 2 pm	Redfern Oval Community Room
Tuesday 23 June 2015	4 – 8 pm	Canterbury-Hurlstone Park RSL
Saturday 27 June 2015	10 am – 2 pm	Bankstown Sports Club

Invitations to attend the community information sessions were included in the 'Have your say, more choice, more opportunity with metro rail' newsletter that was delivered to properties within about one kilometre of the proposed alignment and station locations. In total, 220,000 newsletters were delivered.

Invitations to attend the community information sessions were also advertised in local and ethnic newspapers, the Sydney Metro City & Southwest Project Overview booklet and via the Sydney Metro City & Southwest website.

8.3.3 Industry consultation

An industry briefing session was held on 16 June 2015 at the Roslyn Packer Theatre, Walsh Bay. Invitations to attend the briefing were included in:

- The Sydney Metro City & Southwest website
- Advertisements in Australian and international newspapers
- Direct invitations.

The briefing detailed plans for Sydney Metro City & Southwest, the scope of works and the process for industry to contribute to the project and take part in its delivery. The session was attended by just under 500 industry representatives from Australian and international firms. Attendees received a copy of the booklet – 'Delivering Sydney Metro, Industry Briefing'.

8.3.4 Outcomes of project scope consultation and exhibition

During the consultation period eight drop-in community information sessions were held along the project corridor. Just under 800 people attended the sessions which provided community members with the opportunity to view key project material, make an enquiry, or put forward a submission.

As part of the project scope exhibition the project team sought feedback on a number of design elements including station locations, proposed tunnelling sites and general project feedback.

In total the project received more than 1500 submissions as part of this consultation process. The project team has reviewed each individual submission and prepared a report that captures key themes raised and how the Sydney Metro City & Southwest concept has been modified as a direct result of community input.

Appendix C outlines a summary of the feedback received to date regarding the Sydney Metro City & Southwest scope exhibition and how this will be considered in defining the scope of the environmental impact statement.

8.4 Consultation during preparation of the environmental impact statement

The project team will continue to consult with the community and stakeholders during the preparation of the environmental impact statement. A number of activities are planned during the preparation of the environmental impact statement to collect feedback from stakeholders and to further inform the investigations being carried out for the project. Key elements of this consultation are outlined below.

8.4.1 Place Managers

Place Managers will continue their role as a vital link in maintaining close and ongoing contact with local communities and stakeholders during preparation of the environmental impact statement. They will seek to understand local issues and bring this feedback to the project team.

8.4.2 Interactive online forums

During the second half of 2015, Transport for NSW sought further feedback from stakeholders via an interactive online forum. One of the objectives of the forum is to collect feedback from the local community on the planning process and how they would like to see the project delivered and impacts managed.

A number of questions were posted on the forum in a staged approach to ensure regular engagement via the project website. Stakeholders will be encouraged to visit the web forum via posts on the Sydney Metro Northwest Facebook page (there are currently over 4000 followers) and via direct email to the project's email subscription list (there are currently over 4000 respondents).

Examples of the questions posted include:

- *During the development of the project we will work with the Department of Planning and Environment to ensure that all the appropriate environmental issues are considered and studies undertaken. Examples of specialist studies the project will undertake include noise and vibration, traffic, Aboriginal and non-Aboriginal heritage. These studies are generally undertaken along the project corridor. What other studies do you think may be important?*
- *We want to know what experiences you have had with other infrastructure projects (both positive and negative), and how we can apply those learnings to this project.*
- *We are interested to find out how you may want to stay in touch with the project. What is the best way to engage with you and your local community?*
- *During construction, temporary adjustments may be required to current business operations – such as changes to access, parking or to deliveries. To plan how the project can best assist local businesses we'd like your feedback on how to reduce any potential impacts as best we can.*
- *During construction of a major infrastructure project there are a range of works that need to be undertaken. Most of this work can be undertaken during the day. However, for an infrastructure project of this type and scale, works will need to be undertaken outside standard hours and for works such as tunnelling – 24-hours. Projects like ours work hard to minimise noise and keep the community informed about works. There are different ways to manage construction noise for example scheduling noisier works during the day, installing squawker alarms for reversing vehicles rather than beepers and temporary noise barriers. Have you ever been affected by construction noise and if so how was it managed, and was it successful?*

The responses to the questions received will be considered in ongoing project development and preparation of the environmental impact statement.

8.4.3 Community contact and information

The community contact and information tools outlined in Table 8.4 will remain in place for the duration of the environmental impact statement and for the remainder of the planning and approval process.

Table 8.4 Community contact and information points available during the planning and approval process

Activity	Detail
Community Information Line (toll free)	1800 171 386
Community email address	sydneymetro@transport.nsw.gov.au
Website	www.sydneymetro.info
Postal address	Sydney Metro City & Southwest PO Box K659, Haymarket, NSW 1240
Transport for NSW Community Information Centre	388 George Street, Sydney
Sydney Metro Northwest Community Information Centre	Shop 490, Castle Towers Shopping Centre Old Castle Hill Road, Castle Hill
Place Managers	○ Chatswood to Sydney Harbour ○ Sydney CBD, Central to Sydenham ○ Bankstown Line.

8.4.4 Government agency consultation

As part of the Department of Planning and Environment planning process, a planning focus meeting with government stakeholders will be held to discuss the scope of the environmental impact statement.

Transport for NSW's Government agency consultation lead will continue to focus on cross-agency integration and communication. Regular meetings will be held with a variety of government stakeholders to ensure key issues are appropriately addressed.

8.4.5 Major stakeholder consultation

Transport for NSW's stakeholder consultation team will ensure local members of parliament, councils, peak bodies and industry groups are proactively engaged and informed about the project. Regular briefings will be held to keep stakeholders informed and to ensure key issues raised are addressed

There will also be ongoing consultation with specific groups to inform technical assessments. For example, regular meetings are held to discuss the approach to traffic and transport assessment with the Sydney Metro Roads Integration Working Group, which includes representatives from Transport for NSW and Roads and Maritime Services; and a maritime working group to discuss potential impacts within Sydney Harbour which includes representatives from Roads and Maritime Services and Port Authority of NSW.

8.5 Public exhibition of environmental impact statement

Public exhibition of the environmental impact statement will be for a minimum of 30 days as stated in Section 115Z of the *Environmental Planning and Assessment Act 1979*. Advertisements will be placed in newspapers to advise of the public exhibition and where the environmental impact statement can be viewed, as well as details on proposed community consultation activities and information sessions.

Consultation activities during the public exhibition of the environmental impact statement will be consistent with those undertaken for the project scope exhibition and will include:

- EIS summary document
- Media releases
- Information sessions
- Community event stalls
- Doorknocks
- Newsletter letterbox drop
- Project website and online forums
- Newspaper advertising
- Displays at local councils
- Stakeholder meetings
- Local business engagement
- Government stakeholder engagement.

8.6 Consultation during construction

Should the project be approved, the project team would continue to consult with the community and key stakeholders during construction. In general, this consultation would involve:

- Ongoing consultation with key stakeholders, local councils and other government agencies
- Provision of regular updates to the nearby community
- Development and implementation of a community complaints and response management system.

9 Summary of proposed environmental impact statement scope

This chapter provides a summary of the proposed scope of investigations and assessment to be undertaken as part of the environmental impact statement.

This chapter provides a summary of the proposed environmental impact statement assessment scope, based on the outcomes of the preliminary environmental risk analysis (Chapter 6) and preliminary environmental assessment, which identifies 'key' and 'other' environmental issues (Chapter 7).

The proposed environmental impact statement scope generally focuses on undertaking further detailed specialist investigations for the 'key' environmental issues, based on the potential significance of the resulting impacts.

Some further investigation of the 'other' environmental issues will also be undertaken. These investigations will be used to help confirm the current assumption that these 'other' environmental issues would not result in a significant impact on the environment and could be appropriately managed through the application of design and / or best practice environmental management measures. Should any 'other' environmental issue be identified as being significant during the environmental assessment process, the likely impacts would be adequately assessed and documented in the environmental impact statement.

9.1 Proposed environmental impact statement scope for key issues

Table 9.1 provides a summary of the proposed environmental impact statement assessment scope for 'key' environmental issues. This scope will be refined (if necessary) following receipt of the Secretary of the Department of Planning and Environment's environmental assessment requirements for the project.

Table 9.1 Proposed environmental impact statement scope for key issues

Issue	Proposed environmental impact statement scope
Traffic, transport and access	A detailed traffic and transport impact assessment will be undertaken as part of the environmental impact statement. Relevant government guidelines that will be considered include: • *Guide to Traffic Management – Part 3 Traffic Studies and Analysis* (Austroads, 2013) • *NSW Bicycle Guidelines* (RTA, 2003) • *Guide to Traffic Generating Developments Version 2.2* (RTA, 2002). The assessment will include the construction and operational traffic impacts on the local and regional traffic network, including public transport, cyclists and pedestrians and will include: • Identification of haulage routes, site access and egress points • Daily and peak traffic movements likely to be generated by each component of the project and the cumulative impacts of this traffic on the local and regional traffic network including nearby intersections • Impacts on the overall efficiency, ease, comfort, reliability and convenience of the public transport system (rail and bus), and interchange opportunities • Impacts on vehicular, pedestrian, cyclist and public transport access • Impacts on emergency services • Impacts on parking supply • Impacts on Sydney Harbour maritime traffic • Arrangements to ensure continuity of residential and business access • Operation of and modifications to intersections, and any changes to travel times for public transport services and private motorists • Opportunities for the integration of rail and bus services including modal interchange facilities, local bus services, strategic corridors and external network connections, access and mobility considerations • Measures to minimise or mitigate impacts (where identified), including an assessment of available options and the expected effect of the measures proposed.

Issue	Proposed environmental impact statement scope
Noise and vibration	A detailed construction and operational noise and vibration impact assessment will be undertaken as part of the environmental impact statement. Relevant government guidelines that will be considered include: • *Construction Noise Strategy* (Transport for NSW, 2012) • *Interim Construction Noise Guideline* (Department of Environment, Climate Change and Water, 2009) • *NSW Industrial Noise Policy* (Environment Protection Authority, 2000) • *Rail Infrastructure Noise Guideline* (Environment Protection Authority, 2013) • *NSW Road Noise Policy* (Environment Protection Authority, 2011) • *Assessing Vibration: A Technical Guideline* (Department of Environment and Conservation, 2006) • *German Standard DIN 4150-3: Structural Vibration – Effects of Vibration on Structures* • *Environmental Noise Management Assessing Vibration: A Technical Guideline* (Department of Environment and Conservation, 2006) • *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (Australian and New Zealand Environment Council, 1990). The noise and vibration impact assessment will consider: • The nature of construction activities • The intensity and duration of noise and vibration impacts • The nature, sensitivity and impact on potentially affected receivers • Impacts associated with any works proposed to be undertaken outside standard daytime construction hours • The potential human health impacts associated with long term construction noise • The need to balance potential impacts on sensitive receivers and the mitigation of these impacts considering the overall project delivery program • Other factors that may influence the timing and duration of construction activities (such as traffic management) • Feasible and reasonable mitigation and management measures to address identified construction noise impacts. In relation to operational noise and vibration, the assessment will consider: • Airborne noise, ground-borne noise and vibration impacts • Impacts on sensitive receivers (such as schools, hospitals, and aged care facilities) and sensitive structures (particularly heritage structures and key utilities / infrastructure) • Appropriate mitigation and management measures to address identified operational noise impacts.

Issue	Proposed environmental impact statement scope
Property and land use	The environmental impact statement will identify potential impacts on property and land use, including the following issues: • Existing property and land use ownership along the proposed route • Likely future land use based on zoning and consultation with local councils, the Department of Planning and Environment, and the Barangaroo Delivery Authority • Direct impacts on property and land use • Indirect positive and negative impacts on property and land use, including potential land use integration issues, potential opportunities and / or benefits for urban renewal / development at metro stations. Relevant government guidelines that will be considered include *Environmental Planning and Impact Assessment Practice Note: Socio-economic Assessment* (Roads and Maritime Services, 2013).
Business impacts	A local business impact assessment will be prepared as part of the environmental impact statement. The assessment will: • Identify businesses that would be directly impacted by the project • Identify local businesses near the project that may be indirectly impacted by the construction and / or operation of the project • Undertake a local business survey to understand the nature of businesses and the local economy • Assess the potential impacts of the project on local businesses, and on the local economy from the potential loss of businesses • Identify measures to avoid or mitigate the potential impacts. Relevant government guidelines that will be considered include *Environmental Planning and Impact Assessment Practice Note: Socio-economic Assessment* (Roads and Maritime Services, 2013).

Issue	Proposed environmental impact statement scope
Non-Aboriginal heritage	A non-Aboriginal heritage assessment will be undertaken as part of the environmental impact statement. The following government guidelines will be considered as relevant during the preparation of the non-Aboriginal heritage assessment: • *Commonwealth EPBC 1.1 Significant Impact Guidelines – Matters of National Environmental Significance* (Commonwealth of Australia, 2013) • *Commonwealth EPBC 1.2 Significant Impact Guidelines – Actions on, or Impacting upon, Commonwealth Land and Actions by Commonwealth Agencies* (Commonwealth of Australia, 2013) • *NSW Skeletal Remains: Guidelines for Management of Human Remains* (Heritage Office, 1998) • *Criteria for the Assessment of Excavation Directors* (NSW Heritage Council, 2011). The non-Aboriginal heritage assessment will: • Identify items and areas of heritage significance 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 • Consider 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, where such potential exists, the likely significance of those impacts • 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 best practice guidelines.

Aboriginal heritage	The following government guidelines will be considered as relevant during the preparation of the Aboriginal heritage assessment:
	• *Guide to investigating, assessing and reporting on Aboriginal Cultural Heritage in NSW* (Department of Environment, Climate Change and Water, 2011)
	• *Aboriginal Cultural Heritage Consultation requirements for proponents* (Department of Environment and Climate Change, 2010)
	• *NSW Skeletal Remains: Guidelines for Management of Human Remains* (Heritage Office, 1998)
	• *Criteria for the assessment of excavation directors* (NSW Heritage Council, 2011).
	The Aboriginal heritage assessment will:
	• Identify the potential for the project to disturb Aboriginal heritage (sites, objects, remains, values, features or places) and, where this is the case, to:
	  ◦ Determine, in consultation with relevant stakeholders, the significance of the heritage resources to the Aboriginal community
	  ◦ Determine the extent and significance of impact to those resources as a result of construction and / or operation of the project
	• Identify any requirements for in situ conservation of items and / or areas (as appropriate), the need for further archaeological testing and / or detailed archaeological excavations
	• Identify appropriate measures to avoid, minimise and / or mitigate potential impacts.

Issue	Proposed environmental impact statement scope
Landscape character and visual amenity	A visual and urban design impact assessment will be undertaken as part of the environmental impact statement. The assessment will: • Describe the visual character and unique qualities of the project area • Interpret the design to identify the visual character and urban design of the project • Assess the compatibility of the project with its context • Identify the visual impacts of the project during daytime and night-time conditions (including lighting), and throughout construction and operation • Consider land use changes where they may influence the character of the existing site • Consider the heritage and other social values of the site to establish the potential sensitivity of receptors and visual absorption capacity • Consider potential cumulative impacts associated with the construction / operation of other major projects near the project site • Identify measures to avoid, minimise and / or mitigate potential impacts.
Groundwater and geology	A desktop-based hydrogeological assessment will be undertaken as part of the environmental impact statement. The following government guidelines will be considered as relevant during the preparation of the hydrogeology assessment: • *NSW Aquifer Interference Policy* (Department of Primary Industries, 2012). The hydrogeological assessment will: • Describe the aquifer system(s) traversed by the project • Identify existing groundwater levels along the alignment and near the stations and portals • Identify sensitive groundwater receptors (registered groundwater bores) • Discuss the nature and extent of potential impacts on groundwater associated with construction and the presence of end-state project infrastructure including tunnels, portals and station excavations. This would take into account existing groundwater levels, the geological context, the extent to which the infrastructure is 'tanked' (with sealed walls) and experience on other projects (including groundwater inflow rates) • Propose monitoring / management measures to address identified impacts.

Issue	Proposed environmental impact statement scope
Soils, contamination and water quality	A soils, contamination and water quality assessment will be undertaken as part of the environmental impact statement. The following government guidelines will be considered as relevant: • *Acid Sulfate Soils Assessment Guidelines* (Department of Planning, 2008) • *Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land* (Department of Urban Affairs and Planning and Environment Protection Authority, 1998) • *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004) • *Managing Urban Stormwater: Soils and Construction Volume 2* (Department of Environment and Climate Change, 2008) • *Guidelines for Consultants Reporting on Contaminated Sites* (Office of Environment and Heritage, 2000) • *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* (Department of Environment and Climate Change, 2009) • *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (Department of Environment and Climate Change, 2008) • *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC / ARMCANZ, 2000) • *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (Department of Environment and Conservation, 2006). The soils, contamination and water quality assessment will include: • A review of previous contamination assessments (where available) • A review of historical aerial photography of the project area (to identify potential contamination sources along and / or adjacent to the project) • A review of publicly available data (web-based information searches) • A site inspection to identify potential contamination sources and verify those potential areas of concern identified in the review of historical and available information • Recommendations for additional investigations and / or management of potentially contaminated sites which could be encountered during construction. The environmental impact statement will also: • Identify potential impacts on surface water quality and groundwater quality • Identify the potential to disturb acid sulfate soils and the associated impacts • Consider the potential impacts associated with erosion and sedimentation.

Issue	Proposed environmental impact statement scope
Social impacts and community infrastructure	An assessment of potential social and community impacts will be undertaken as part of the environmental impact statement. Relevant government guidelines that will be considered include *Environmental Planning and Impact Assessment Practice Note: Socio-economic Assessment* (Roads and Maritime Services, 2013). This assessment will: • Identify any community facilities that would be lost as a result of construction or operation of the project. In this instance, the assessment will identify if alternative facilities are available or if the facilities can be replaced in the local area • Identify community facilities adjacent to construction sites and operational infrastructure that may be impacted by reduced amenity • Identify where access may be lost or restricted as a result of construction of the project. In this instance, the assessment will identify if suitable alternative access can be provided to the facility • Consider electric and magnetic fields in accordance with the Draft Radiation Standard – *Exposure Limits for Magnetic Fields* (Australian Radiation Protection and Nuclear Safety Agency, 2006) • Consider the potential health benefits associated with public transport.
Cumulative impacts	An assessment of potential cumulative impacts will be undertaken as part of the environmental impact statement. This assessment will include: • Identification of known surrounding developments with the potential to interact with the construction and / or operation of the project (these will be identified through consultation with stakeholders and a review of relevant local environmental plans, the Department of Planning and Environment's major projects database and local council development application registers) • Qualitative assessment of the potential cumulative impacts arising from the interaction of these projects • Management and mitigation measures, where appropriate.

9.2 Proposed environmental impact statement scope for other environmental issues

Table 9.2 provides a summary of the proposed environmental impact statement assessment scope for 'other' environmental issues. This scope will be refined (if necessary) following receipt of the Secretary of the Department of Planning and Environment's environmental assessment requirements for the project. Should any 'other' environmental issue be identified as being significant during the environmental assessment process, the likely impacts will be adequately assessed and documented in the environmental impact statement.

Table 9.2 Proposed environmental impact statement scope for other environmental issues

Issue	Proposed environmental impact statement scope
Ecology	An ecology assessment will be prepared as part of the environmental impact statement. The following government guidelines will be considered as relevant during preparation of the ecology assessment: • *Commonwealth EPBC 1.1 Significant Impact Guidelines – Matters of National Environmental Significance* (Commonwealth of Australia, 2013) • *Commonwealth EPBC 1.2 Significant Impact Guidelines – Actions on, or Impacting upon, Commonwealth Land and Actions by Commonwealth Agencies* (Commonwealth of Australia, 2013) • *Commonwealth Department of the Environment – Nationally Threatened Ecological Communities and Threatened Species Guidelines* (various) • *Commonwealth Department of the Environment – Survey Guidelines for Nationally Threatened Species* (various) • Threatened Species Survey and Assessment Guidelines at http://www.environment.nsw.gov.au/threatenedspecies/surveyassessmentgdlns.htm • *NSW Biodiversity Offsets Policy for Major Projects* (Office and Environment and Heritage, 2014) • *Framework for Biodiversity Assessment* (Office and Environment and Heritage, 2014). The ecology assessment will be based on a desktop review of database searches, regional biodiversity mapping and any relevant existing site-specific reports, as well as site inspection and detailed targeted field surveys, if necessary. The ecology assessment will: • Identify and describe the flora and fauna species, habitat, populations and ecological communities (including groundwater dependent ecosystems) that occur or are considered likely to occur • Assess the direct and indirect impacts of the project on terrestrial and aquatic flora and fauna species, populations, ecological communities and their habitats, and groundwater dependent ecosystems • Assess the significance of the impacts of the project on species, ecological communities and populations, and groundwater dependent ecosystems listed under the EPBC Act, the TSC Act and *Fisheries Management Act 1994* that occur or are considered likely to occur • Identify and describe mitigation measures using the principles of 'avoid, minimise, mitigate', and propose offsets where residual impacts occur. Offsets would be determined in accordance with the *NSW Biodiversity Offsets Policy for Major Projects* (Office and Environment and Heritage, 2014).

Issue	Proposed environmental impact statement scope
Hydrology and flooding	A hydrology and flooding impact assessment will be prepared as part of the environmental impact statement. Relevant government guidelines that will be followed include: • *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom 2004) and *Volume 2 (A. Installation of Services; B. Waste Landfills; C. Unsealed Roads; D. Main Roads; E. Mines and Quarries)* (DECC 2008) • NSW Government's *Floodplain Development Manual* (2005). The assessment will include: • Identification of potential impacts on stormwater quantity • Broad assessment of the potential change in stormwater runoff (increase or decrease) • 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 • An assessment of the potential impact on surface water quantity • Identification of any potential changes to flood levels, discharges, velocities, duration of flood inundation and flood hazards for the 20 and, 100 year average recurrence interval flood event, and the probable maximum flood • Identification of appropriate mitigation and management measures.
Air quality	An air quality impact assessment will be prepared as part of the environmental impact statement. The assessment will include: • Identification and description of the background air quality environment based on a desktop assessment • Identification of potential sources of air emissions during construction and operation of the project • Identification of potential sensitive receivers likely to be impacted by emissions to air from the project • Mitigation measures using the principles of 'avoid, minimise, mitigate'.
Greenhouse gas and energy	A greenhouse gas and energy assessment will be prepared as part of the environmental impact statement. Relevant government guidelines that will be followed include: • *NSW's Sustainable Design Guidelines (Version 3.0)* (Transport for NSW, 2013) • *Greenhouse Gas Inventory Guide for Construction Projects* (Transport for NSW, 2012). The assessment will include: • Consideration of the potential savings of greenhouse gas emissions during the operation of the project associated with a mode shift of customer from road to rail • Mitigation and management measures to reduce potential emissions of greenhouse gases.

Issue	Proposed environmental impact statement scope
Climate change adaptation	A climate change adaptation assessment will be prepared as part of the environmental impact statement. Relevant government guidelines that will be followed include: • *Commonwealth Scientific and Industrial Research Organisation Climate Change in Australia Technical report 2007,* which is based on the *Intergovernmental Panel on Climate Change Fourth Assessment Report* (2007) • *ISO 31000-2009: Risk Management – Principles and Guidelines* • *AS 5334 – Climate change adaptation for settlements and infrastructure* • *Flood Risk Management Guide: Incorporating sea level rise benchmarks in flood risk assessments* (DECCW, 2011). The assessment will include: • Identification of possible climate related impacts with an emphasis on any that are projected to undergo a substantial change • Identification of project components that may be vulnerable to the climate change impacts such as increased bushfires • Identification of possible current and future controls that may increase the resilience of particular project components to climate impacts • Recommendations of what should be considered, and how to establish if further information is needed, to adequately assess the climate change risk associated with the project.
Hazard and risks	A high level, desktop hazard and risk assessment will be prepared as part of the environmental impact statement and mitigation measures will be proposed, where relevant. Relevant government guidelines that will be followed include: • *Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (Department of Planning, 2011) • *International Standard (ISO / IEC 31010) Risk management – Risk assessment techniques* • *Australian Code for the Transport of Dangerous Goods by Road and Rail (7th edition)* (National Transport Commission, 2007) • *Code of Practice for the Safe Removal of Asbestos 2nd edition NOHSC* (National Occupational Health and Safety Commission, 2005) • *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover, 2005).

Issue	Proposed environmental impact statement scope
Waste and resource use	A desktop waste and resource assessment will be undertaken as part of the environmental impact statement. This assessment will include: ○ A review of the likely waste streams and volumes from construction and operation of the project, including spoil, wastewater and demolition materials ○ A review of the likely resources required for construction and operation of the project, including energy, fuel, steel etc ○ Management strategies to adequately address waste and resource use during construction and operation. These strategies would likely include: • Measures for managing construction waste through the waste hierarchy established under the *Waste Avoidance and Recovery Act 2001* (ie avoidance of waste, resource recovery, disposal of waste) • Targets for the beneficial reuse of spoil, wastewater and other construction wastes in accordance with the project's sustainability strategy • Procedures for assessing, handling, stockpiling and disposing of potentially contaminated materials and wastewater, in accordance with the NSW Office of Environment and Heritage's *Waste Classification Guidelines* (Department of Environment, Climate Change and Water, 2009) • Opportunities to reduce the project's demand on electricity and other resources • A spoil management strategy identifying how spoil 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, including NorthConnex and WestConnex.

10 Conclusion

This chapter provides a conclusion to the report and identifies the next steps following receipt of the Secretary's environmental assessment requirements.

The *NSW Long Term Transport Master Plan* (Transport for NSW, 2012b) sets the direction for transport planning for the next 20 years, providing a framework for transport policy and investment decisions. An integral component of the *NSW Long Term Transport Master Plan* is *Sydney's Rail Future*, which provides a plan to modernise Sydney's rail network by investing in new services and upgrading existing infrastructure.

Sydney Metro is a major rail network identified in *Sydney's Rail Future*. Sydney Metro consists of Sydney Metro Northwest (previously known as the North West Rail Link) and Sydney Metro City & Southwest.

Transport for NSW proposes to construct and operate a new underground rail line, about 15 kilometres long, and new stations between Chatswood and Sydenham (known as the Chatswood to Sydenham project), as part of the NSW Government's plan to implement *Sydney's Rail Future*.

The project would deliver a major increase in the capacity of Sydney's rail network, with the capacity to run up to 30 trains per hour through the Sydney CBD in each direction. This would represent a 60 per cent increase in the number of trains operating on Sydney's rail network in peak periods, which would cater for an extra 100,000 customers per hour.

The project has sought a declaration to be State significant infrastructure and critical State significant infrastructure under sections 115U(4) and 115V of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Therefore, the project would be subject to assessment and approval by the Minister for Planning under Part 5.1 of the EP&A Act.

This document supports an application to the NSW Minister for Planning seeking the Secretary's environmental assessment requirements for the environmental impact statement. It has been prepared based on the indicative locations and design included within the plans in this report, for the purposes of informing the preparation of the Secretary's environmental assessment requirements. The project components, location and design may be subject to further changes as part of the ongoing design development and community consultation and clarifications may be made during the environmental impact assessment process.

A preliminary environmental risk analysis for the project has identified the following 'key' environmental issues:

- Traffic, transport and access
- Noise and vibration
- Property and land use
- Business impacts
- Non-Aboriginal heritage
- Aboriginal heritage
- Landscape character and visual amenity
- Groundwater and geology
- Soils, contamination and water quality
- Social impacts and community infrastructure
- Cumulative impacts.

A preliminary environmental assessment of the project's potential impact has confirmed that the above issues have the potential to result in a significant impact (without the adoption of adequate environmental mitigation measures). Detailed assessment of these issues, and other potential environmental issues, would be undertaken as part of an environmental impact statement.

Following the receipt of the Secretary's environmental assessments requirements, Transport for NSW will prepare and publicly exhibit an environmental impact statement, in accordance with the requirements of Part 5.1 of the EP&A Act. The environmental impact statement will include:

- A description of the project, including its components and construction activities
- A description of the existing environment and an assessment of potential direct and indirect impacts on the key and other potential environmental issues during construction and operation of the project
- Identification of measures to be implemented to avoid, minimise, manage, mitigate, offset and / or monitor potential impacts of the project
- Identification and consideration of issues raised by stakeholders and the community.

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Glossary and abbreviations

Term / acronym	Definition
A Plan for Growing Sydney	*A Plan for Growing Sydney* (NSW Government, 2014a) sets out the NSW Government's strategy for accommodating Sydney's future population growth over the next 20 years
AADT	annual average daily traffic
agglomeration benefits	agglomeration benefits refer to the productivity benefits firms derive from being located in close proximity to each other, enabling increased interaction between firms with resulting improved productivity through knowledge sharing and collaboration
AHIMS	Aboriginal Heritage Information Management System
ARI	the average recurrence interval refers to the average or expected value of the periods between exceedances of a given rainfall total accumulated over a given duration
AS	Australian Standard
CBD	central business district
CCTV	closed-circuit television
Chatswood to Sydenham project	the Chatswood to Sydenham project (the subject of this report) forms one of two core components of Sydney Metro City & Southwest. It comprises the establishment of two underground metro tracks between Chatswood and Sydenham. The tracks would be in twin tunnels about 15 kilometres long. The tunnels would be bored from Mowbray Road, Chatswood, under Sydney Harbour and the CBD to Bedwin Road, Marrickville. This work would also involve constructing metro stations at Crows Nest, Victoria Cross, Barangaroo, Pitt Street and Martin Place, and underground platforms at Central Station
CO	carbon monoxide
DEC	the former NSW Department of Environment and Conservation; now the NSW Office of Environment and Heritage
DECC	the former NSW Department of Environment and Climate Change; now the NSW Office of Environment and Heritage
DECCW	the former NSW Department of Environment, Climate Change and Water; now the NSW Office of Environment and Heritage
Dive structure	refers to the change in grade from the surface to the tunnel portal (refer to tunnel portal)
dwell time	the length of time that a train is stopped at a station
EMF	electromagnetic fields
EPA	NSW Environment Protection Authority
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EP&A Regulation	NSW *Environmental Planning and Assessment Regulation 2000*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EPL	environment protection licence
Global Economic Corridor	Sydney's key employment and economic areas are clustered along a corridor that runs from Port Botany and Sydney Airport to Macquarie Park known as the Global Economic Corridor

Term / acronym	Definition
ISO	International Organization for Standardization
LEP	local environmental plan
LGA	local government area
µg / m^3	micrograms per cubic metre
mg / m^3	milligrams per cubic metre
MNES	matter of national environmental significance. Under the *Environment Protection and Biodiversity Conservation Act 1999*, actions that have, or are likely to have, a significant impact on a matter of national environmental significance require approval from the Australian Government Minister for the Environment
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
NPI	the Commonwealth Department of the Environment's National Pollutant Inventory
NSW	New South Wales
NSW 2021	*NSW 2021: A Plan to Make NSW Number One* (NSW Department of Premier and Cabinet, 2011) is the NSW Government's 10 year strategic business plan to rebuild the NSW economy, provide quality services, renovate infrastructure, restore government accountability, and strengthen local environment and communities
NSW Long Term Transport Master Plan	the *NSW Long Term Transport Master Plan* (Transport for NSW, 2012b) is the NSW Government's 20 year plan to improve the NSW transport system by delivering an integrated, modern transport system that puts the customer first
OEH	NSW Office of Environment and Heritage
PAD	potential archaeological deposit
PCB	polychlorinated biphenyl
$PM_{2.5}$	particulate matter with an aerodynamic diameter less than 2.5 microns
PM_{10}	particulate matter with an aerodynamic diameter less than 10 microns
PMF	probable maximum flood
POEO Act	NSW *Protection of the Environment Operations Act 1997*
(the) project	refers to the Chatswood to Sydenham project (the subject of this report)
Rebuilding NSW	*Rebuilding NSW: State Infrastructure Strategy 2014* (NSW Government, 2014b) outlines the NSW Government's plan to invest $20 billion in new productive infrastructure to sustain productivity growth in NSW's major centres and regional communities, as well as to support forecasted population growth of almost six million people in Sydney and more than nine million people in NSW
S170 Register	Section 170 Register under the NSW *Heritage Act 1977*
SBS	Special Broadcasting Service
SEPP	State Environmental Planning Policy
SO_2	sulfur dioxide

Term / acronym	Definition
SRD SEPP	*State Environmental Planning Policy (State and Regional Development) 2011*
Sydenham to Bankstown upgrade	one of two core components of the Sydney Metro City & Southwest, which would involve upgrading the existing 13.5 kilometre rail line and existing stations between Sydenham and Bankstown to support metro operations
Sydney LEP 2012	*Sydney Local Environmental Plan 2012*
Sydney City Centre Access Strategy	The *Sydney City Centre Access Strategy* (Transport for NSW, 2013) is the NSW Government's plan to deliver a fully integrated transport network in Sydney's city centre that puts the customer first and meets the city's growing transport task
Sydney Harbour Catchment SREP	*Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005*
Sydney Metro	Sydney Metro is a major rail system identified by *Sydney's Rail Future*. Sydney Metro consists of Sydney Metro Northwest and Sydney Metro City & Southwest.
Sydney Metro City & Southwest	Sydney Metro City & Southwest comprises an extension of the Sydney Metro Northwest (formerly the North West Rail Link) from Chatswood under Sydney Harbour, through the central business district of Sydney, and west to Bankstown. The Sydney Metro City & Southwest involves two core components – the Chatswood to Sydenham project (the subject of this report) and the Sydenham to Bankstown upgrade
Sydney Metro Northwest	Sydney Metro Northwest (formerly the North West Rail Link) comprises a new metro service between Cudgegong Road (in Rouse Hill) and Chatswood. The Sydney Metro Northwest is the first stage of the NSW Government's plan to develop a metro rail system in Sydney, and is a key initiative outlined in *Sydney's Rail Future* (Transport for NSW, 2012a)
Sydney's Rail Future	*Sydney's Rail Future: Modernising Sydney's Trains* (Transport for NSW, 2012a) is the NSW Government's long-term plan to increase the capacity of Sydney's rail network though investment in new services and upgrading of existing infrastructure. Sydney's Rail Future is being delivered in five stages. The project comprises Stage 4 of *Sydney's Rail Future*, which would provide the largest increase in capacity to the Sydney rail network for 80 years
TAFE	Technical and Further Education (TAFE) NSW
the project	refers to the Chatswood to Sydenham project (the subject of this report)
TSC Act	NSW *Threatened Species Conservation Act 1995*
TSP	total suspended solids
tunnel crown	refers to the top surface of a tunnel structure
tunnel portal	refers to the entrance of the tunnel structure
UTS	University of Technology, Sydney
VOCs	volatile organic compounds

Appendix A
Requirements of the Environmental Planning and Assessment Regulation 2000

A1
Requirements of the Environmental Planning and Assessment Regulation 2000

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

- Details of any approval that would, but for section 115ZG of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act), be required for the carrying out of the State significant infrastructure; and
- Details of any authorisations that must be given under section 115ZH of the EP&A Act if the application is approved; and
- 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.

The above requirements are provided in the following sections.

A1.1 Approvals that would otherwise apply

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

- Concurrence under Part 3 of the *Coastal Protection Act 1979* of the Minister administering that Part of the Act
- Permits under sections 201, 205 and 219 of the *Fisheries Management Act 1994*
- Approvals under Part 4, or excavation permits under section 139 and Division 8 of Part 6 of the *Heritage Act 1977*
- Aboriginal heritage impact permits under section 90 of the *National Parks and Wildlife Act 1974*
- Various approvals under the (NSW) *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
- An environment protection notice under Chapter 4 of the *Protection of the Environment Operations Act 1997* (POEO Act).

A1.2 Authorisations if the application is approved

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

- Environment protection licence (EPL) under Chapter 3 of the POEO Act
- A consent under section 138 of the Roads Act 1993, which requires consent 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. The Roads Act 1993 only applies to a public authority where the activity affects a classified road – which in most cases would mean that the appropriate roads authority is Roads and Maritime Services.

A1.3 Other legislation and regulations that may be applicable

A number of other planning related legislation and regulations may still be applicable to an approved critical State significant infrastructure project and based on current scope, may be relevant to the Chatswood to Sydenham project. This legislation is identified in Table A1.

Table A1 Planning related legislation and regulations of potential relevance to the project

Legislation	Requirement
Water Management Act 2000	The *NSW Aquifer Interference Policy* (Department of Primary Industries, 2012) documents the NSW Government's intention to implement the requirement for approval of 'aquifer interference activities' under the *Water Management Act 2000*. The requirement for aquifer interference approvals has not yet commenced.
Contaminated Land Management Act 1997	The *Contaminated Land Management Act 1997* outlines the circumstances in which notification of the Environment Protection Authority (EPA) is required in relation to the contamination of land. This may become relevant during construction and / or operation of the project.
Crowns Land Act 1989	Ministerial approval is required to grant a 'relevant interest' (i.e. a lease, license, permit, easement or right of way) over a Crown Reserve if required. The project would pass underneath a number of parcels of Crown land. In addition, there is the potential for construction compounds to be temporarily located on Crown land. Any affected Crown land would be managed in accordance with the objectives of this Act.
Heritage Act 1977 (section 146)	Heritage Council must be notified if a relic is uncovered during construction and if it is reasonable to believe that the Heritage Council is unaware of the location of the relic.
Fisheries Management Act 1994 (section 199)	A public authority is required to give the Minister written notice of proposed dredging or reclamation work prior to carrying out or authorising the carrying out of such work. In the event that reclamation / dredging work is required to support construction of the project, the Minister would be provided with written notice of any construction activities requiring dredging or reclamation work, in accordance with section 199 of this Act.
Marine Pollution Act 2012	Includes various provisions to protect the sea and waters from pollution by oil and other noxious substances discharged from vessels. Any construction activities requiring the use of a vessel (eg barge) must comply with the requirements of the *Marine Pollution Act 2012* and the *Marine Pollution Regulation 2014*.
Marine Services Act 1935 and Ports and Maritime Administration Act 1995	A number of authorisations / approvals / permits may be required with respect to the placement of any structures in the water and / or with respect to obstruction to navigation. This would include the construction of the Harbour crossing.
Management of Waters and Waterside Lands Regulations — N.S.W.	The written approval of the Harbour Master is required for any proposed works that would disturb the bed of the Special Port Areas defined under these regulations – which includes Sydney Harbour and any adjoining or adjacent land. Activities where this may be required include the construction of the Harbour crossing.
Native Title (NSW) Act 1994	Provides for native title in relation to land or waters. The project would not affect land subject to native title or to which an Indigenous Land Use Agreement applies.

Legislation	Requirement
Aboriginal Land Rights Act 1983	The NSW *Aboriginal Land Rights Act 1983* establishes the NSW Aboriginal Land Council and local Aboriginal land councils. The Act requires these bodies to: • Take action to protect the culture and heritage of Aboriginal persons in the council's area, subject to any other law • Promote awareness in the community of the culture and heritage of Aboriginal persons in the council's area. The preamble of the Aboriginal Land Rights Act 1983 states that land was traditionally owned and occupied by Aboriginal people and accepts that as a result of past government decisions, the amount of land set aside for Aboriginal people was reduced without compensation. To redress the loss of land, Aboriginal land councils can claim Crown land which, if granted, is transferred as freehold title. 'Claimable Crown lands' includes Crown lands that are not lawfully used or occupied and that are not needed, nor likely to be needed, for an essential public purpose. No claimable Crown lands would be affected by the project.
The Land Acquisition (Just Terms Compensation) Act 1991	This Act would apply to the acquisition of land required for the project except for underground stratum acquisition where the *Transport Administration Act 1988* applies.
Transport Administration Act 1988	This Act also applies to compulsory acquisitions for the purpose of underground rail facilities.
Waste Avoidance and Resource Recovery Act 2001	This Act, among other things, encourages the most efficient use of resources and to reduce environmental harm.

A1.4 State significant infrastructure statement

Clause 79 of *State Environmental Planning Policy (Infrastructure) 2007* (the 'Infrastructure SEPP') permits development for the purpose of a railway or rail infrastructure facilities to be carried out by or on behalf of a public authority without consent, provided that the proposal is not carried out on land reserved under the NSW *National Parks and Wildlife Act 1974* (NPW Act).

As the Chatswood to Sydenham project comprises a railway that would be carried out by or on behalf of Transport for NSW on land that is not reserved under the NPW Act, the project can be assessed under Part 5 of the EP&A Act. Development consent (under Part 4 of the EP&A Act) from the relevant Council is not required.

The project is permissible without consent by virtue of Clause 79 of Infrastructure SEPP, meaning that the project is an activity within the meaning of Part 5 of the EP&A Act and Transport for NSW is the determining authority.Transport for NSW, as proponent and determining authority, has formed the view that the project is likely to significantly affect the environment.

It is also intended to declare the project, by Ministerial Order, to be State significant infrastructure and critical State significant infrastructure under sections 115U(4) and 115V of the EP&A Act, respectively. Schedule 5 of *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP) would also be amended to include the project as critical State significant infrastructure.

On this basis the project would be critical State significant infrastructure and subject to Part 5.1 of the EP&A Act.

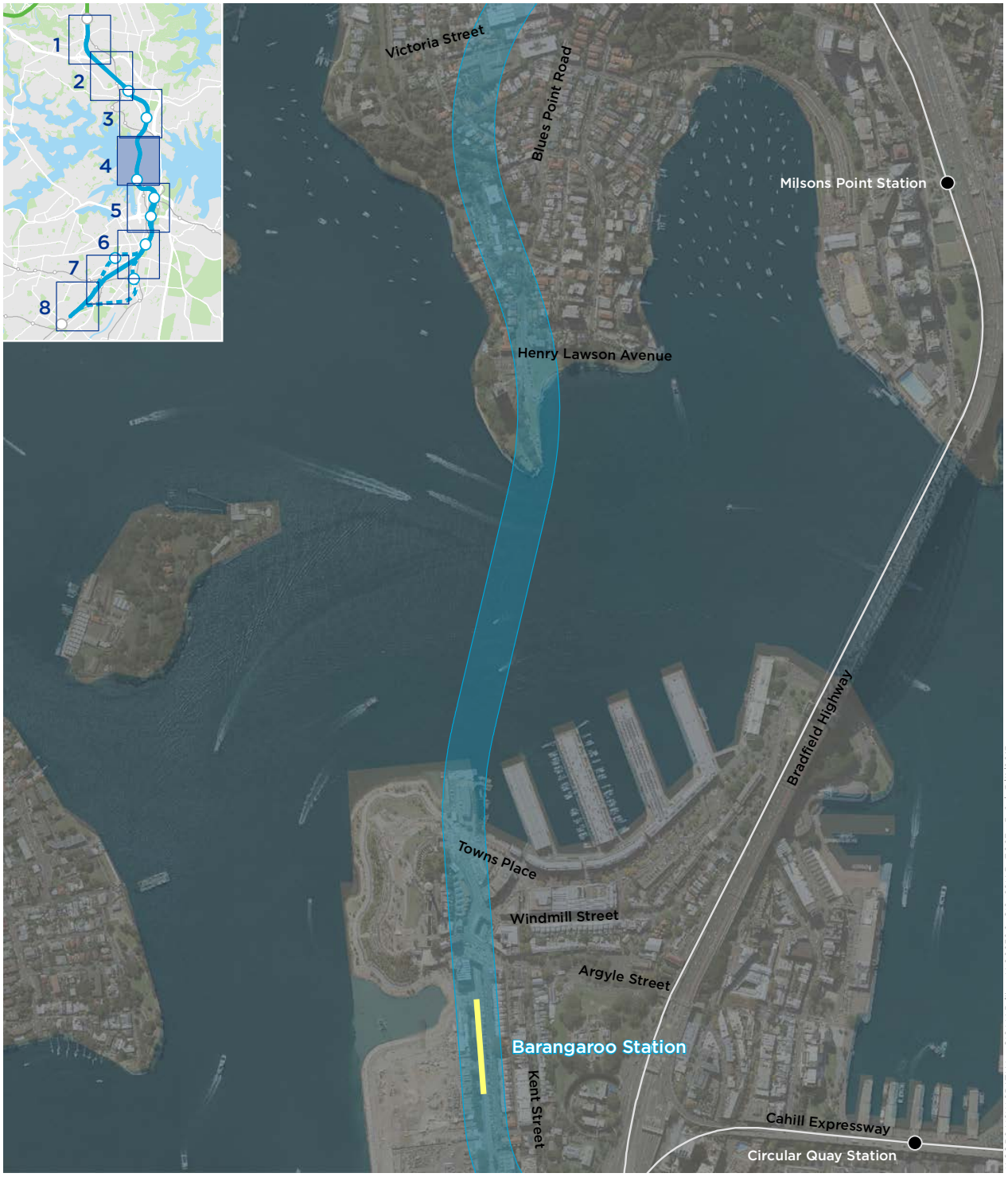
Appendix B
Indicative project corridor

Sydney Metro Northwest
Chatswood to Sydenham surface works
Chatswood to Sydenham corridor
Proposed dive structure
Proposed ancillary infrastructure
Existing suburban rail
Existing rail station

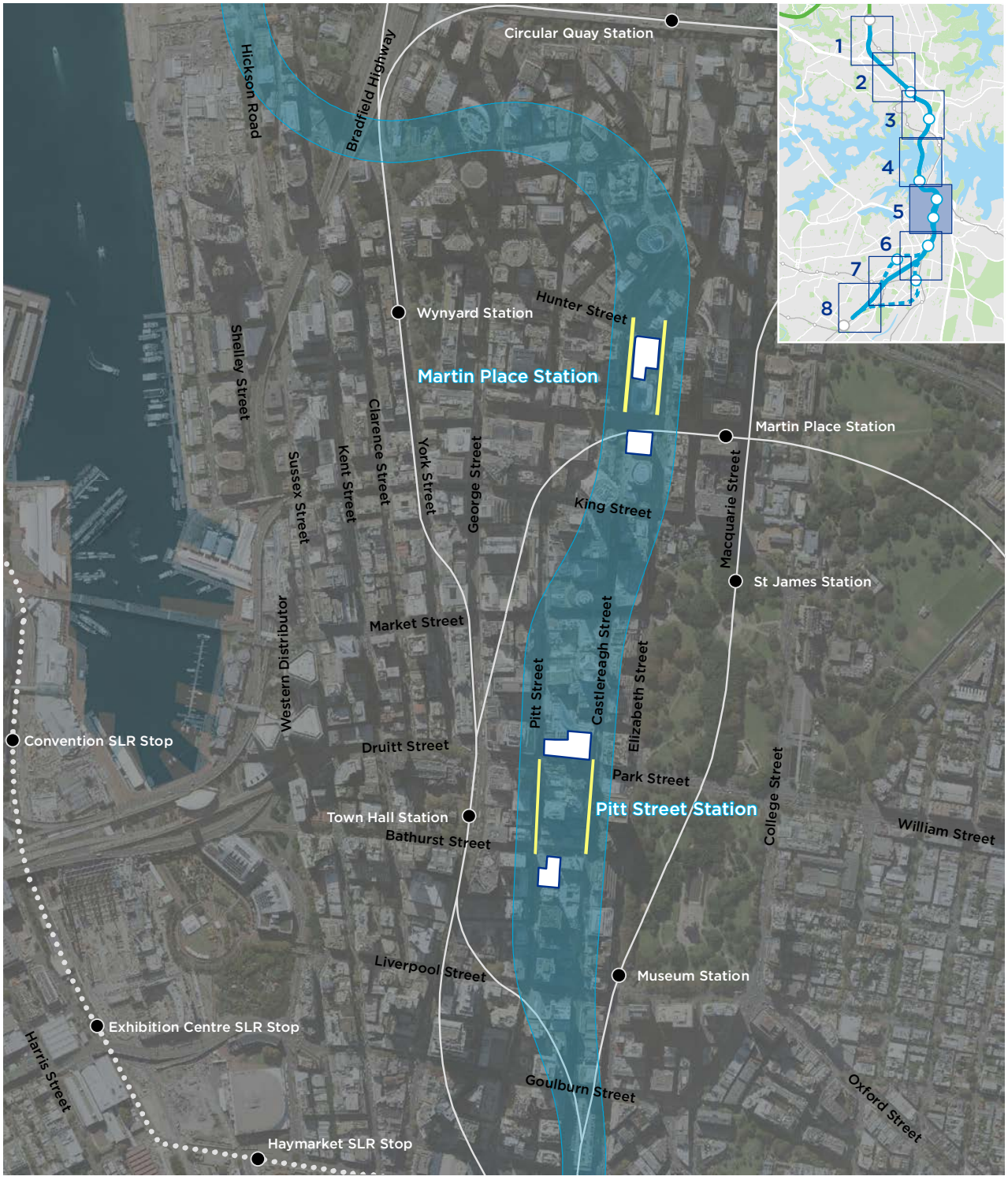
Corridor Map 1

Corridor Map 2

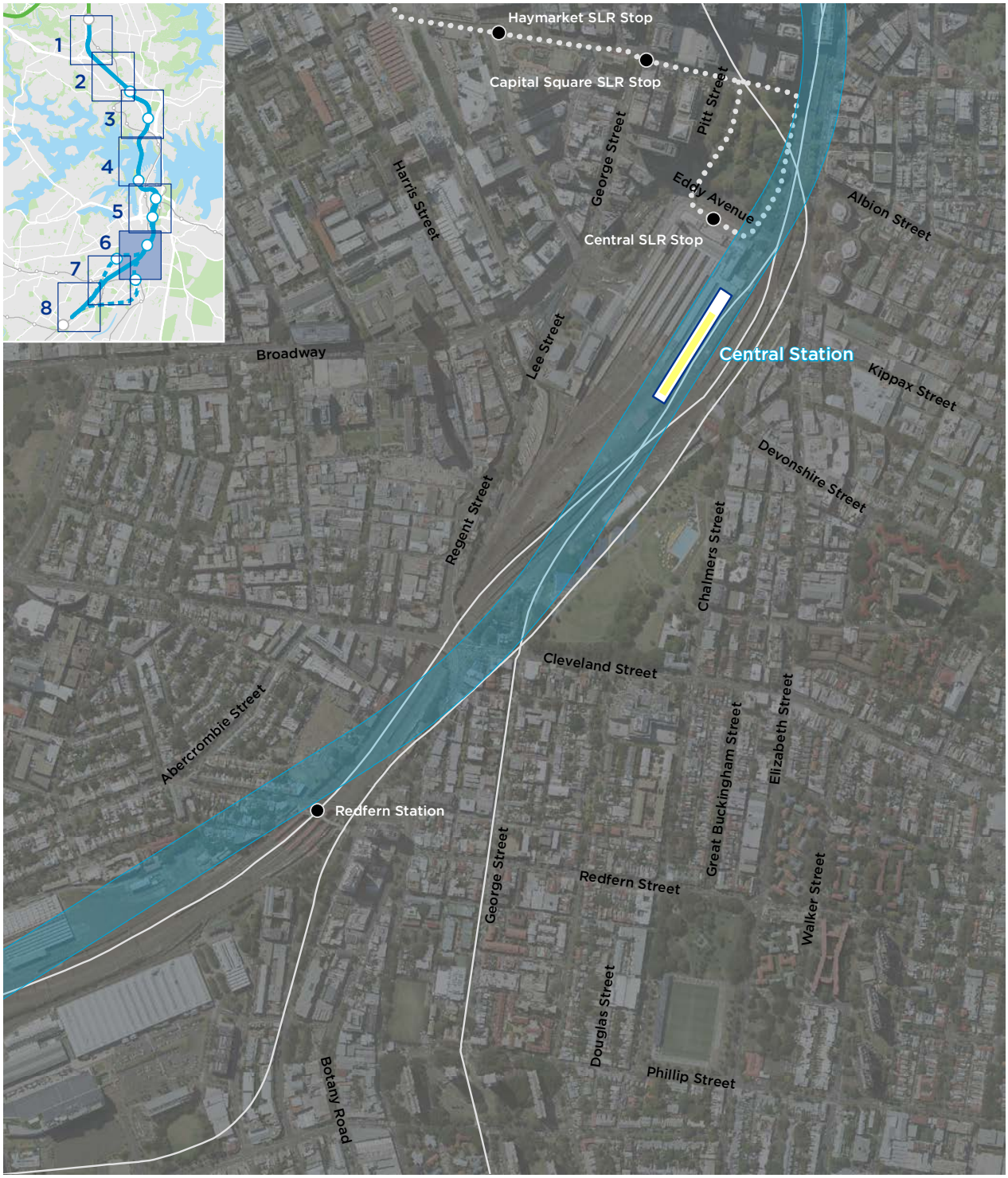
Corridor Map 3



Corridor Map 4



Corridor Map 5



Corridor Map 6

Corridor Map 7

Corridor Map 8

Appendix C
Feedback from Project Scope Consultation

C1
Feedback from Project Scope Consultation

Table C1 outlines the feedback received to date regarding the Sydney Metro City & Southwest scope exhibition and how this will be considered in defining the scope of the environmental impact statement.

Table C1 Feedback from the project scope consultation

Topic	Key issues raised	Environmental impact statement scope
Chatswood tunnel	Concern about the impact of aboveground rail operations on localities such as Artarmon	The environmental impact statement will include an assessment of all areas impacted by construction and operation of the project as outlined in Chapter 5 of this report.
	Concern about the impact of an aboveground metro on the flora and fauna in Artarmon Reserve	The environmental impact statement will include an ecological assessment of areas impacted by construction and operation of the project as outlined in Section 7.2.1 of this report.
	Request for more information on the proposed tunnel and construction	The environmental impact statement will include a detailed description of the preferred tunnel portal locations and construction methodology as outlined in Chapter 5 of this report.
Artarmon Industrial Area (optional station)	• Support for a station in the Artarmon Industrial Area to service local employment	• The environmental impact statement will include details on the station location option evaluation as outlined in Chapter 4 of this report.
	• Opposition to a station in the Artarmon Industrial Area due to lack of density and the area being serviced by the existing Artarmon Station	• The environmental impact statement will include details on the station location option evaluation as outlined in Chapter 4 of this report.
	• Concern about the heritage value of Artarmon Station	• The environmental impact statement will include a heritage assessment of all areas impacted by construction and operation of the project as outlined in sections 7.1.5 and 7.1.6 of this report.
	• Concern about increased noise pollution	• The environmental impact statement will include a noise and vibration assessment of all areas impacted by construction and operation of the project as outlined in Section 7.1.2 of this report.
	• Concern about the impact of an aboveground metro on the flora and fauna in Artarmon Reserve, in particular the Blue Gum population	• The environmental impact statement will include an ecological assessment of areas impacted by construction and operation of the project as outlined in Section 7.2.1 of this report.

Topic	Key issues raised	Environmental impact statement scope
St Leonards / Crows Nest	• Support for Crows Nest over St Leonards as a metro station location • Positive comments in regards to increased accessibility to the station for small businesses, restaurants and new housing • Positive comments in regards to proximity of the station to public services and facilities such as the Royal North Shore Hospital and TAFE	• The environmental impact statement will include details on the station location option evaluation as outlined in Chapter 4 of this report. • The environmental impact statement will include business impact assessment and community infrastructure assessment of all areas impacted by construction and operation of the project as outlined in sections 7.1.4 and 7.1.10 of this report.
	• Opposition to a metro station at St Leonards because it is already well serviced by public transport	• The environmental impact statement will include details on the station location option evaluation as outlined in Chapter 4 of this report.
Barangaroo	• Overwhelming support for a station at Barangaroo	• The NSW Government has now confirmed Barangaroo as a proposed station site as outlined in Chapters 4 and 5 of this report.
The University of Sydney (optional station)	• Strong support for a metro station at The University of Sydney rather than Waterloo • Positive comments in regards to greater accessibility to the university, RPA Hospital, Broadway shopping centre, businesses in Glebe and nearby entertainment facilities	• The environmental impact statement will include details on the station location option evaluation as outlined in Chapter 4 of this report.
	• Opposition to the station because the area is already well serviced by public transport	• The environmental impact statement will include details on the station location option evaluation taking into account the issues raised as outlined in Chapter 4 of this report.
Waterloo (optional station)	• Moderate support for a metro station at Waterloo • Comment that the area is not well serviced by public transport, and Green Square and Redfern stations are not close enough to service the Waterloo area • Comment that the public transport that is available is not coping with demand, and road congestion is a major issue for bus services	• The environmental impact statement will include details on the station location option evaluation taking into account the issues raised as outlined in Chapter 4 of this report.
	• Opposition to a metro station at Waterloo because the area is already serviced by Green Square and Redfern stations and bike paths	• The environmental impact statement will include details on the station location option evaluation taking into account the issues raised as outlined in Chapter 4 of this report.

Topic	Key issues raised	Environmental impact statement scope
Safety	• Concern about current overcrowding of stations, in particular Erskineville, St Peters and Town Hall • Perception that the metro would be unsafe due to automated trains. In particular, concern there would be no support for passengers if the train breaks down, and that crime could escalate • Concern about accessibility issues for elderly customers, the inclusion of lifts in the station design, air quality maintenance and a desire for a smaller gap between the train and the platform	• The environmental impact statement will include a review of the station design principles for customer comfort, accessibility and access as outlined in Chapter 5 of this report. • The environmental impact statement will include a hazard and risk assessment as outlined in Section 7.2.7 of this report.
Proposed network extensions	• Suggestions for line extensions to the Northern Beaches, Frenchs Forest, Sydney Airport, Badgerys Creek, Liverpool, Darling Harbour, Inner West line, Lidcombe, north west, West Pennant Hills, Balmain and Rozelle	• The environmental impact statement will include a discussion of strategic alignment options and the decision for the proposed connection between Chatswood and Bankstown as outlined in Chapter 3 of this report.
Local issues	• Submissions classified as 'local issues' covered a wide range of issues relating to specific localities such as Waterloo, The University of Sydney, St Leonards, Crows Nest, Lane Cove, Dulwich Hill, Victoria Cross, the T2 Inner West Line and the Central Coast line • Concerns about overcrowding at existing stations • Concern about lack of information provided regarding public acquisitions, line closure time periods and the project's relationship with WestConnex • Concern about the need to protect Artarmon Reserve • Concern about the development that would arise around new metro stations and whether additional car parking would be provided	• The environmental impact statement will include details on the station location option evaluation taking into account the issues raised as outlined in Chapter 4 of this report. • The environmental impact statement will include a detailed traffic, transport and access assessment of areas impacted by construction and operation of the project as outlined in Section 7.1.1 of this report. • The environmental impact statement will include an ecological assessment of areas impacted by construction and operation of the project as outlined in Section 7.2.1 of this report. • The environmental impact statement will include a cumulative impact assessment as outlined in Section 7.1.10 of this report.
Heritage	• Desire to retain and maintain the heritage significance of current stations located on the proposed metro line, including Artarmon and Marrickville stations	• The environmental impact statement will include an Aboriginal and non-Aboriginal heritage assessment of all areas impacted by construction and operation of the project as outlined in sections 7.1.5 and 7.1.6 of this report. • The heritage assessment of Marrickville Station will be subject to a separate environmental assessment for the Sydenham to Bankstown upgrade.

Topic	Key issues raised	Environmental impact statement scope
Operation	• Comment that the frequency of services along the Bankstown line needs to increase and the metro needs to include Erskineville and St Peters stations • Concerns about power usage and sustainability	• Frequency of services on the Sydney Metro Sydenham to Bankstown upgrade will be subject to a separate environmental assessment • The environmental impact statement will include a review of the station design principles and the sustainability measures that could be considered (where feasible) as outlined in Chapter 5 of this report. • The EIS will include climate change adaptation and greenhouse gas and energy assessments as outlined in sections 7.2.5 and 7.2.4 of this report.
Rolling stock	• Preference expressed for double-deck trains • Concern about seating configuration on the metro • Concern about advertising inside and outside the carriages • Comment about the need for bicycle facilities including lifts and lockers • Comment about the need for a level platform to access metro carriages • Request for platform screen doors	• The environmental impact statement will include a review of the station design principles for customer comfort, accessibility and access as outlined in Chapter 5 of this report.
Construction	• Concern about replacement services during the construction period, the frequency of these services, and compensation to affected customers • Concern about closure of existing stations during construction • Request for regular construction updates • Concern about compensation for those affected by tunnelling • Opposition to tunnelling in some areas • Preference for the Harbour Bridge to be used instead of a new tunnel • Comment about the need for alternative construction methodology	• The environmental impact statement will identify temporary arrangements for rail customers during construction activities as outlined in Section 7.1.1 of this report.
St Peters and Erskineville stations	• Comment about level of service at these stations once metro is operational • Opposition to tunnels around St Peters and Newtown • Concern about any loss of direct services from Erskineville Station	• The environmental impact statement will assess operation impacts on existing services as outlined in Section 7.1.1 of this report.