PROJECT DESCRIPTION – OPERATION

CHAPTER SIX

6 Project description – operation

This chapter provides a description of the project once it is operational, including the proposed layout of the stations, the location of the track alignment and how customers would use Sydney Metro. A description of how the project is likely to be constructed is provided in Chapter 7 (Project description – construction).

6.1 Secretary's environmental assessment requirements

The Secretary's environmental assessment requirements relating to project description – operation, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 6-1.

Table 6-1 Secretary's environmental assessment requirements – project description – operation

Ref.	Secretary's environmental assessment requirements	Where addressed
2. Environmental Impact Statement		
2 (b)	The EIS must include, but not necessarily be limited to, the following: a description of the project, including all components and activities (including ancillary components and activities) required to construct and operate it	This chapter provides a description of the project once operational. Chapter 7 (Project description – construction) provides a description of how the project would be constructed.
2 (i)	a demonstration of how the project design has been developed to avoid or minimise likely adverse impacts	Details of adverse impacts which have been avoided through design are described in Section 6.2.4. Additional details of adverse impacts which have been avoided through construction methodologies are described in Chapter 7 (Project description – construction).

6.2 Project overview

6.2.1 Key features of the project

The Sydney Metro Chatswood to Sydenham project (the project) involves the construction and operation of a metro rail line and associated stations between Chatswood Station and just north of Sydenham Station. The proposed alignment and key operational features of the project are shown in Figure 6-1 and would include:

- 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 Sydney Trains 'down' (northbound) track to pass over the proposed northern dive structure
- About 250 metres of aboveground metro tracks between Chatswood Station and the Chatswood dive structure
- A dive structure (about 400 metres long) and tunnel portal south of Chatswood Station and north of Mowbray Road, Chatswood (the Chatswood dive structure)

- About 15.5 kilometres of twin rail tunnels (that is, two tunnels located side-by-side) between Mowbray Road, Chatswood and Bedwin Road, Marrickville. The tunnel corridor would extend about 30 metres either side of each tunnel centre line and around all stations
- A substation (for traction power supply) in Artarmon, next to the Gore Hill Freeway, between the proposed Crows Nest Station and the Chatswood tunnel portal
- Metro stations at Crows Nest, Victoria Cross, Barangaroo, Martin Place, Pitt Street and Waterloo; and new underground platforms at Central Station
- A dive structure (about 400 metres long) and tunnel portal between Sydenham Station and Bedwin Road, Marrickville (the Marrickville dive structure)
- A services facility beside the Marrickville dive structure and tunnel portal, including a tunnel water treatment plant and a substation (for traction power supply).

The project would also include:

- Permanent closure of the road bridge at Nelson Street, Chatswood, and provision of an all vehicle right-turn movement from the Pacific Highway (southbound) into Mowbray Road (westbound)
- Signalisation of the Mowbray Road / Hampden Road intersection at Chatswood
- Permanent support work to the western abutment of Mowbray Road bridge. The western pier would also require a deflection wall around the existing pier columns
- Installation and modification of existing Sydney Trains rail systems including overhead wiring, signalling, access tracks / paths, rail corridor fencing and noise barriers, within the surface section between Chatswood Station and the dive structure at the northern end of the project
- Retaining walls for the realigned T1 North Shore Line 'down' track (between around Ellis Street, Chatswood and around Drake Street, Artarmon)
- Removal of the Sydney Trains maintenance access point at Hopetoun Avenue, Chatswood
- Maintenance access stairs from Albert Avenue, Chatswood to the eastern side of the rail corridor immediately south of Chatswood Station
- A maintenance access point from Brand Street, Artarmon on the 'down' (northbound) side of the T1 North Shore Line and modifications to the existing access point from Drake Street, Artarmon
- Services within each of the stations, including mechanical, electrical and ventilation equipment
- A permanent power supply from Pyrmont or Surry Hills to Pitt Street Station
- Underground pedestrian links at some stations and connections to other modes of transport (such as the existing suburban rail network) and surrounding land uses
- Alterations to pedestrian and traffic arrangements and public transport infrastructure (where required) around the new stations and surrounding Central Station
- Permanent signalisation of the Edinburgh Road / Edgeware Road / Bedwin Road intersection at Marrickville
- Noise barriers (where required) and other environmental protection measures.

The project is described in more detail in the following sections.

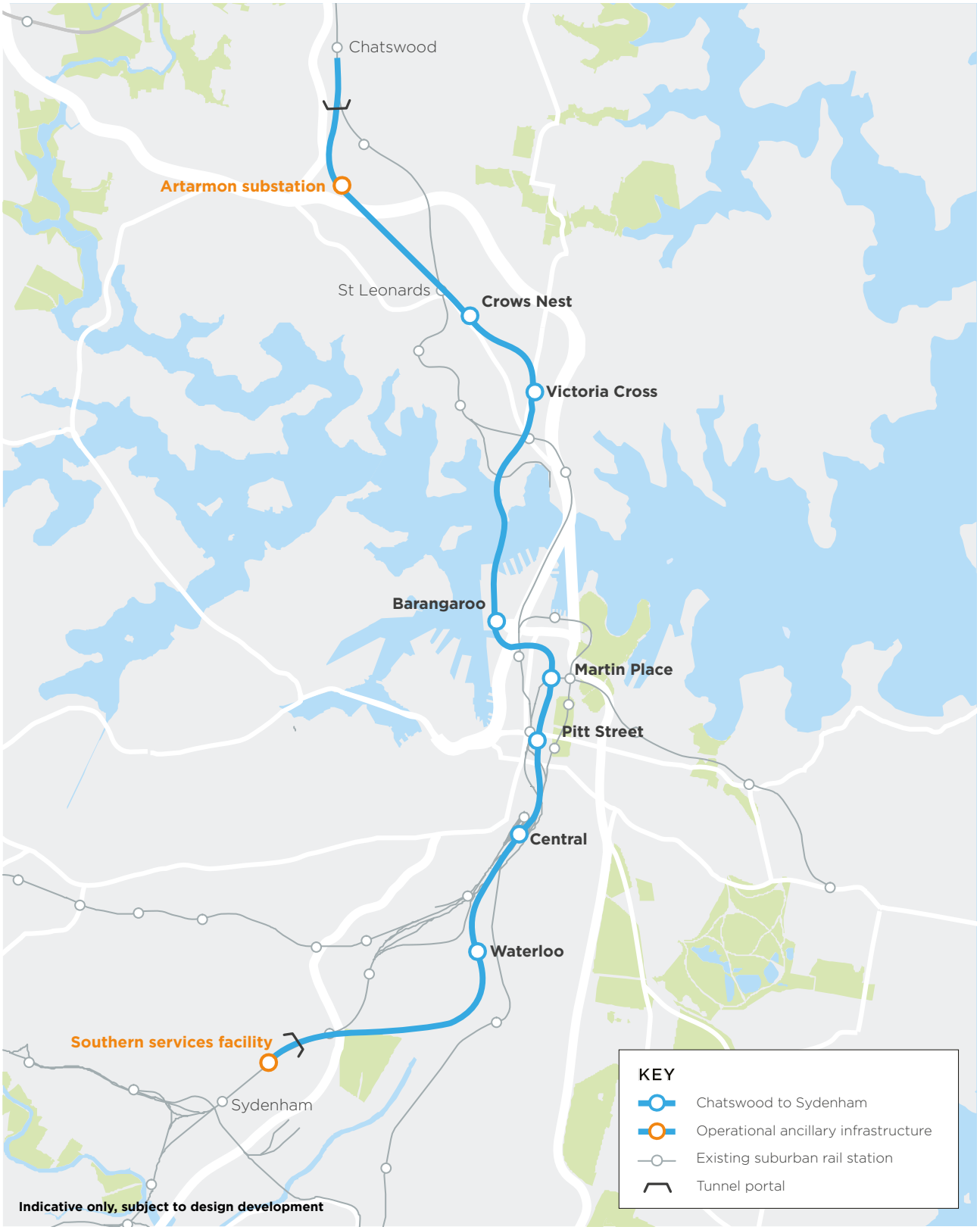


Figure 6-1 Key features of the project

6.2.2 Key metro characteristics

The customer experience underpins how Sydney Metro is being 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 – new metro services would be integrated with other transport modes, including interchanges with the existing Sydney railway network as well as buses, light rail and ferries
- The travel information available – state-of-the-art technology is proposed to keep customers connected at all stages of their journey, from smart phone travel apps on the way to stations to real time journey information at metro stations and onboard trains
- The speed and comfort of the journey
- The range and quantity of services available at stations, interchanges and within station precincts – the project would help customers achieve their daily tasks, whether it's getting to work or getting home, for school or education, sport, a day out or running errands.

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. This includes providing a system that is inherently safe for customers on trains, at stations and at the interface with the public domain; providing direct, comfortable, legible and safe routes for customers between transport modes; and provide a clean, pleasant and comfortable environment for customers at stations and on trains.

Making it easy for customers at each stage of their journey is integral to the successful delivery of Sydney Metro. Key characteristics of Sydney Metro that would be delivered by the project are outlined in Table 6-2.

Table 6-2 Key metro characteristics

Product characteristic	Description
Fast and reliable service	• Delivering fast journeys between stations with new generation single deck trains • Ensuring easy boarding and alighting to reduce dwell times at stations • Creating a highly reliable service (expected target of 98 per cent on time running).
Ability to move more people	• Designing infrastructure, trains and systems to be able to run 30 trains per hour through the Sydney CBD • Ability to move more than 40,000 customers per hour in each direction at ultimate capacity (23,000 customers per hour at opening) • Catering for short to medium length journeys between multiple centres means metro is able to make better use of train capacity.
Modern trains and technology	• Trains operate safely closer together with communications-based train control that allows automated train operations and driverless operation • Improving safety and comfort with platform screen doors that run the full length of all metro platforms and only open at the same time as the train doors • On-board real time travel information and live electronic route maps.
Accessible system	• Fully accessible stations and single deck trains • Three double doors per side per carriage for faster loading and unloading • Level access between the platform and train and reduced gaps between the platform and the train – providing access for all • Designing for bicycles on trains • Delivering modern customer information systems.
Highly legible	• 'Turn up and go' frequencies means there is no need for a timetable • Consistent stopping patterns that mean metro would stop at all stations.
Safe and secure	• Improving customer experiences, with customer service assistants at every station and moving through the network during the day and night • Stations and precincts that are designed to be highly visible, active spaces with good lighting and amenity • Ensuring customers can see all the way along the train and move easily between carriages, including wide, open walkways between carriages • Providing platform screen doors at stations which keep people and objects away from the edge, improving customer safety and allowing trains to get in and out of stations much faster • Station and train design allows for good line of sight to enable passive and active surveillance.
Comfortable service	• Air-conditioned trains with large windows, warm lighting and open walkways • Seating and standing room designed to maximise personal space • Easy boarding and alighting at stations.

6.2.3 Design guidelines

Sydney Metro has developed design guidelines in order to guide the design development process, and establish the aesthetic standards for the project. The development of the design guidelines has considered the urban design strategies and initiatives of the relevant local councils. These guide the design of:

- The interface between stations and their surrounding locality including:
  - Station entries
  - Transport interchange facilities (bicycle facilities, bus stops, kiss-and-ride, taxi ranks and connections to existing rail, ferry and light rail transport)
  - Landscaping and other public domain elements.
- Rail corridor works including the tunnel dive structures, rail cuttings and embankments.
- Station and service buildings, including underground stations.

Five design objectives for the project have been developed to guide decision making and the design process for the project. These are:

1. Ensuring an easy customer experience
2. Being part of a fully integrated transport system
3. Being a catalyst for positive change
4. Being responsive to distinct contexts and communities
5. Delivering an enduring and sustainable legacy for Sydney.

The Chatswood to Sydenham Design Guidelines are provided in Appendix B.

6.2.4 Environmental considerations in design

The design of the project has been influenced by a number of environmental factors. In general, the project has been designed to:

- Avoid known structures including buildings, basements, utilities and infrastructure (including other rail and road infrastructure)
- Minimise the potential for direct and indirect impacts to heritage items
- Minimise direct impact on property.

Specific design responses to avoid and minimise adverse impacts are identified in Table 6-3.

Table 6-3 Adverse operational impacts avoided or minimised through design

Environmental aspect	Design response
Noise	○ Provision of track form to meet ground-borne noise and vibration goals ○ Provision of new noise barriers and increases to the height of existing noise barriers at the northern end of the project to mitigate airborne noise from train operations ○ Location of the northern dive structure minimises the extent of surface track and potential airborne noise impacts.
Property and land use	○ Provision of mined stations at Victoria Cross, Martin Place and Pitt Street to avoid more extensive property acquisition ○ Location of the Artarmon substation to avoid the need to acquire residential, commercial or industrial property ○ Location of the Marrickville dive structure to avoid potential impacts on Sydney Water assets and a Transgrid 330 kilovolt (kV) underground cable.
Heritage	○ The design has avoided the following listed heritage items: ♦ Mowbray House adjacent to the Chatswood dive structure ♦ The brutalist building adjacent to Crows Nest Station ♦ The Edinburgh Castle Hotel adjacent to Pitt Street Station ♦ The Congregational Church adjacent to Waterloo Station ♦ The Sydney Water Pit and Drainage Pumping Station near the Marrickville dive structure. ○ The design has minimised impacts to the Lost Property Office at Central Station.
Groundwater	○ Provision of tanked tunnels, mined stations and cut-and-cover stations at Barangaroo and Waterloo to minimise the inflow of groundwater ○ Provision of a tanked station at Barangaroo to minimise the potential for contaminated groundwater inflow.
Biodiversity	○ Location of the northern dive structure has avoided impacts to Blue Gum High Forest at Artarmon Reserve.

6.3 Metro rail tunnels

6.3.1 Tunnel alignment

The twin underground metro rail tunnels would extend about 15.5 kilometres between the Chatswood tunnel portal (north of Mowbray Road, Chatswood) and the Marrickville tunnel portal (south of Bedwin Road, Marrickville). The tunnel alignment (as shown on Figure 6-2 (a-i)) is indicative at this stage, and has been used for the purposes of the environmental impact assessment including all specialist investigations. During detailed design the alignment may change (horizontally and / or vertically). Any changes to the alignment would be reviewed for consistency with the assessment contained in this Environmental Impact Statement including relevant mitigation measures, performance outcomes and any future conditions of approval. The key features of the tunnels are described in the following sections.

The location of the proposed alignment was primarily driven by the general location of metro stations and then refined by the functional requirements of a metro system. In particular there is a need to:

- Match up with the location, depth and platform configurations of the metro stations
- Provide a track with a maximum vertical grade of 4.5 per cent
- Locate station platforms along a straight and level section of track (ie zero per cent grade)
- Construct tunnels that are deep enough, where possible, to provide suitable rock cover above the tunnel crown (the top surface of the tunnel structure) to minimise the requirement for ground support
- Provide track curvature, where possible, that can 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)
- Respond to a number of physical constraints across Sydney Harbour, including major submarine utilities, services and structures and shipping channel requirements; and to ensure acceptable depths at Barangaroo and Victoria Cross stations
- Accommodate stub tunnels to the north of Victoria Cross Station and between Waterloo Station and the Marrickville dive structure. The stub tunnels are required to minimise disruption to the operating Metro network during construction of any potential future extensions to the network.

There would be a future statutory corridor for the project established through the *State Environmental Planning Policy (Infrastructure) 2007*. Any future development within this corridor would be referred to Transport for NSW for concurrence. A preliminary project corridor, which extends 30 metres either side of the tunnel alignment, is shown on Figure 6-2 (a-i). This corridor would be confirmed consistent with any changes to the alignment described above.

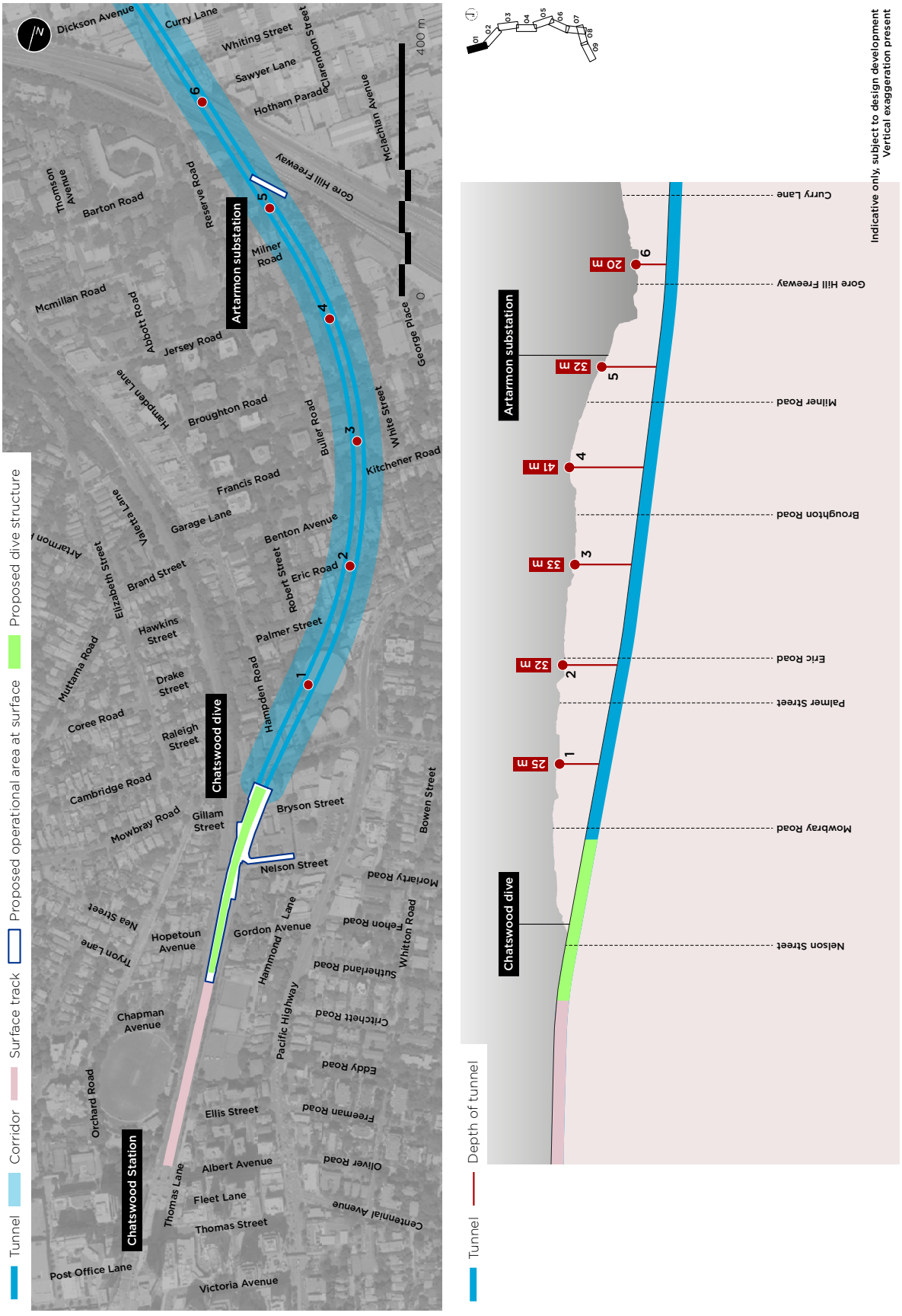


Figure 6-2a Indicative Chatswood to Sydenham alignment plan and long section

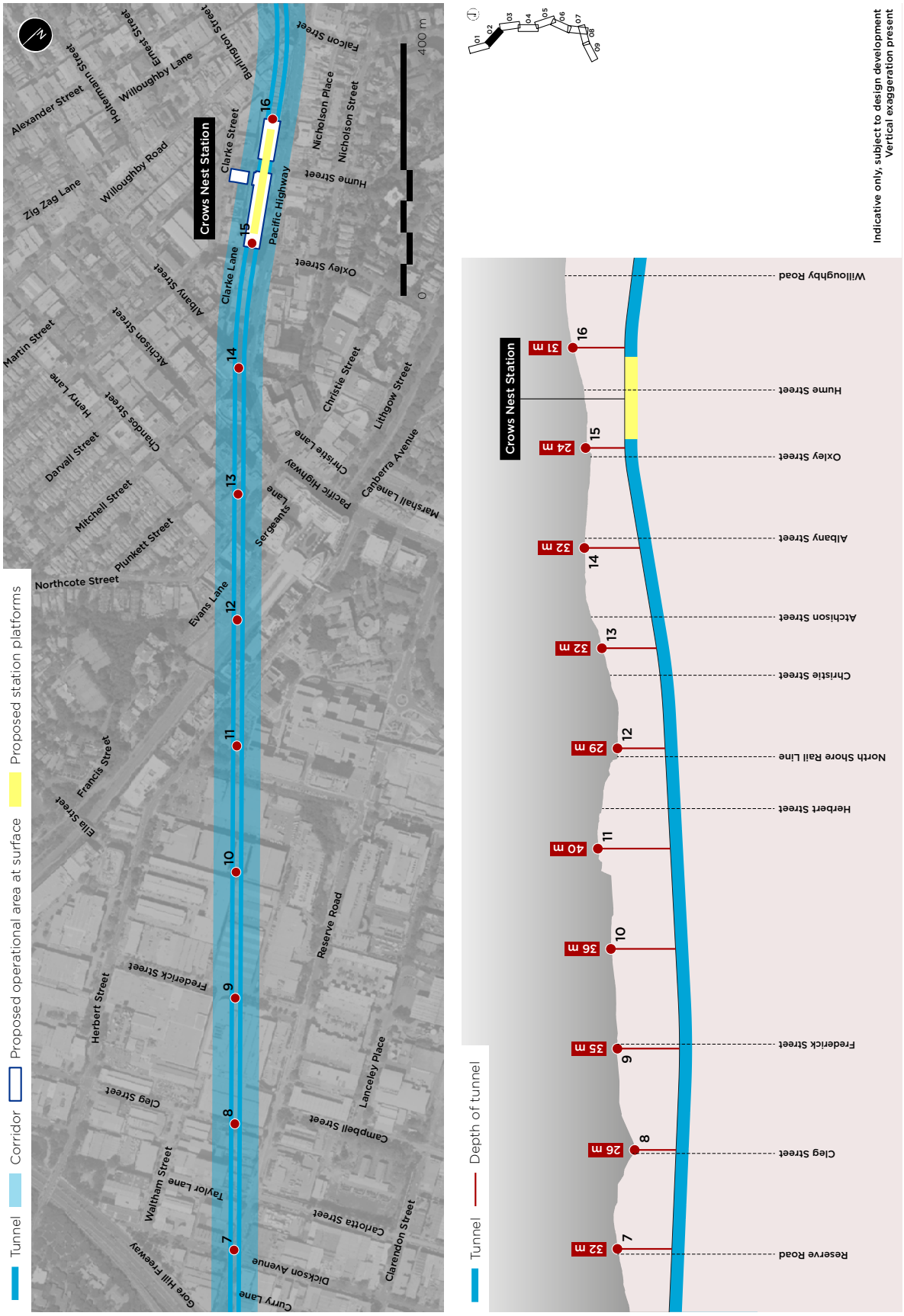


Figure 6-2b Indicative Chatswood to Sydenham alignment plan and long section

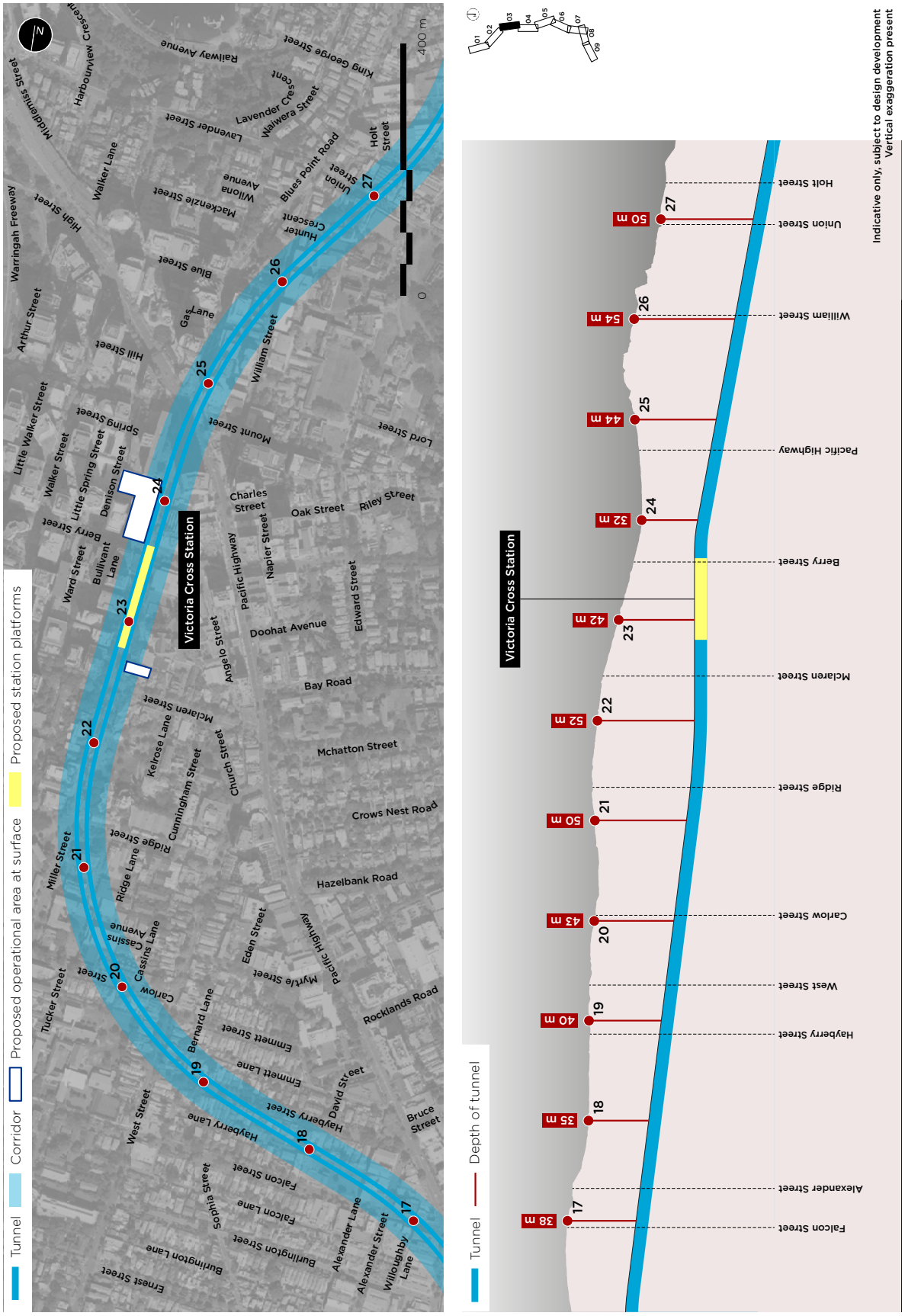


Figure 6-2c Indicative Chatswood to Sydenham alignment plan and long section

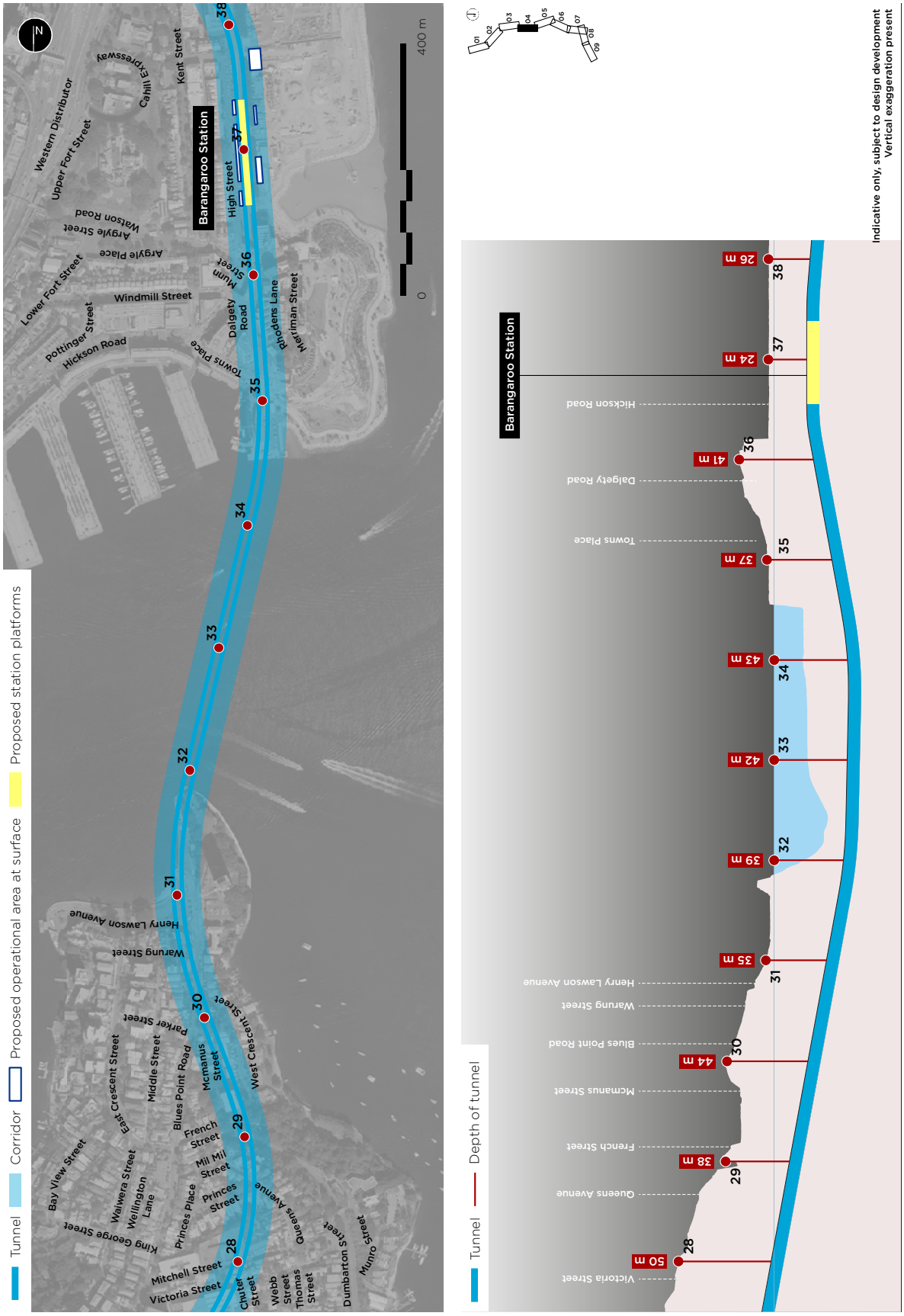


Figure 6-2d Indicative Chatswood to Sydenham alignment plan and long section

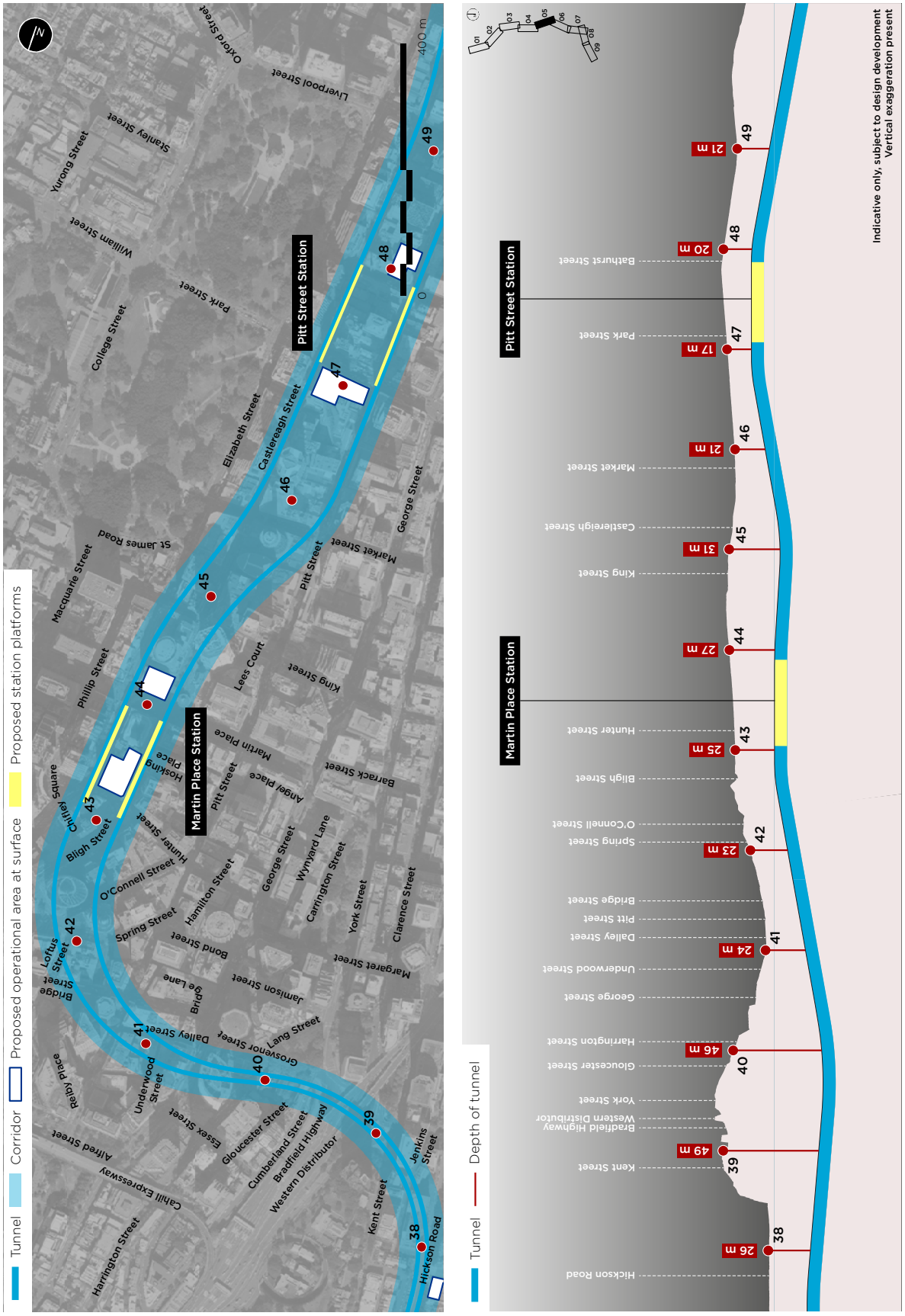


Figure 6-2e Indicative Chatswood to Sydenham alignment plan and long section

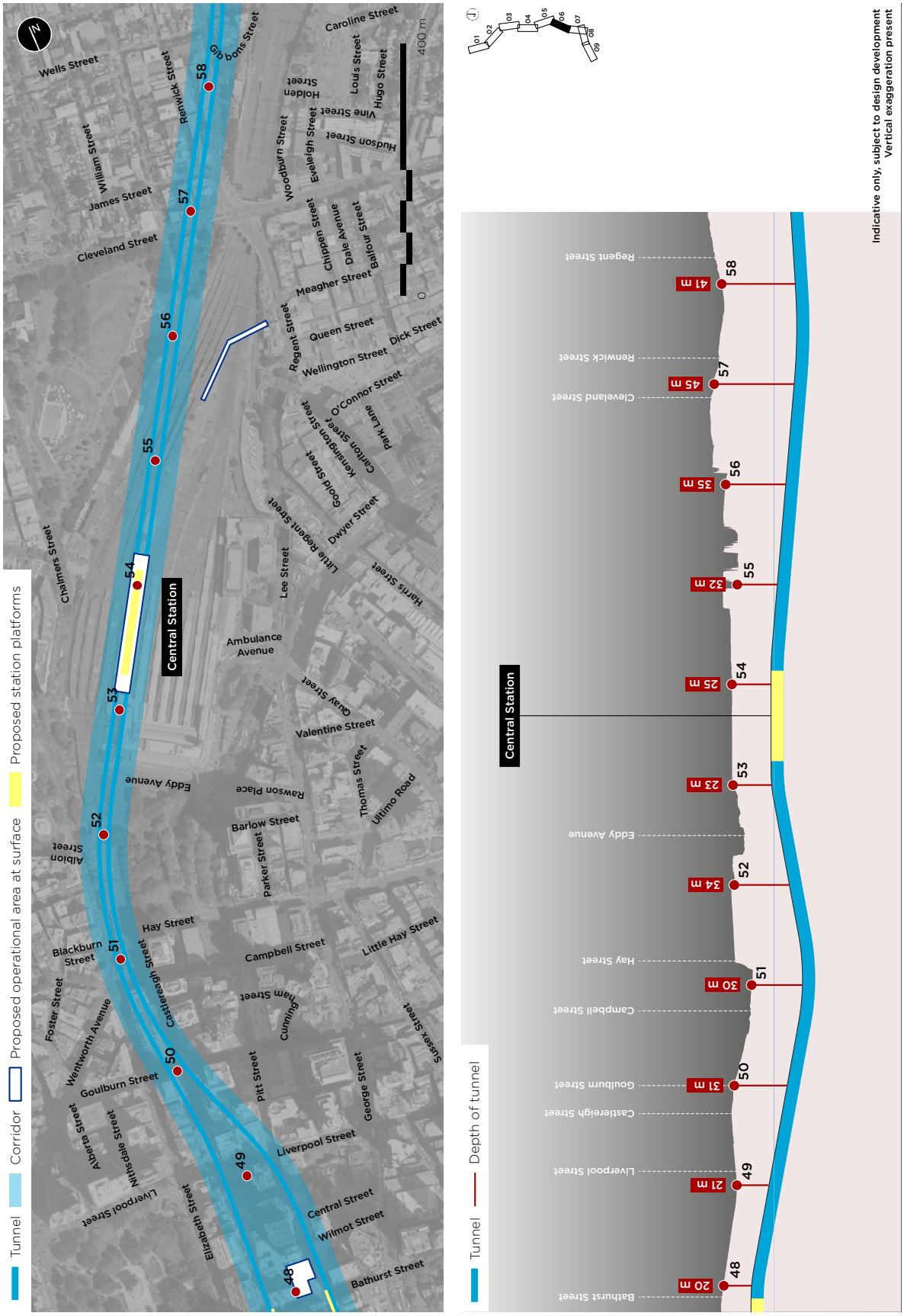


Figure 6-2f Indicative Chatswood to Sydenham alignment plan and long section

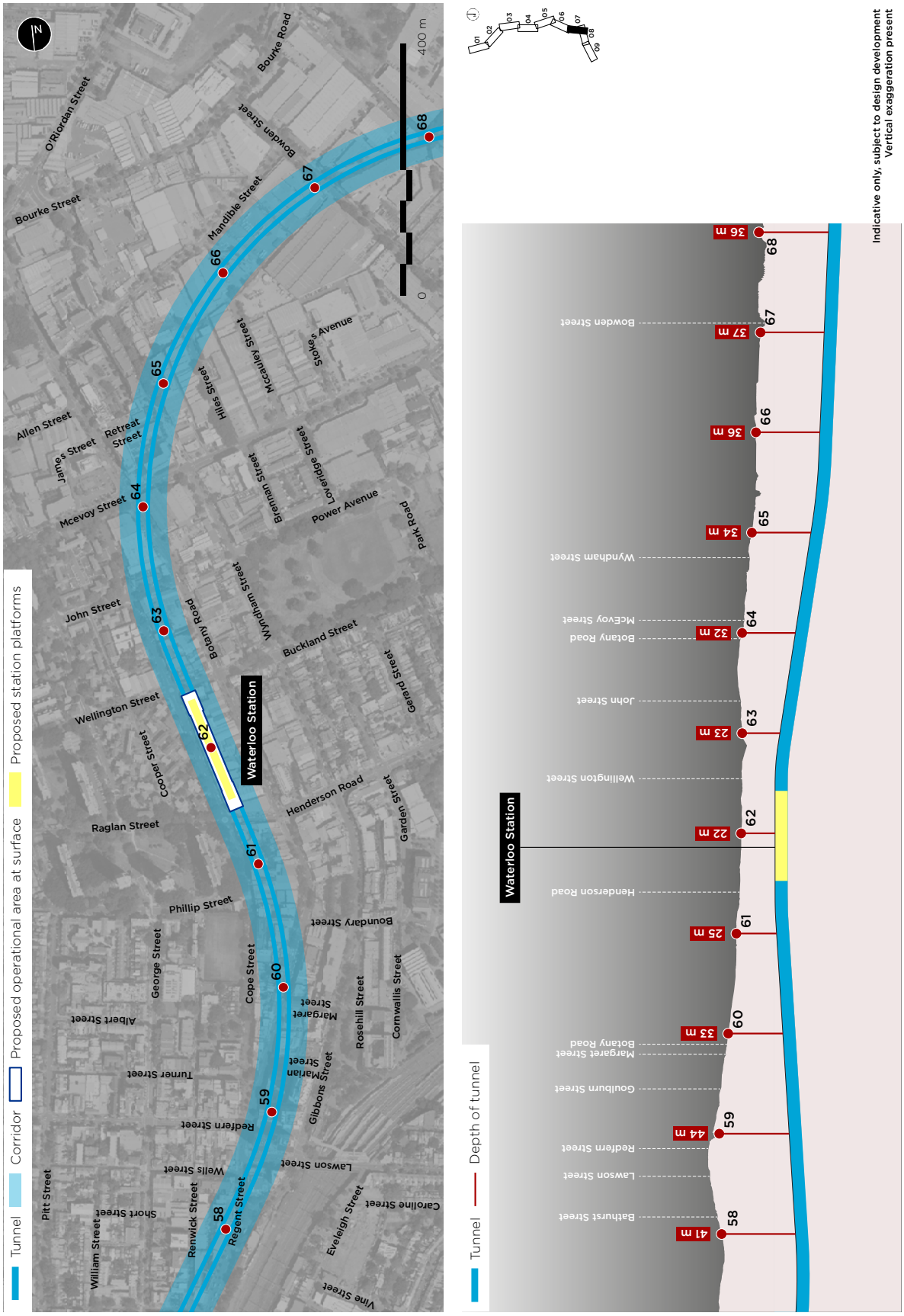


Figure 6-2g Indicative Chatswood to Sydenham alignment plan and long section

Figure 6-2h Indicative Chatswood to Sydenham alignment plan and long section

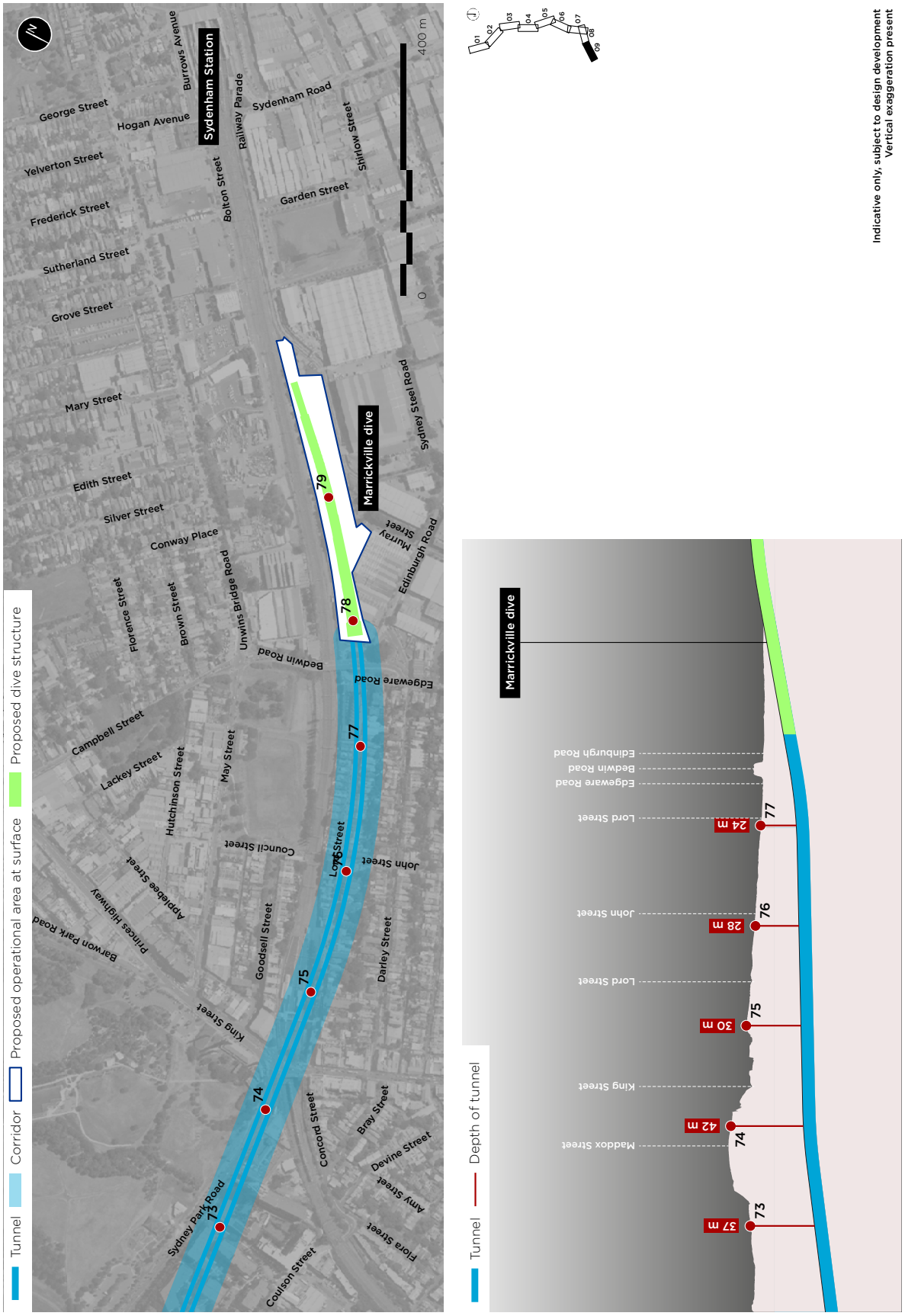


Figure 6-2i Indicative Chatswood to Sydenham alignment plan and long section

6.3.2 Tunnel and underground track features

Tunnel size

The metro rail tunnels would have a circular cross-section with an internal diameter of about six metres (radius of about three metres) and would be sized to accommodate the type of metro trains planned for Sydney Metro Northwest. The tunnels would be lined with pre-cast concrete segments to maximise the tunnel lifespan and minimise groundwater inflow. In addition to accommodating the trains and tracks, the tunnels would provide space for other equipment and services including rail signalling, controls and communication, overhead traction power, ventilation, fire and life safety systems, lighting and drainage.

An indicative cross-section of the underground tunnel is shown in Figure 6-3.

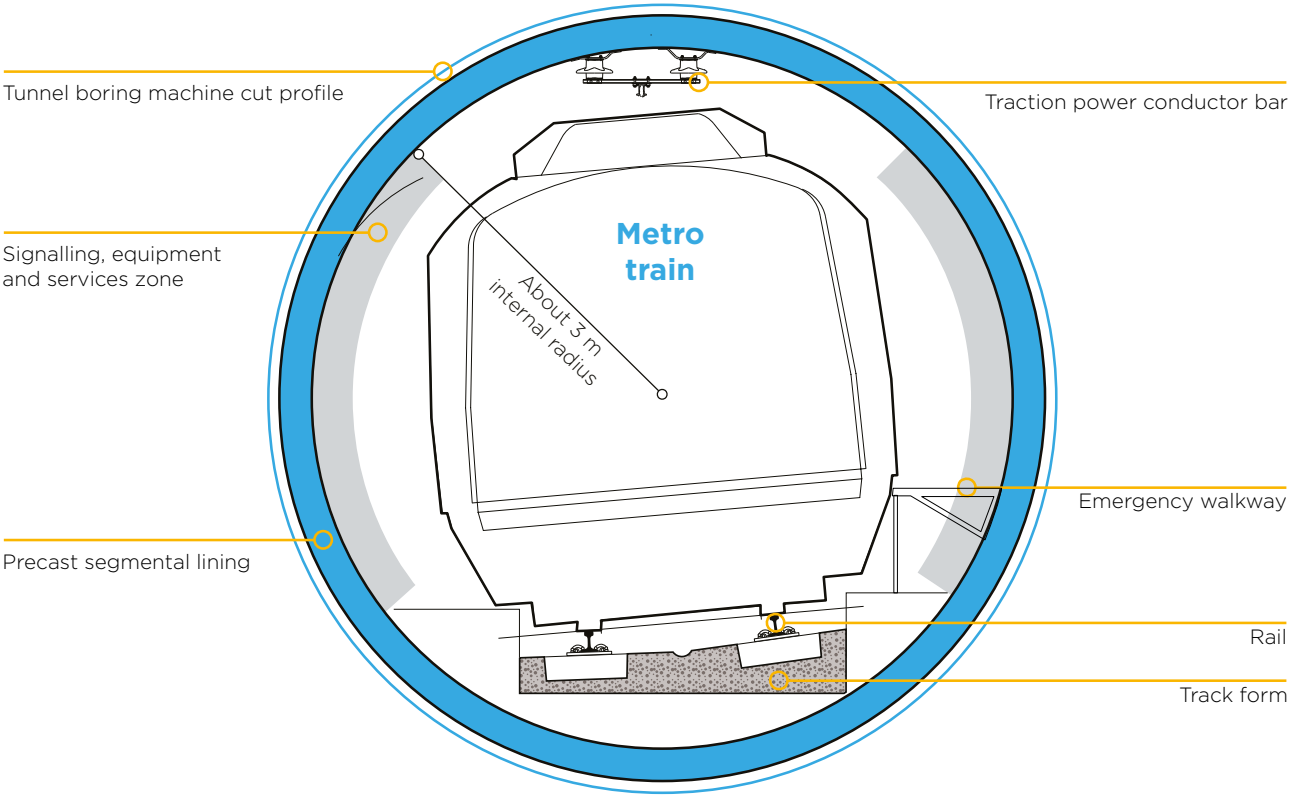


Figure 6-3 Indicative cross-section of a metro tunnel

Track type and configuration

The track in tunnel would consist of a fixed concrete slab combined with a continuously welded rail.

Track with higher noise and vibration attenuation may be used, where feasible and reasonable, to further mitigate ground-borne noise in certain locations (for example, where the tunnels are close to particularly sensitive receptors, such as residential buildings, schools, medical facilities or places of worship). Based on the current design this is likely to include a combination of hard, medium and soft resilient baseplates. Operational noise and vibration issues are addressed in Chapter 11 (Operational noise and vibration).

The tunnel track centrelines would typically be about 14 metres apart; however, variations to this tunnel spacing would occur at a number of locations to overcome geotechnical and other subsurface constraints (such as foundations and basements of existing overlying buildings).

The proposed configuration of the metro tracks between Chatswood and Sydenham is shown in Figure 6-4.

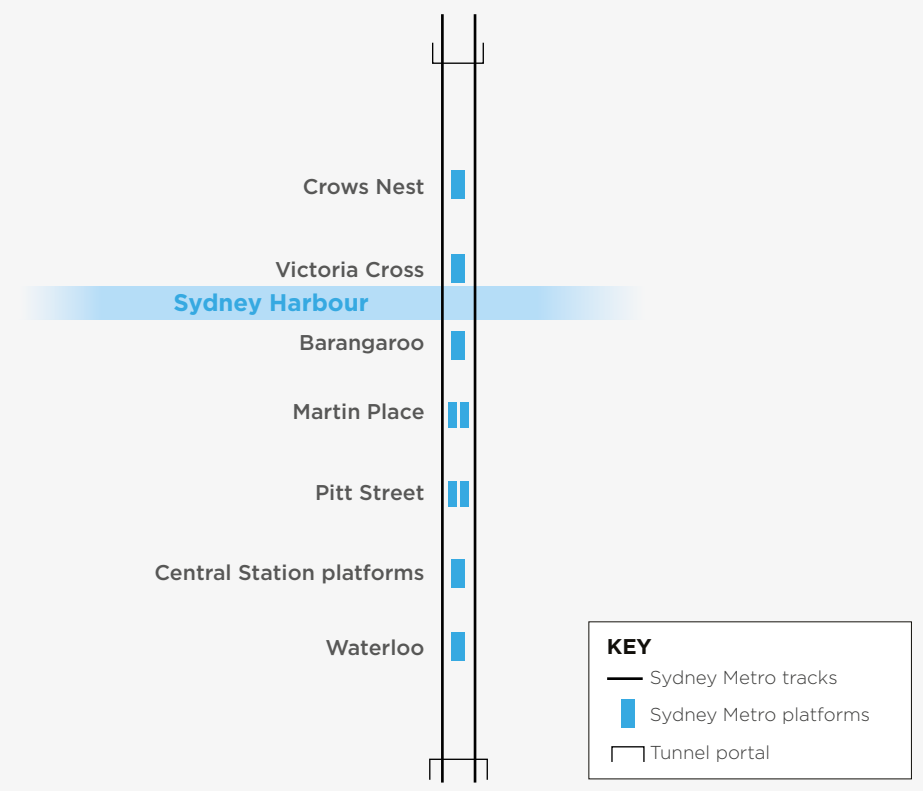


Figure 6-4 Track configuration for the project

Tunnel depth

Tunnels would typically be about 25 to 40 metres below surface level (the indicative depth of the tunnels is shown on Figure 6-2). At its shallowest point (approaching the tunnel portals), the tunnel crown (top of the tunnel) would be about 20 metres below the ground surface, while its deepest point (between Barangaroo and Martin Place stations) would be about 60 metres below the ground surface. For the section below Sydney Harbour, the tunnels would be about 40 metres below surface water level.

Emergency tunnel access and exit

A raised walkway would be provided throughout the tunnels to provide for emergency access and exit. These walkways would be the same height as the train floor so customers could evacuate in an emergency. To facilitate emergency access and exit between the two tunnels, cross passages would be provided at maximum intervals of about 240 metres. Figure 6-5 shows an indicative cross-section of a cross passage.

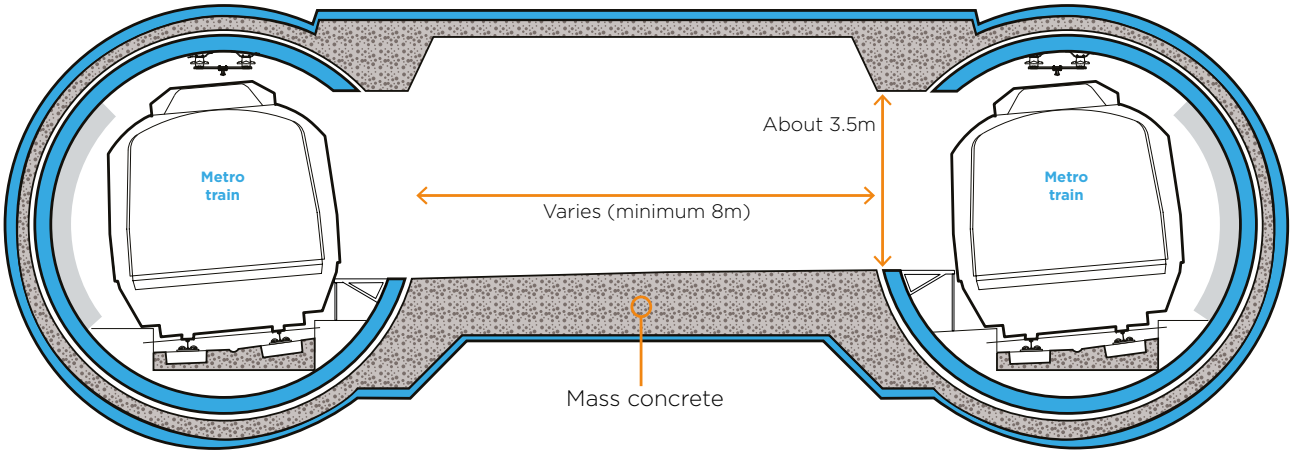


Figure 6-5 Indicative section of a tunnel cross passage

Ventilation system

During normal operations, tunnel ventilation would be provided by train movements and the operation of fans at the stations to exhaust air from the tunnels. Heat removal would typically occur via the tunnel exhaust; however, ventilation fans could also be operated to provide additional heat removal particularly in peak summer conditions. Typically, the direction of ventilation would be the direction of train travel; however, the system would be designed to allow for ventilation in both directions.

In the event of a tunnel fire, the ventilation system would generate longitudinal flow in the incident tunnel to prevent smoke building up in the area of the fire.

Separate mechanical ventilation systems would be provided at each underground station for heat removal and to provide fresh air. Full height platform screen doors at stations would assist in controlling underground station temperatures by physically separating the tunnel and station environments.

Drainage and stormwater

Within the tunnels, drainage depressions would be incorporated into the concrete slabs that form the base for the rail track. Drainage at the dive structures would be designed for the 100 year average recurrence interval event and drainage of at-grade sections would be through a combination of pit and pipe, open and subsurface drains.

Stormwater drainage at the dive structures would be designed to ensure no net increase in discharge rates to downstream stormwater systems for all storm events up to and including the 100 year average recurrence interval event. Further details regarding flooding are provided in Chapter 21 (Flooding and hydrology).

A tunnel water treatment plant would be located adjacent to the Marrickville dive structure. The water treatment plant would treat wastewater pumped from the tunnels, stations and other underground facilities. The water treatment plant building would contain holding tanks, chemical treatment tanks and filters. Further information regarding the likely treatment methods, wastewater volumes and discharge points is provided in Chapter 18 (Soils, contamination and water quality).

In order to mitigate the potential flood impacts around the Marrickville dive structure, the project would include the introduction of 10 grated inlets (around 3m x 1.2m) at around ten metre spacing on the eastern side of the proposed metro rail tracks, each connected to Eastern Channel via two underground reinforced concrete box culverts (around 1.2m x 0.9m).

6.4 Surface tracks

6.4.1 Metro tracks

The project would include about 250 metres of surface metro tracks between the Chatswood dive structure and Chatswood Station, connecting to the Sydney Metro Northwest tracks. The surface metro tracks would be located between the T1 North Shore Line tracks. The spacing (track centres) between the Sydney Trains tracks and the metro tracks would be about 4.7 metres. The arrangement of these tracks is shown on Figure 6-6 and an indicative cross-section on Figure 6-7.

The surface metro tracks would generally be placed on ballast with concrete sleepers. Alternative track types may be used in some locations where additional noise mitigation is required.

The connection of the metro tracks from the Marrickville dive structure to Sydenham Station would be subject to a separate assessment as part of the Sydenham to Bankstown upgrade project.

6.4.2 Sydney Trains tracks

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

Between Chatswood Station and the Chatswood dive structure the T1 North Shore Line tracks would be re-located to the outside of the metro tracks. To accommodate the metro tracks, including the dive structure and tunnel portal, the T1 North Shore Line 'down' (northbound) track would be relocated to the west and would pass over the metro dive structure on a bridge.

The T1 North Shore Line would continue to be managed by Sydney Trains. The arrangement of the T1 North Shore Line tracks and the metro tracks is shown on Figure 6-6.

There would be no changes to the Sydney Trains tracks at the southern end of the project. Any adjustments to these Sydney Trains tracks that may be required would be subject to a separate assessment as part of the Sydenham to Bankstown upgrade project.

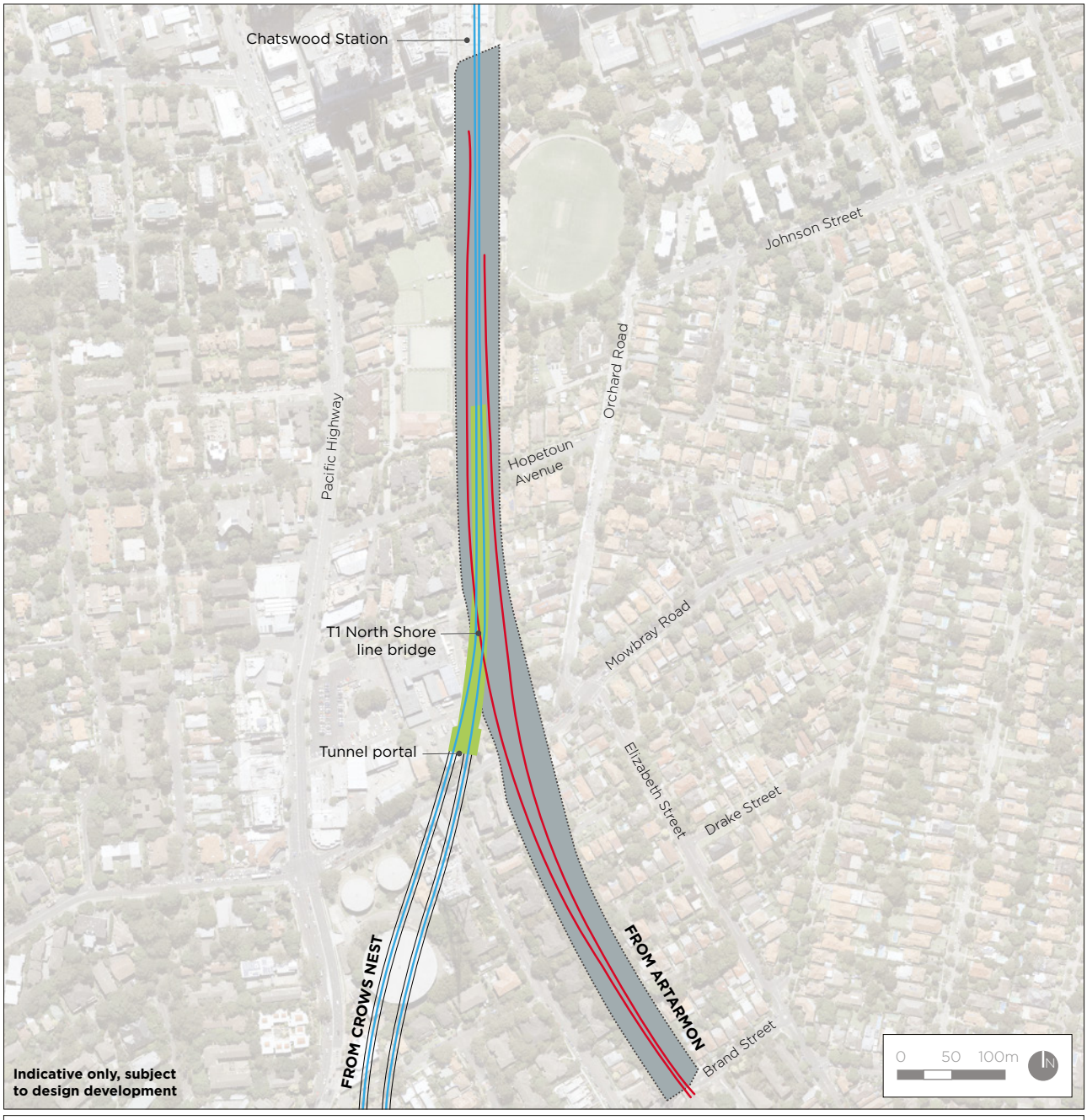


Figure 6-6 Arrangement of metro tracks and T1 North Shore Line tracks

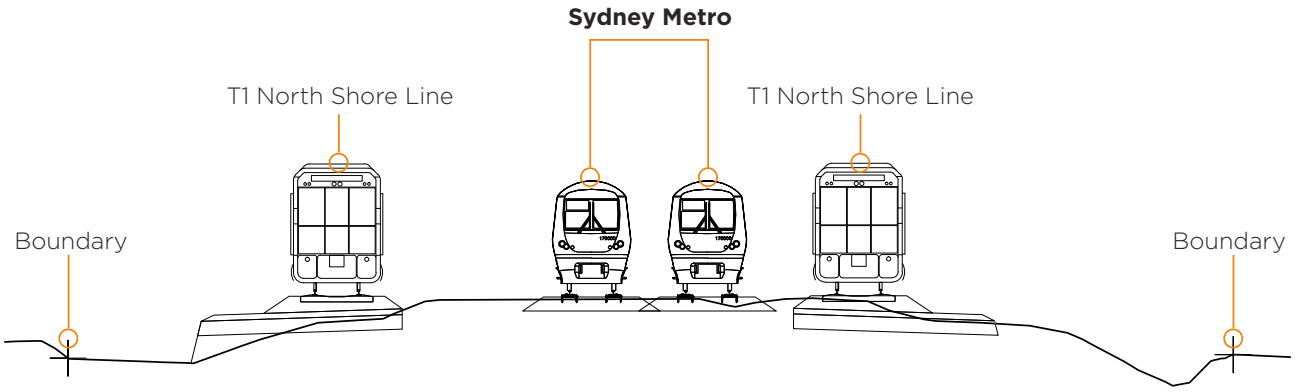


Figure 6-7 Indicative cross-section of metro tracks and T1 North Shore Line tracks

6.5 Overview of metro stations

New metro stations would be located at Crows Nest, Victoria Cross, Barangaroo, Martin Place, Pitt Street and Waterloo, and new metro platforms would be located at Central Station.

This section discusses the common station elements and identifies the station configurations.

6.5.1 Common station elements

Metro stations would be designed to provide safe and efficient interchange between transport modes, including minimising conflicts between pedestrians, cyclists, buses and vehicles.

Each metro station would have a number of common elements or design features. These would include:

- Station concourses (paid and unpaid) and platforms
- Vertical transport including escalators and lifts
- Station service buildings – located to minimise the street frontage within important urban areas
- Signage and wayfinding within the station and the surrounding public domain
- Awnings for shade and shelter at street level station entries
- Retail space within the station building
- Enhancements to the footpath in the vicinity of the station entries
- Landscaping and street furniture to maintain high quality urban design outcomes.

6.5.2 Station configurations

The metro stations would be configured as either a large 'single-span' cavern that accommodates tracks for both directions of travel and a central island platform or a 'binocular cavern' where each platform and track is housed in a single smaller cavern (refer Figure 6-8).

The decision on whether a single-span or binocular station cavern would be used at a particular station has been based primarily on constraints to the tunnel alignment (building basements or other subsurface infrastructure). Where the tunnel alignment is unrestricted by underground constraints, a single-span cavern is the preferred configuration as it is more cost effective to construct and minimises customer travel time to and from the platforms. Single-span caverns can be constructed using either a cut-and-cover or a mined technique (as described in Chapter 7 (Project description – construction).

A single-span mined cavern is proposed for Victoria Cross Station. Single-span cut-and-cover stations are proposed for Crows Nest, Barangaroo, Central and Waterloo stations. Binocular mined cavern stations are proposed for Martin Place and Pitt Street stations.

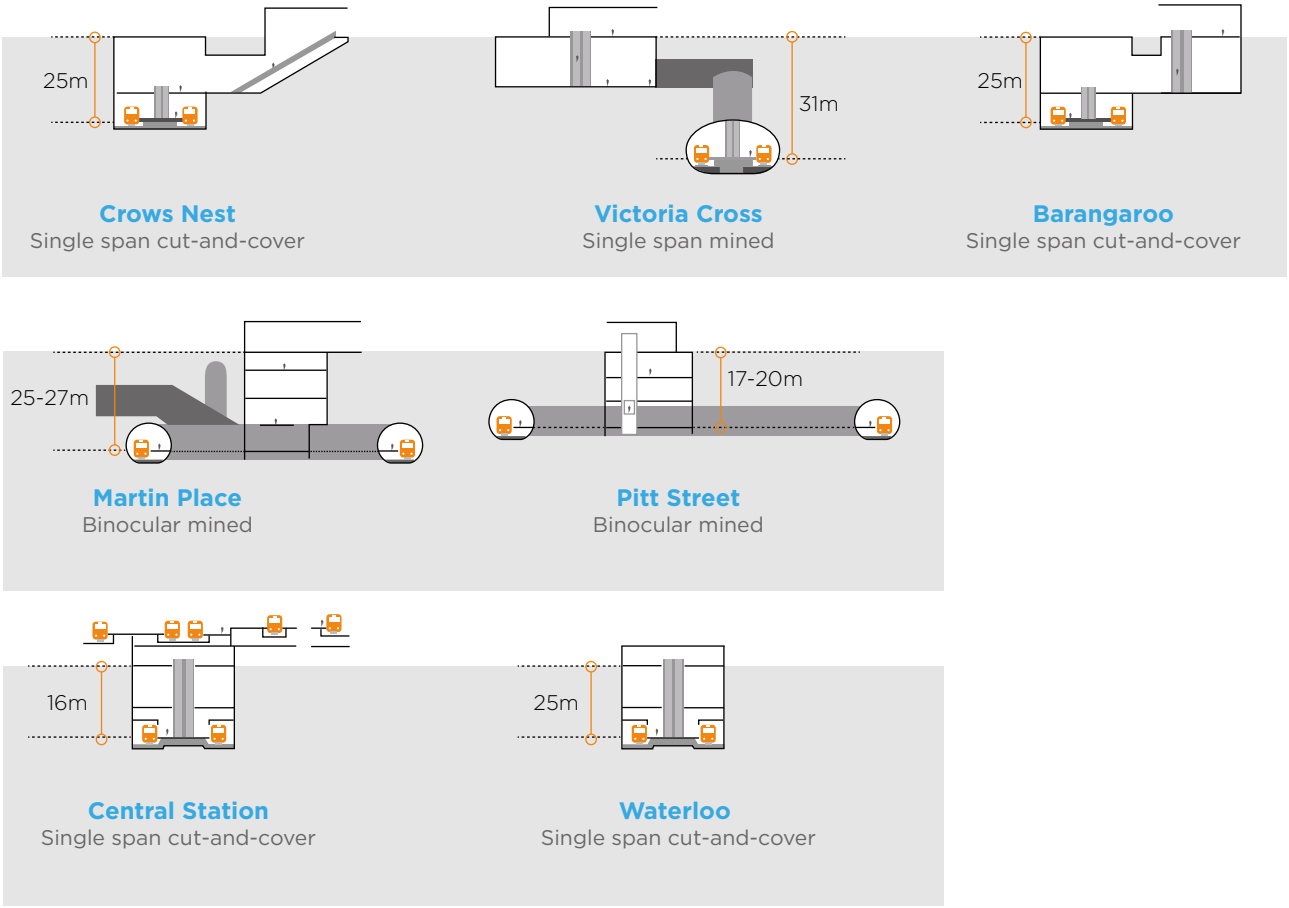


Figure 6-8 Station configurations

6.5.3 Provision for over station development

As discussed in Chapter 2 (Planning and assessment process), all aspects of the over station development above the transfer slab would be subject to a separate planning approval process.

Over station development uses the air-space over rail assets including stations. Sydney Metro has identified the following sites with potential for property development over or associated with the proposed metro stations:

- Crows Nest Station
- Victoria Cross Station (southern site only)
- Martin Place Station (northern and southern sites)
- Pitt Street Station (northern and southern sites)
- Waterloo Station.

Barangaroo Station is located within the Central Barangaroo precinct. Over station development at this site would form part of the Barangaroo development and be the subject of separate applications for approval.

There are no over station development opportunities at Central Station as part of the proposed Sydney Metro works.

The metro stations would be designed to take into account, and make physical provision for, any design or other requirements associated with possible future over station development. In general the metro stations would include:

- Structural elements (steel and / or concrete), building grids, column loadings and building infrastructure to enable to construction of the future over station development
- Space for future lift cores, access, parking and building services for the future over station development.

This design integration would ensure the future developments can be built efficiently and effectively.

Figure 6-9 provides a typical interface of a metro station with an over station development. Typically, the metro station would progress up to a 'transfer slab' level above the ground plane.

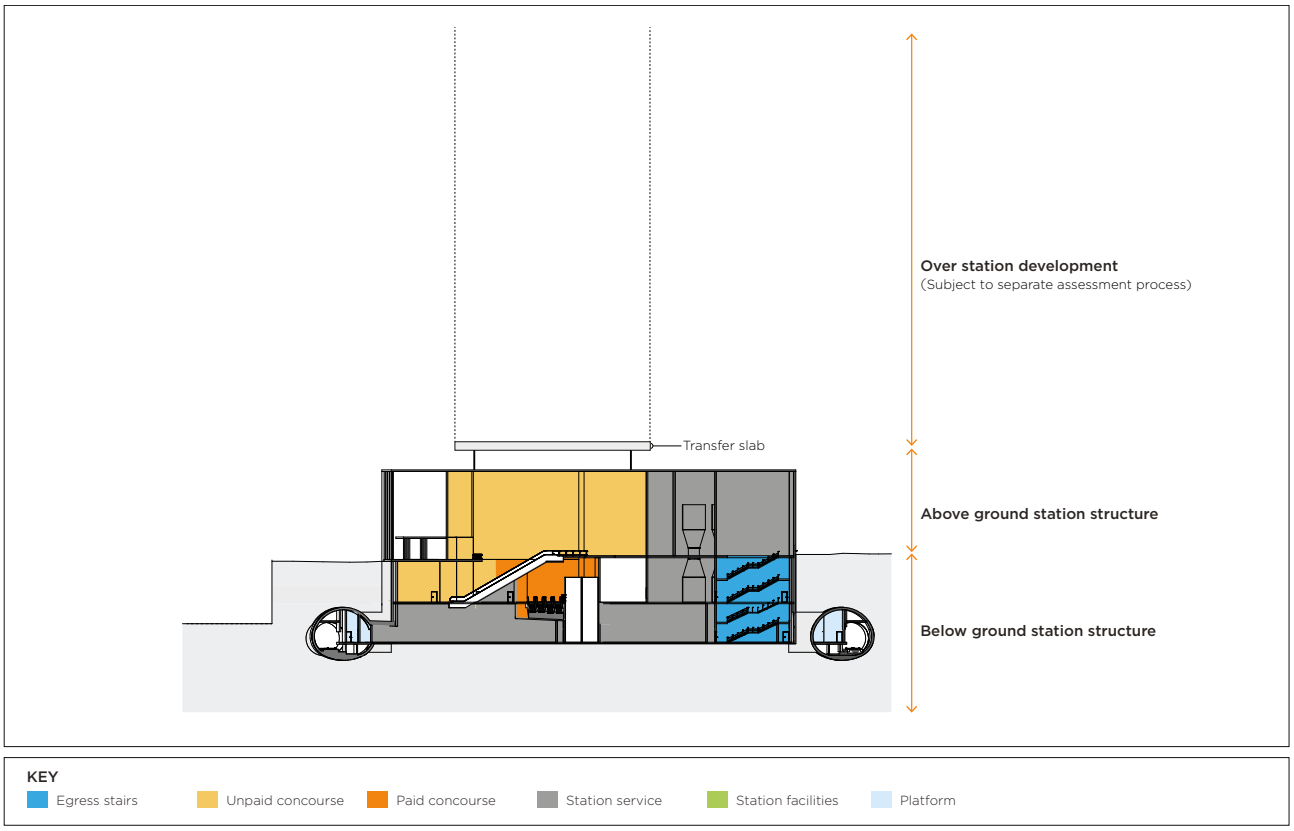


Figure 6-9 Typical over station development interface

6.6 Metro stations

The following sections discuss specific design elements relating to each metro station.

6.6.1 Crows Nest Station

Crows Nest Station would be located between the Pacific Highway and Clarke Lane (eastern side of the Pacific Highway) and between Oxley Street and south of Hume Street (refer to Figure 6-10). It would be strategically located to the south of the existing station at St Leonards and close to the leisure 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 location and key features of Crows Nest Station are shown in Figure 6-10 to Figure 6-12 and summarised in Table 6-4.

Figure 6-10 Crows Nest Station – location and indicative layout

Figure 6-11 Crows Nest Station – artist's impression

Table 6-4 Crows Nest Station design elements

Feature	Description
Centre type	Specialised centre
Station type	Single-span (cut-and-cover) cavern with island platform
Transport interchange	Walking, cycling, bus, taxi and kiss-and-ride
Station entry / exit	• On the corner of Hume and Clarke Streets • On the corner of Pacific Highway and Oxley Street
Customers	• Existing residents within walking and cycling distance • Visitors and patrons accessing the leisure and retail strip along Willoughby Road • Existing employment area along Willoughby Road, Christie Street and the Pacific Highway
Platform depth	About 25 metres
Platform length	About 170 metres
Platform width	About 10 metres
Overall station length	About 210 metres
Transport and access	• New signalised pedestrian crossing on northern side of Pacific Highway / Oxley Street intersection • New pedestrian crossings on Clarke, Hume and Oxley streets • New bike parking on Hume and Oxley streets • New on-road marked cycle link on Hume Street • Existing bus stops close to the station retained on the Pacific Highway • New kiss-and-ride and taxi bays on Clarke Street

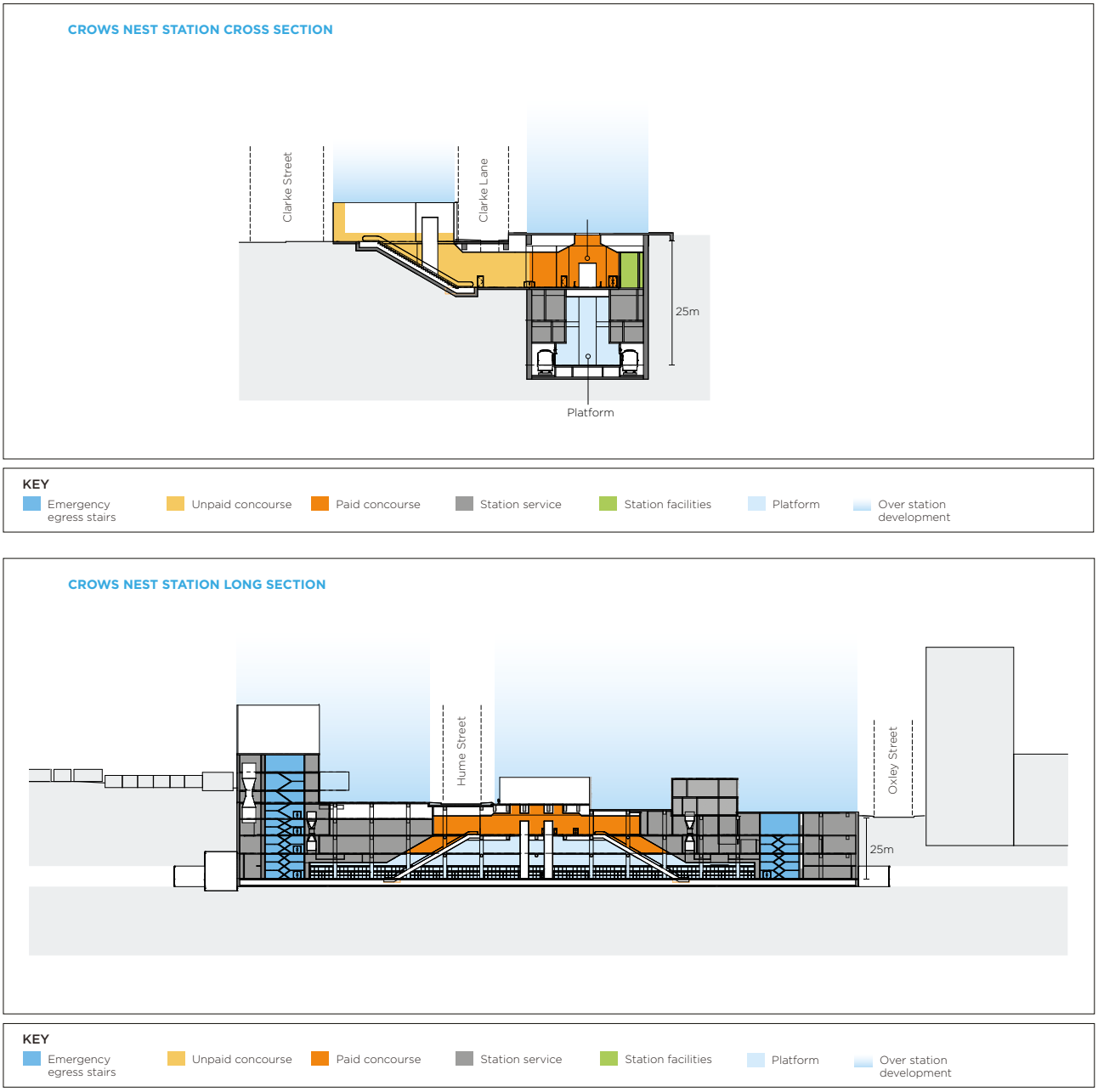


Figure 6-12 Crows Nest Station – indicative cross-section and long section

6.6.2 Victoria Cross Station

Victoria Cross Station would be located beneath Miller Street (to the north of the Pacific Highway) between McLaren Street and south of Berry Street (refer to Figure 6-13). It would be strategically located within the North Sydney CBD and close to a number of educational institutions (including the Australian Catholic University) 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.

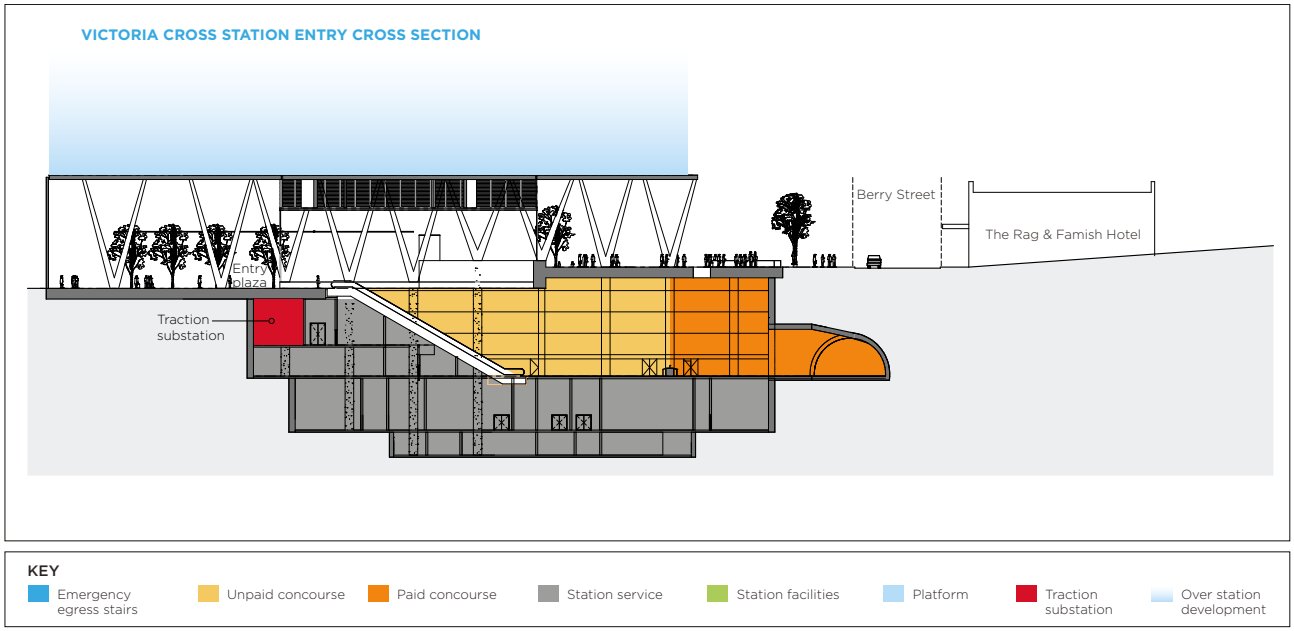
The location and key features of Victoria Cross Station are shown in Figure 6-13 to Figure 6-15 and summarised in Table 6-5.

Figure 6-13 Victoria Cross Station – location and indicative layout

Figure 6-14 Victoria Cross Station – artist's impression

Table 6-5 Victoria Cross Station design elements

Feature	Description
Centre type	Global Sydney (North Sydney CBD)
Station type	Single-span (mined) cavern with island platform
Transport interchange	Walking, cycling, bus, taxi and kiss-and-ride
Station entry / exit	Via a pedestrian plaza opening to Miller, Denison and Berry streets
Customers	Customers travelling to nearby employment, education and residential precincts
Platform depth	About 31 metres
Platform length	About 170 metres
Platform width	About 10 metres
Overall station length	About 220 metres
Transport and access	• New signalised mid-block pedestrian crossing on Miller Street • New bike parking near the corner of Miller and Berry streets • Existing bus stops close to the station retained on Miller Street • New kiss-and-ride bays on Berry Street
Services	Dedicated services building on Miller Street to the north of the station providing station and tunnel services



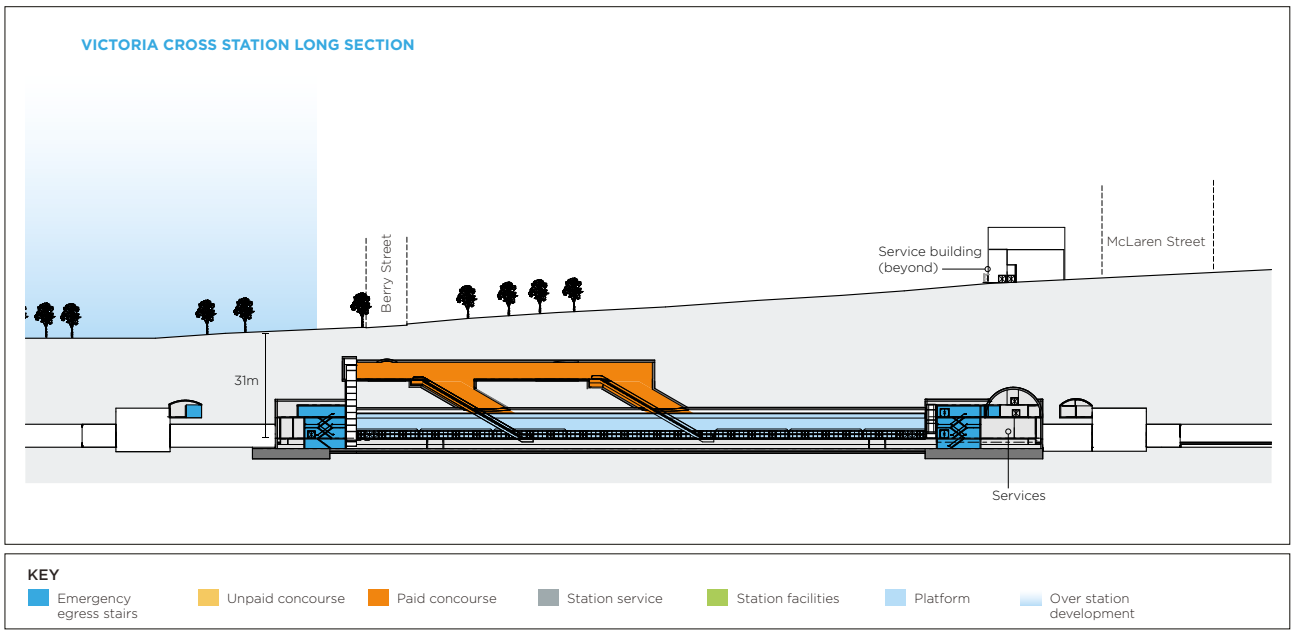


Figure 6-15 Victoria Cross Station – indicative cross-section and long section

6.6.3 Barangaroo Station

Barangaroo Station would be located beneath Hickson Road towards its northern end (refer to Figure 6-16). It would be strategically located to provide immediate access to commercial, mixed use (residential and commercial) and entertainment precincts within the overall Barangaroo development. A station at Barangaroo would also service a residential catchment at Millers Point, Walsh Bay and future residents at Barangaroo. A station at Barangaroo would also provide relief to Wynyard Station.

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 nearby the Barangaroo precinct
- Ensure legible and direct access to Barangaroo Reserve and Barangaroo Ferry Hub
- Integrate with development plans for Barangaroo.

The location and key features of Barangaroo Station are shown in Figure 6-16 to Figure 6-18 and summarised in Table 6-6.

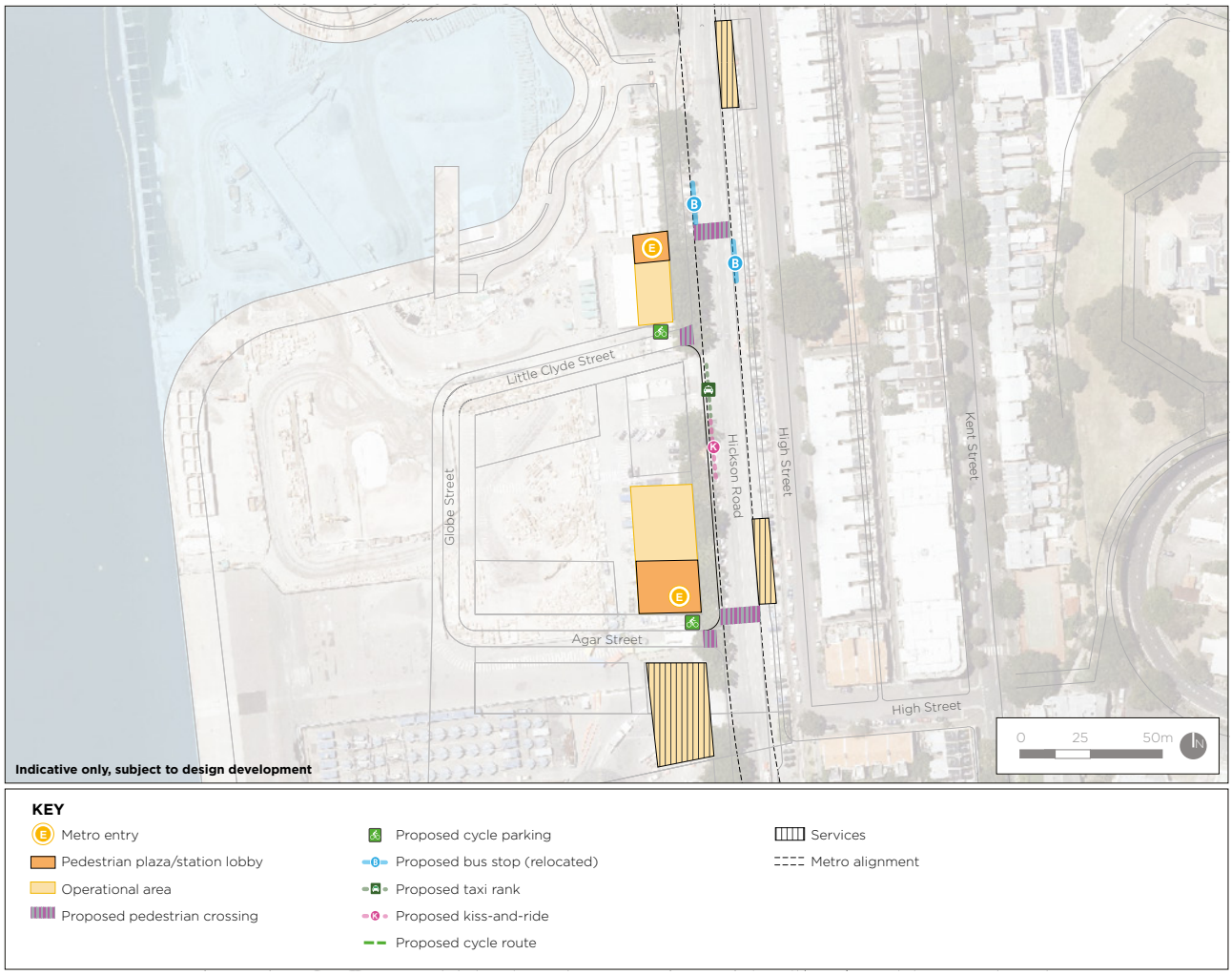


Figure 6-16 Barangaroo Station – location and indicative layout

Figure 6-17 Barangaroo Station – artist's impression

Table 6-6 Barangaroo Station design elements

Feature	Description
Centre type	Global Sydney (Sydney CBD)
Station type	Single-span (cut-and-cover) cavern with island platform
Transport interchange	Walking, cycling, bus, taxi and ferry
Station entry / exit	Within Central Barangaroo and Barangaroo Reserve
Customers	• Customers travelling to nearby employment, recreation and tourist precincts • Customers travelling to and from nearby existing and future residential areas
Platform depth	About 25 metres
Platform length	About 170 metres
Platform width	About 10 metres
Overall station length	About 210 metres

Feature	Description
Transport and access	Transport for NSW would develop transport and access arrangements in consultation with Banangaroo Delivery Authority. At this stage, they are expected to include: • New pedestrian crossings on Hickson Road, Little Clyde Street and Agar Street • New bike parking on Little Clyde and Agar streets • Relocation of the bus stops on Hickson Road closer to the station entry • New kiss-and-ride and taxi bays on Hickson Road.

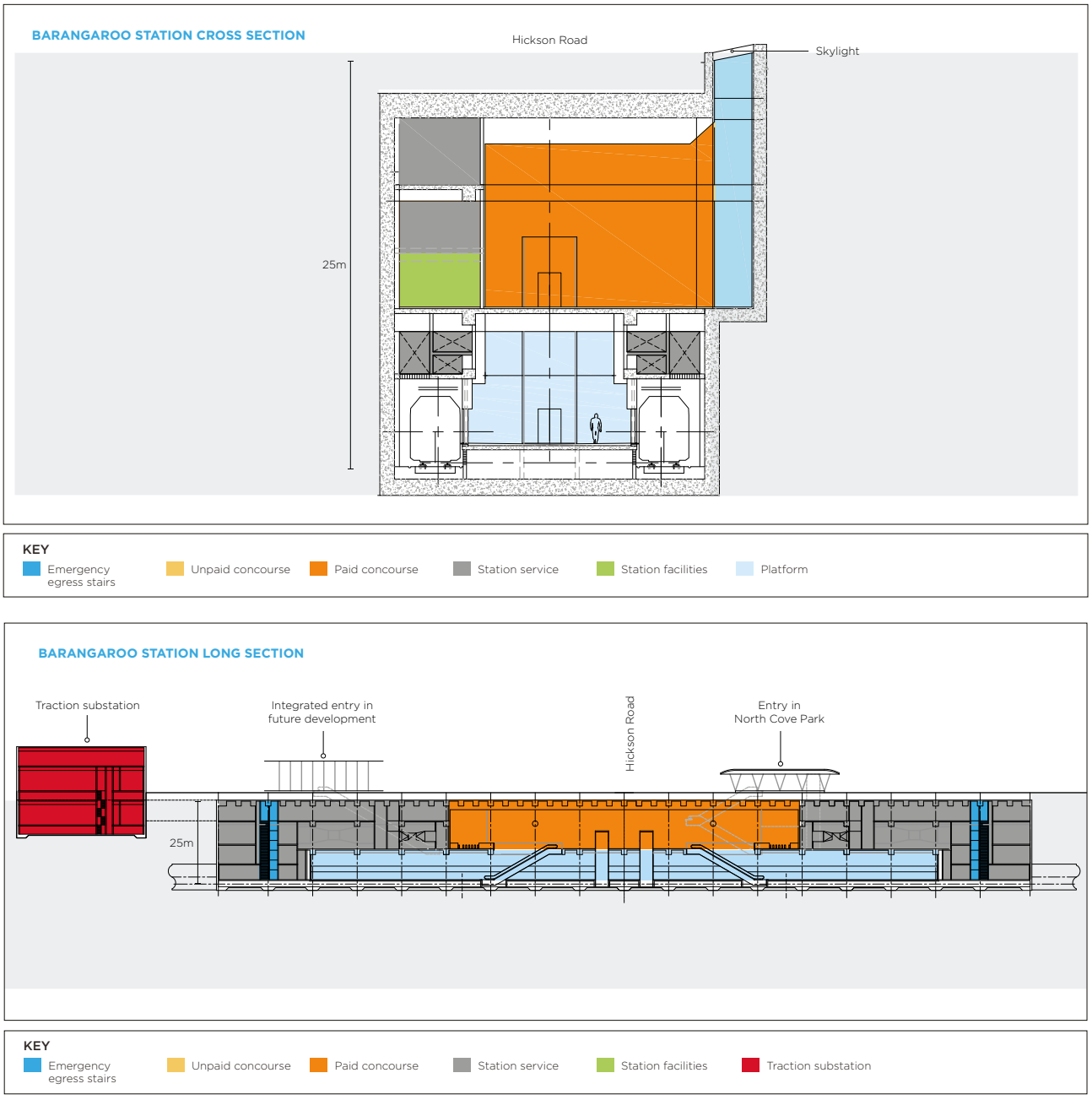


Figure 6-18 Barangaroo Station – indicative cross-section and long section

6.6.4 Martin Place Station

Martin Place Station would be located to the south of Hunter Street between Castlereagh and Elizabeth streets (refer to Figure 6-19). The metro station would be integrated with the existing Martin Place suburban and intercity rail station and would be 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).

Martin Place Station would also involve the closure of existing access and egress points, inclduing the underground connections, to the west of Elizabeth Street from Martin Place to the underground concourse connection to the existing Martin Place Station.

Further investigations are currently being carried out in relation to an underground pedestrian connection at the northern end of the Martin Place Station platform concourse to 33 Bligh Street. The connection would be at platform level leading to an exit via escalators to street level at O'Connell Street and / or Bligh Street. Provision of this connection would aid in the distribution of Metro and Sydney Trains customers into the northern Sydney CBD precinct, from Martin Place Station. A connection from the station to the 33 Bligh Street could also help separate metro customers from vehicular traffic movements at the Castlereagh Street / Hunter Street intersection.

Further investigations are being carried out to refine the optimal station entrance location for the pedestrian connection to 33 Bligh Street.

Station strategy

A metro station at Martin Place would serve Sydney's high-end commercial and financial district, the Macquarie Street precinct and the Pitt 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 station entries
- Provide an efficient interchange in the centre of the Sydney CBD through convenient, direct connections to the T4 Eastern Suburbs and Illawarra line platforms
- Integrate with the public domain and transport access improvements currently planned.

The location and key features of Martin Place Station are shown in Figure 6-19 to Figure 6-22 and summarised in Table 6-7.

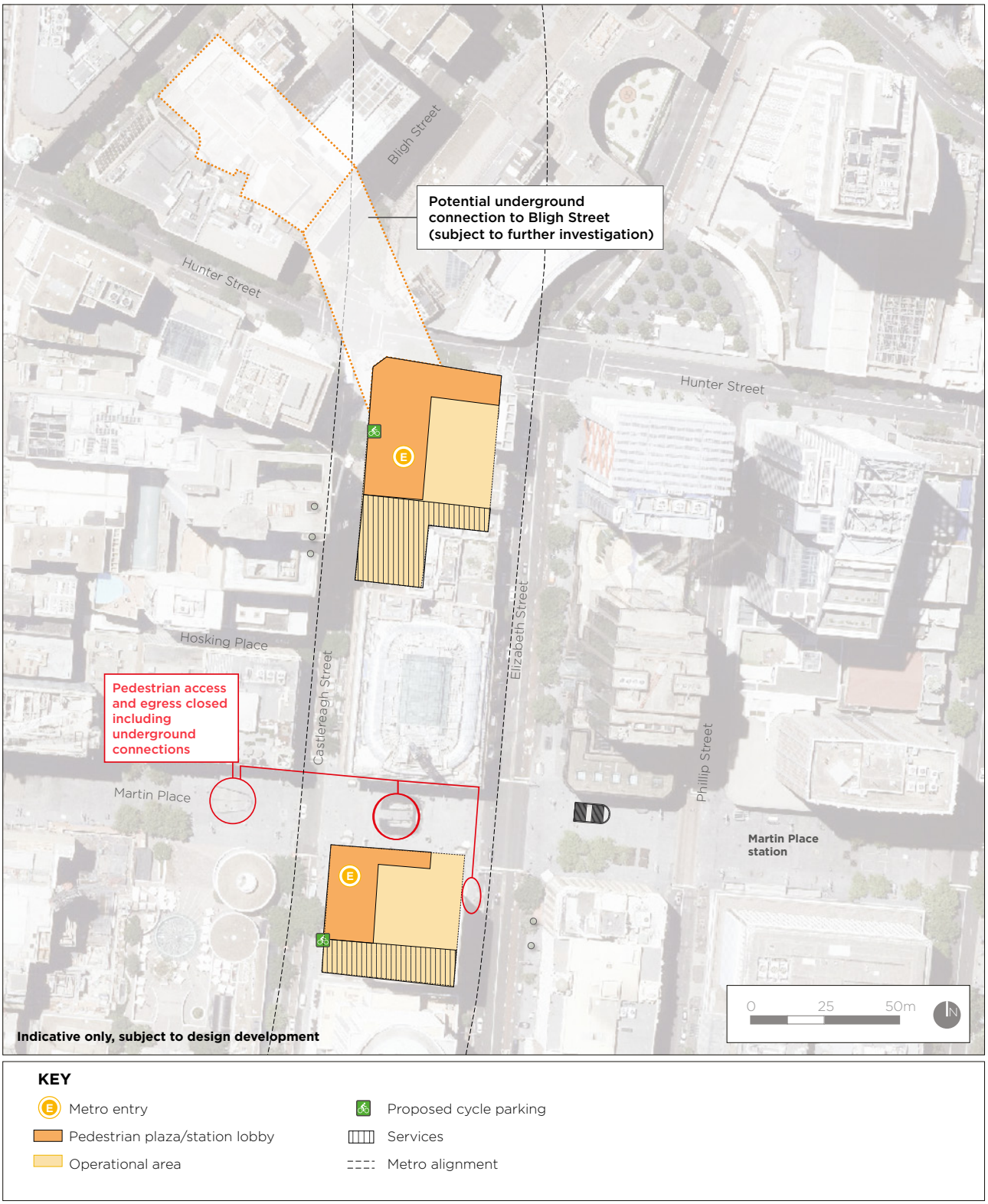


Figure 6-19 Martin Place Station – location and indicative layout

Figure 6-20 Martin Place Station – artist's impression

Table 6-7 Martin Place Station design elements

Feature	Description
Centre type	Global Sydney (Sydney CBD)
Station type	Binocular cavern (mined) with two single side platforms
Transport interchange	Walking, cycling, taxi, bus, light rail and suburban and intercity rail
Station entry / exit	• A northern entry via a pedestrian plaza opening to Castlereagh, Hunter and Elizabeth streets • A northern entry via an underground pedestrian connection below Hunter Street to O'Connell Street and / or Bligh Street (subject to further investigation) • A southern entry via a pedestrian plaza opening to Martin Place and Castlereagh Street
Customers	• Customers travelling to and from nearby employment, civic, commercial, retail, entertainment and recreational precincts • Customers interchanging to and from metro services and other modes of transport
Platform depth	About 25 metres (at the northern end) and about 27 metres (at the southern end)
Platform length	About 170 metres
Platform width	About six metres (each platform)
Overall station length	About 200 metres
Transport and access	• New underground pedestrian link between the existing suburban and intercity Martin Place Station platforms and the metro station platforms (shown on Figure 6-22) • New underground pedestrian connection between the station platform at O'Connell Street and / or Bligh Street (subject to further investigation) • New bike parking on Castlereagh Street at both station entries • Existing bus stops close to the station retained on Elizabeth and Castlereagh streets • Existing taxi ranks close to the station retained on Elizabeth and Castlereagh streets.

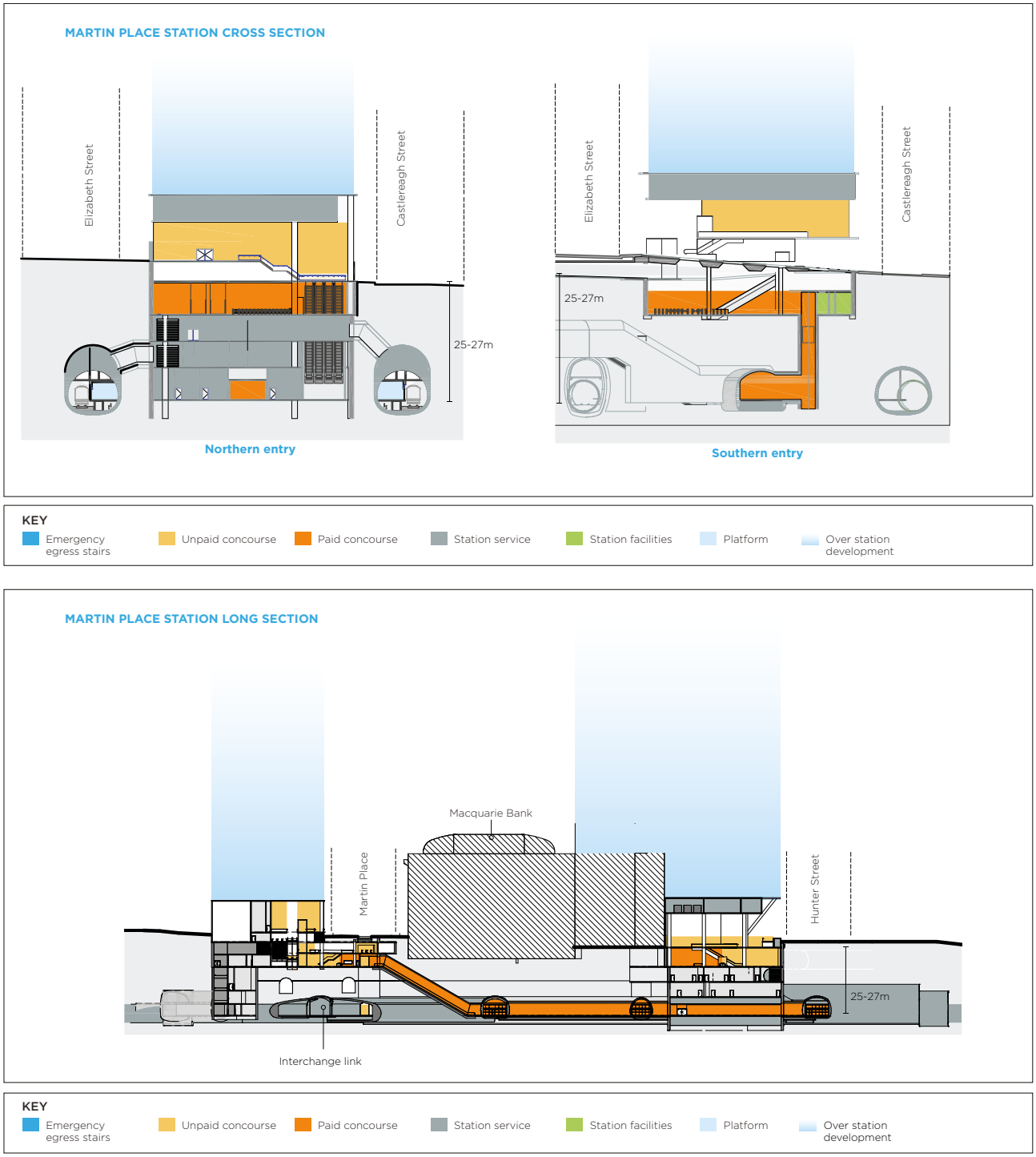


Figure 6-21 Martin Place Station – indicative cross-section and long section

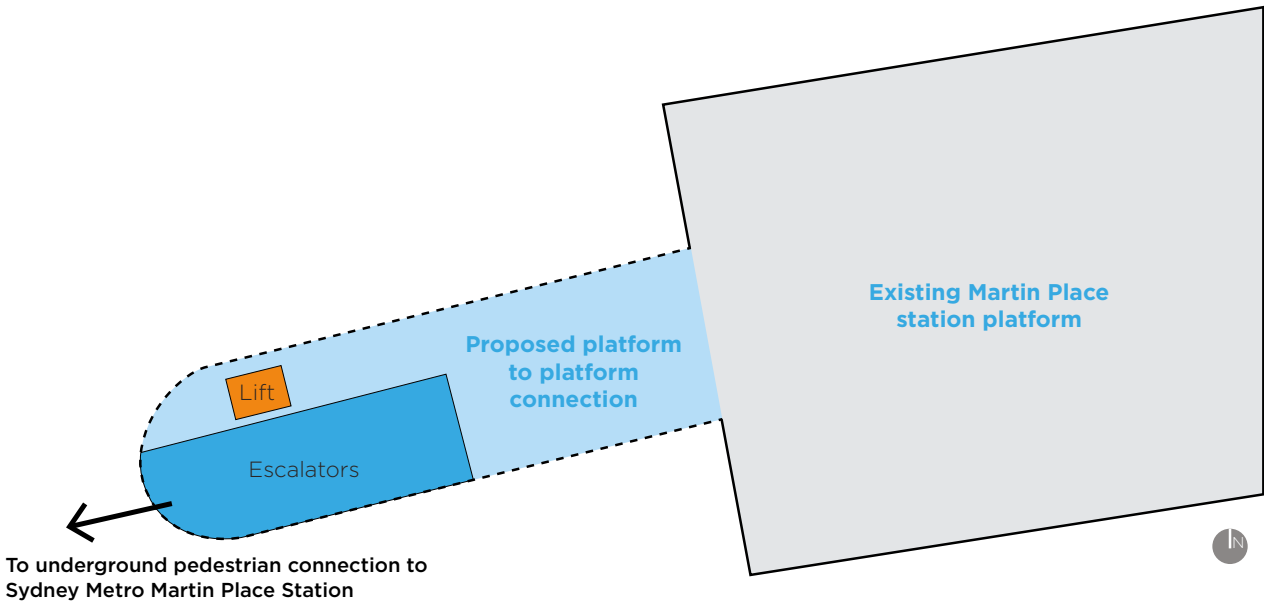


Figure 6-22 Martin Place Station – metro platform to Sydney Trains platform connection

6.6.5 Pitt Street Station

Pitt Street Station would be located between Pitt and Castlereagh streets, north of the Park Street intersection and south of the Bathurst Street intersection (refer to Figure 6-23). 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 in 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 strategy for Pitt Street would:

- Provide 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
- Extend the transport focus along Park Street, near Pitt Street.

The location and key features of Pitt Street Station are shown in Figure 6-23 to Figure 6-25 and summarised in Table 6-8.

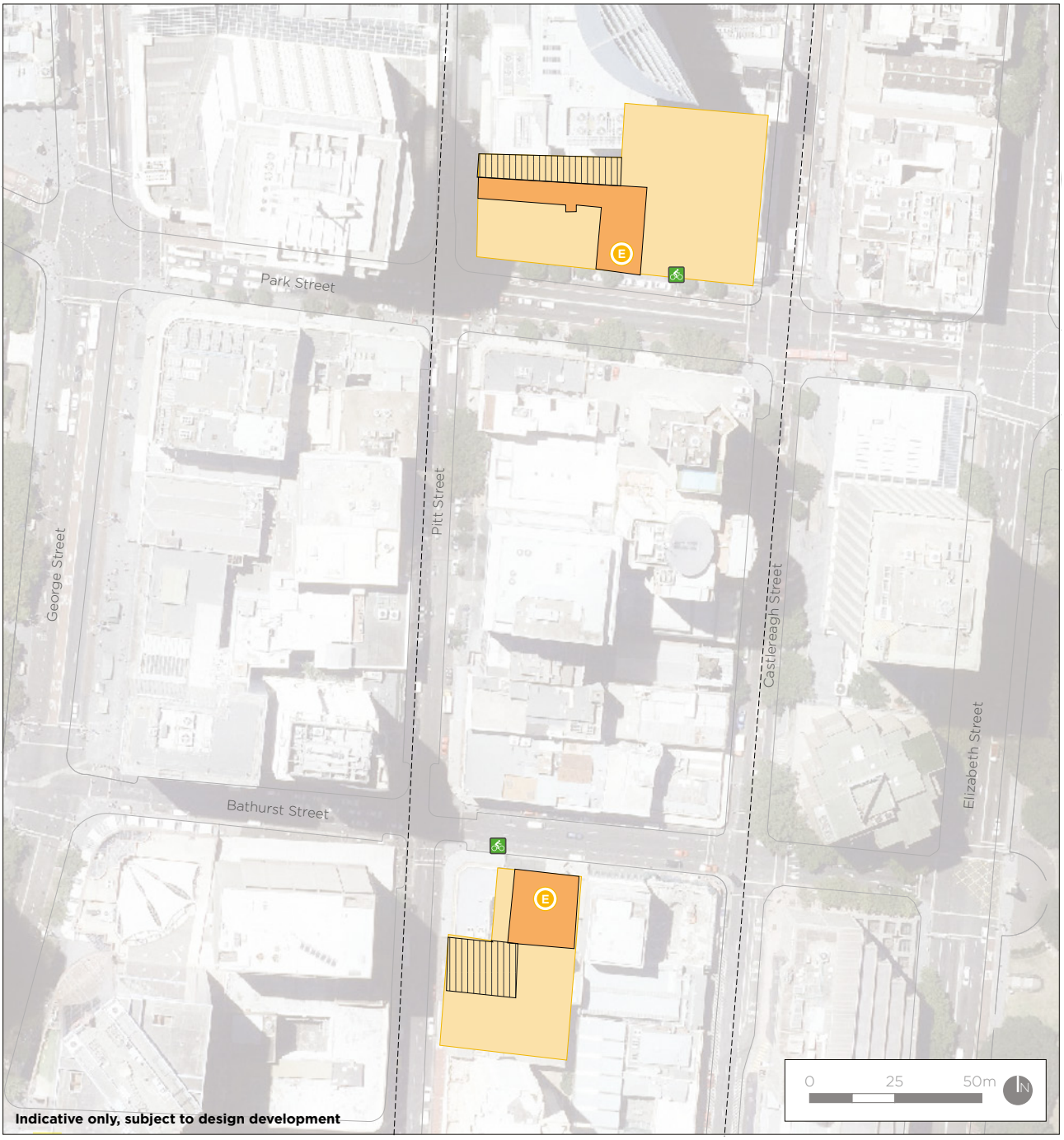
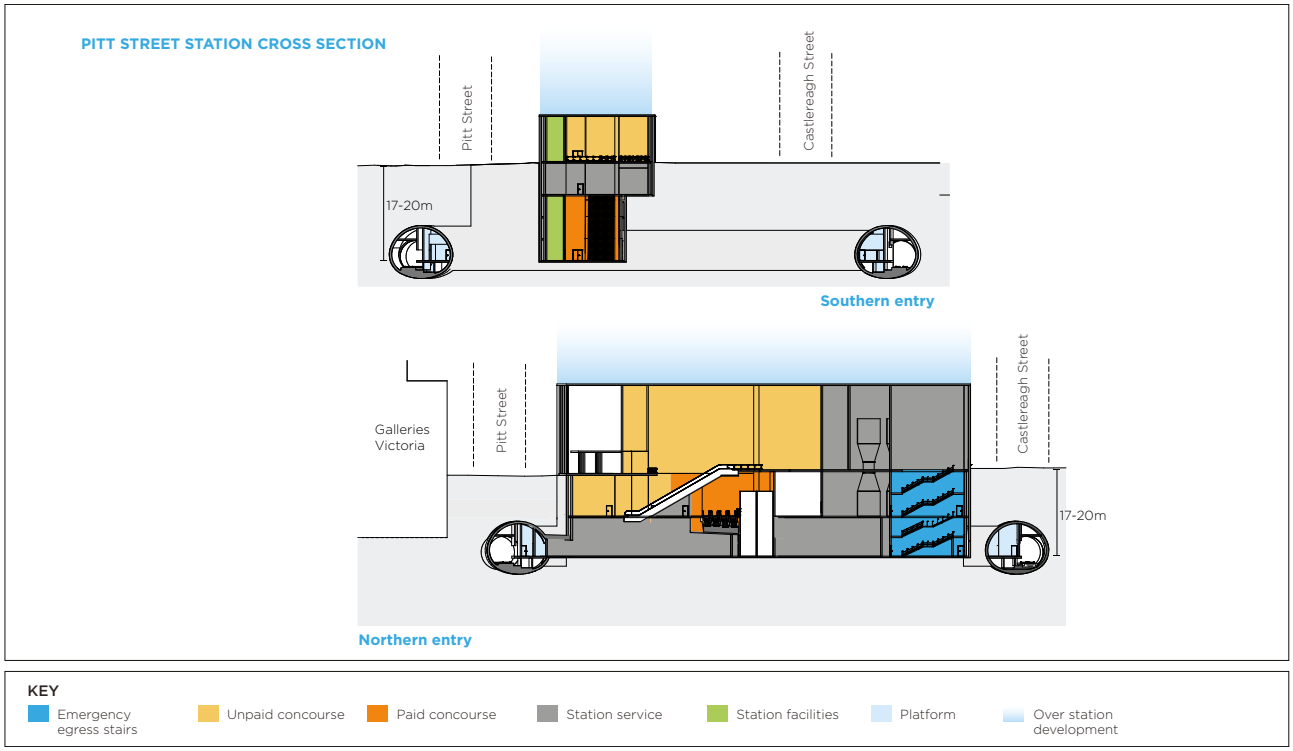


Figure 6-23 Pitt Street Station – location and indicative layout

Figure 6-24 Pitt Street Station – artist's impression

Table 6-8 Pitt Street Station design elements

Feature	Description
Centre type	Global Sydney (Sydney CBD)
Station type	Binocular cavern (mined) with two single side platforms
Transport interchange	Walking, cycling, taxi, bus and light rail
Station entry / exit	• A northern entry via a pedestrian plaza opening to Pitt and Park streets • A southern entry via a pedestrian plaza opening to Bathurst Street
Customers	Mid-town retail, employment, entertainment and residential precinct
Platform depth	About 17 metres (at northern end) and about 20 metres (at southern end)
Platform length	About 170 metres
Platform width	About five metres (each platform)
Overall station length	About 200 metres
Transport and access	• New bike parking on Park and Bathurst streets • Existing bus stops close to the station retained on Park and Castlereagh streets • Existing taxi ranks retained near to the station.



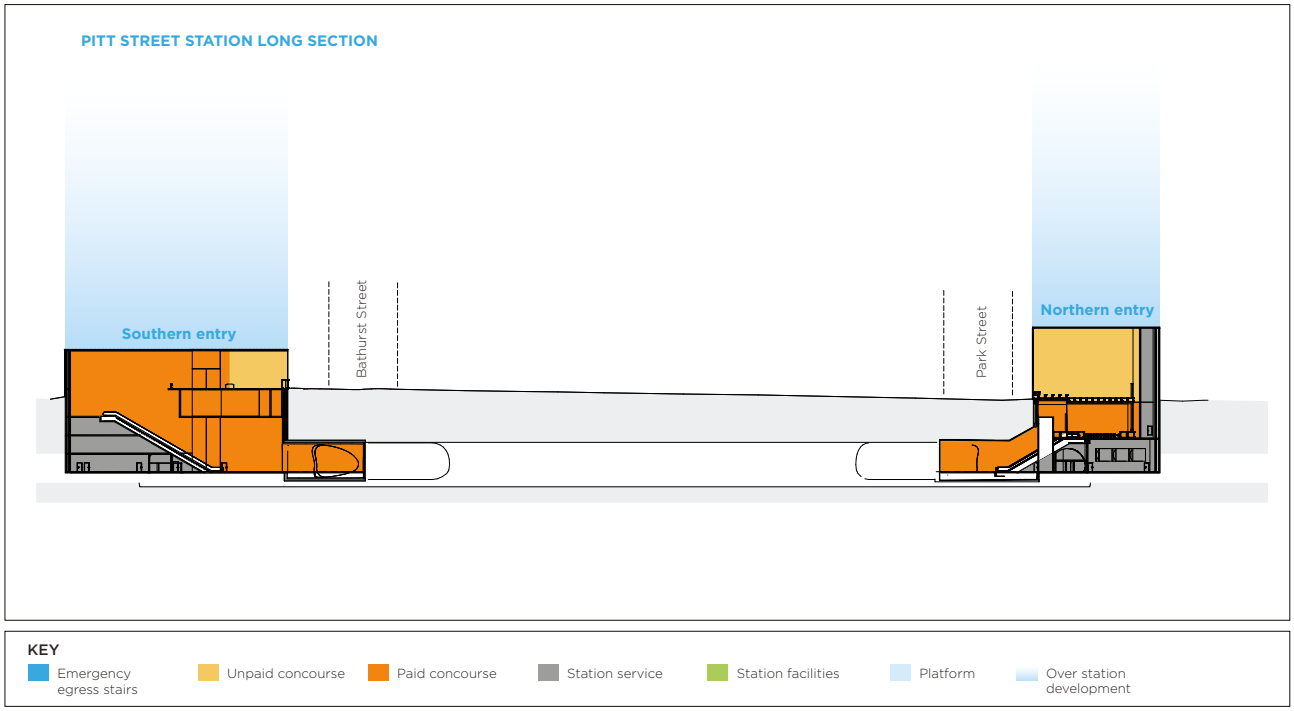


Figure 6-25 Pitt Street Station – indicative cross-section and long section

6.6.6 Central Station metro platforms

The metro platforms at Central Station would be located within the existing Central Station precinct, below the existing suburban rail service platforms 13, 14 and 15 (refer to Figure 6-26). The location of the two new underground metro platforms would facilitate an essential 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 (referred to as the Sydney Yard Access Bridge). Further details regarding the Sydney Yard Access Bridge are provided in section 6.9.2.

Platforms 13 and 14 would be reinstated as intercity platforms, and platform 15 could potentially be converted to a suburban platform following construction of the new Sydney Metro platforms.

Station strategy

The 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 would provide access to retail and mixed use precincts in the locality such as 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 the Sydney metro underground platforms at Central Station would:

- Provide an efficient and a high quality interchange for customers to connect 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 Precinct Plan
- Support connectivity with major land uses and development in the locality.

The location and key features of Central Station are shown in Figure 6-26 and Figure 6-27 and summarised in Table 6-9.

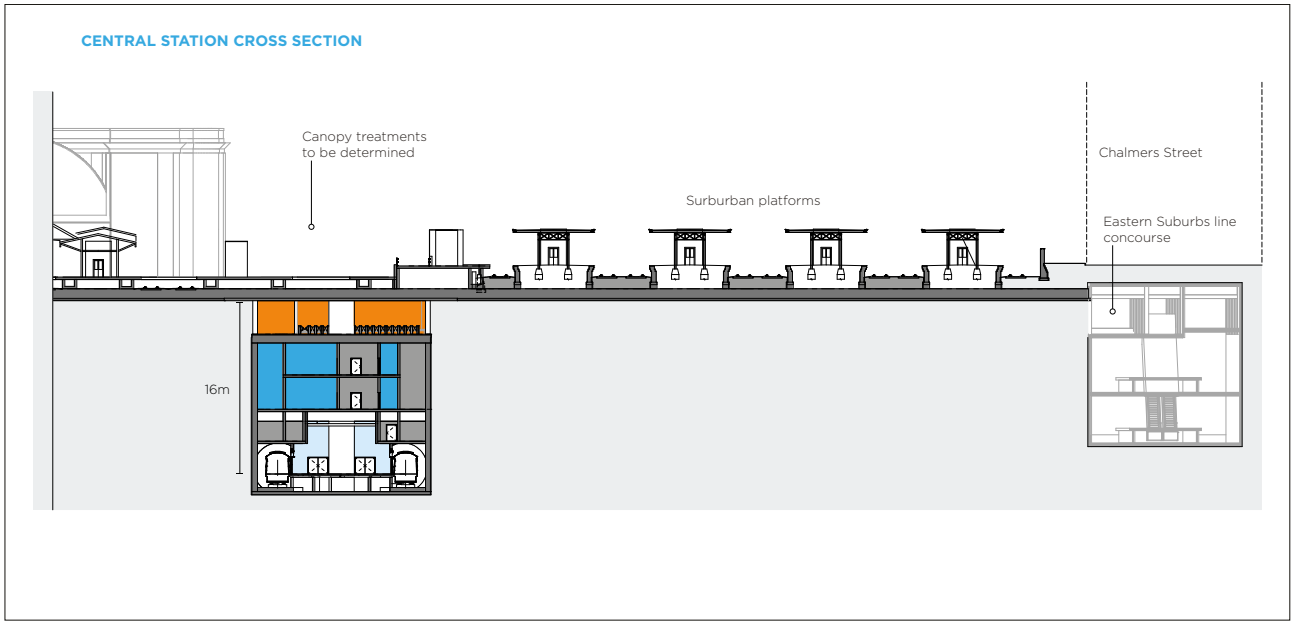
KEY

Metro entry | Metro concourse | Metro platforms | Services | Metro alignment

Figure 6-26 Central Station – location and indicative layout

Table 6-9 Central Station metro platforms design elements

Feature	Description
Centre type	Global Sydney (Sydney CBD)
Station type	Single-span (cut-and-cover) cavern with island platform
Transport interchange	Walking, cycling, intercity rail, suburban rail, light rail, bus, coach, taxi and kiss-and-ride
Station entry / exit	• Via the existing northern station entry from Eddy Avenue and the main northern concourse • Via the existing paid underground pedestrian connections within Central Station
Customers	• Customers travelling to nearby employment, education and entertainment precincts • Customers interchanging to and from metro services and other modes of transport
Platform depth	About 16 metres
Platform length	About 170 metres
Platform width	About 12 metres
Overall station length	About 220 metres
Transport and access	• Connect to the northern concourse and existing underground pedestrians links with Central Station for interchange • Existing bike parking retained • Existing bus stops retained • Existing kiss-and-ride and taxi ranks retained



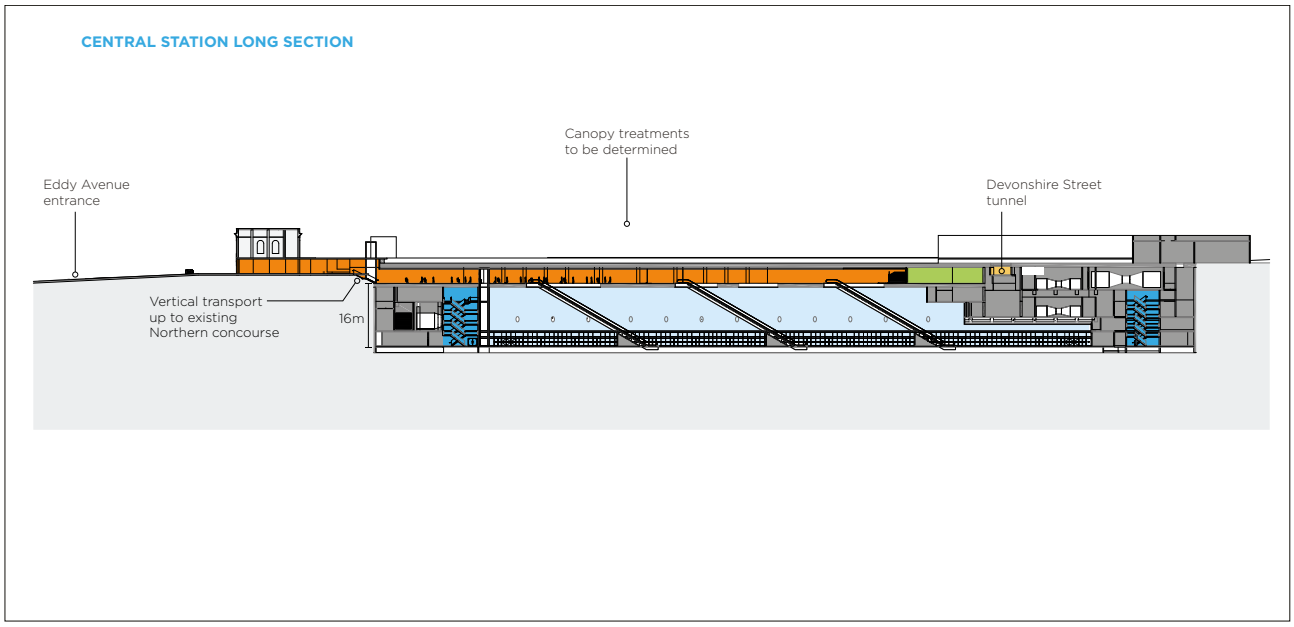


Figure 6-27 Central Station – indicative cross-section and long section

6.6.7 Waterloo Station

Waterloo Station would be located on Cope Street between Raglan and Wellington streets (refer to Figure 6-28).

Station strategy

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. 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.

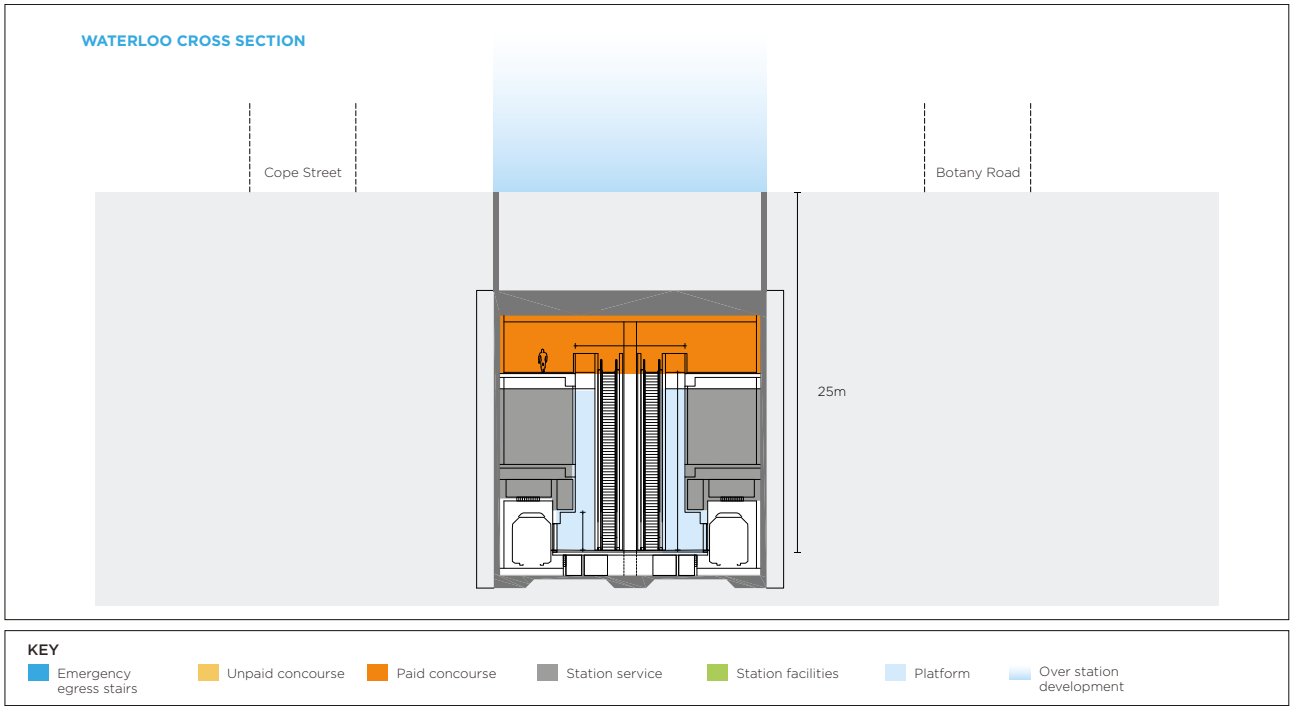
The location and key features of Waterloo Station are shown in Figure 6-28 to Figure 6-30 and summarised in Table 6-10.

Figure 6-28 Waterloo Station – location and indicative layout

Figure 6-29 Waterloo Station – artist's impression

Table 6-10 Waterloo Station design elements

Feature	Description
Centre type	Global Sydney (Sydney CBD)
Station type	Single-span (cut-and-cover) cavern with island platform
Transport interchange	Walking, cycling, bus, taxi, and kiss-and-ride
Station entry / exit	At the northern end of the station on the corner of Raglan and Cope streets
Customers	• Customers travelling to and from the nearby residential developments (existing and future) • Customers travelling to and from commercial precincts
Platform depth	About 25 metres
Platform length	About 170 metres
Platform width	About 10 metres
Overall station length	About 210 metres
Transport and access	• New pedestrian crossings on Raglan and Cope streets • New bike parking on Cope Street • New on-road marked cycle link on Raglan Street • Existing bus stops retained northbound along Botany Road • Relocation of the bus stops southbound on Botany Road closer to Raglan Street • Relocation of the bus stops on Cope Street to Botany Road • New taxi and kiss-and-ride bays on Cope Street



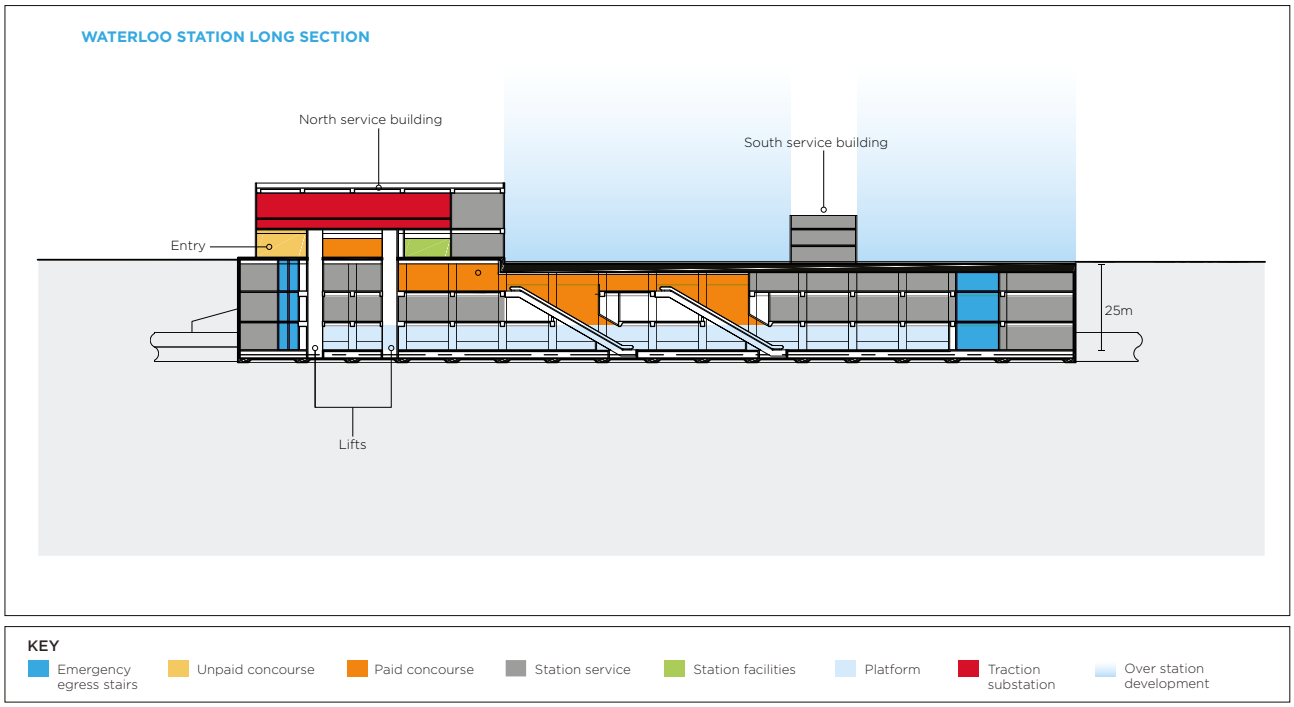


Figure 6-30 Waterloo Station – indicative cross-section and long section

6.7 Dive structures and tunnel portals

6.7.1 Chatswood dive structure and tunnel portal

As shown in Figure 6-31 and Figure 6-32, the Chatswood dive structure would commence about 250 metres south of Chatswood Station, while the Chatswood tunnel portal would be located to the north of Mowbray Road.

The dive structure would comprise an initial length of open trough, which would then transition to a cut-and-cover structure (the tunnel portal). A fire protection wall would be installed along the entire length of the dive structure to provide separation between the two metro tracks. The Chatswood dive structure would also incorporate rail dampers and deck absorption to provide mitigation for operational train noise.

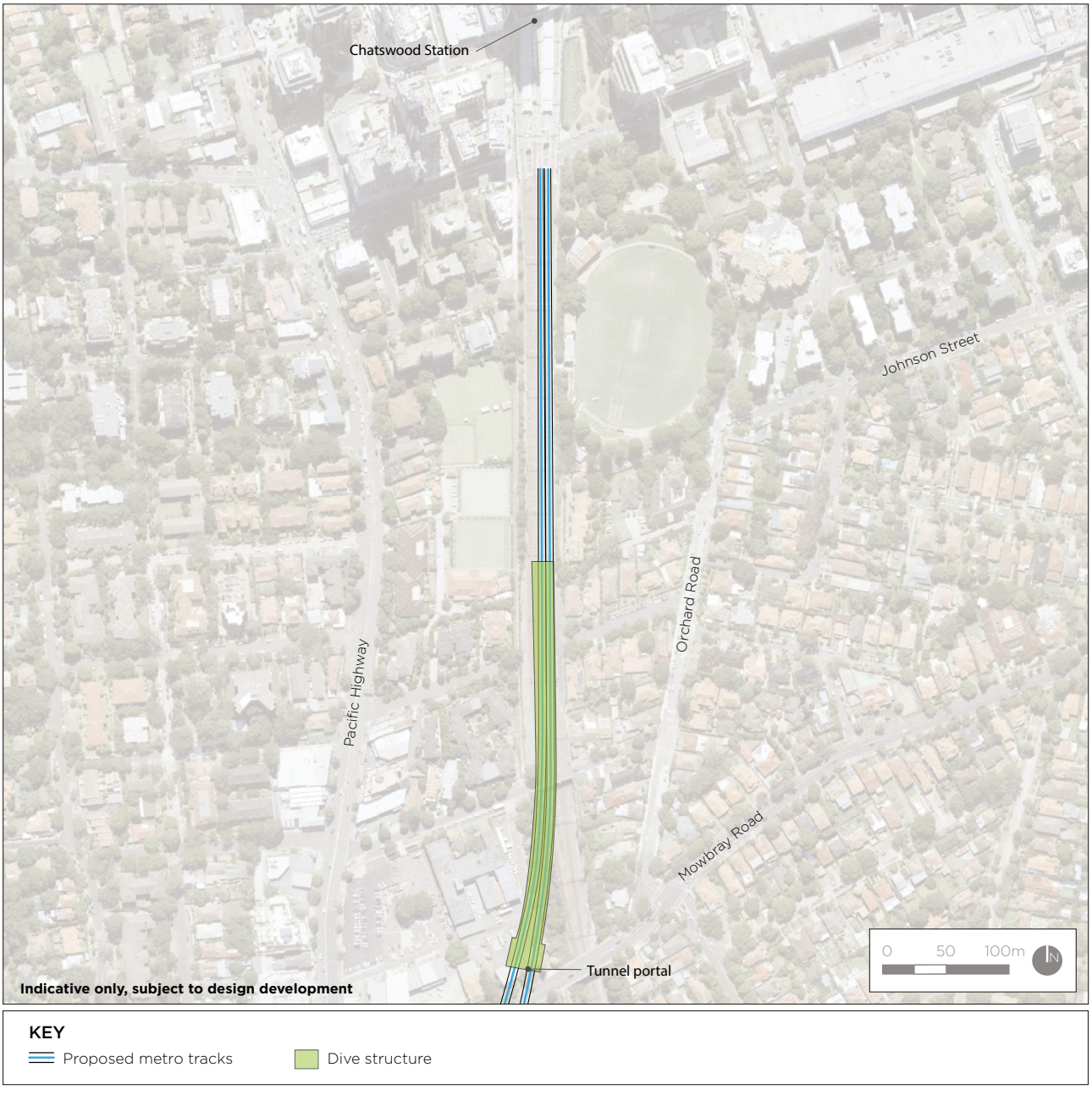


Figure 6-31 Chatswood dive structure and tunnel portal – indicative plan view

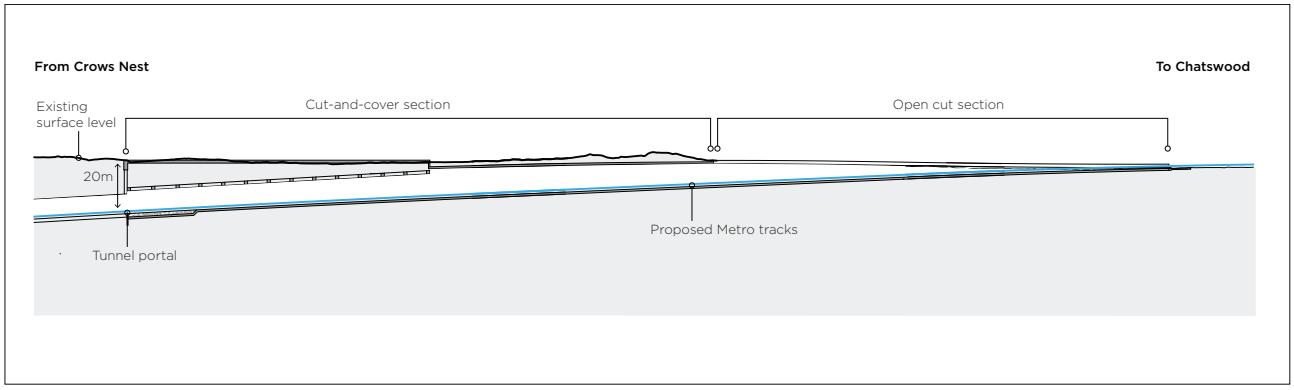


Figure 6-32 Chatswood dive structure and tunnel portal – indicative long section

6.7.2 Marrickville dive structure and tunnel portal

The Marrickville dive structure, shown in Figure 6-33 and Figure 6-34, would commence about 400 metres north of Sydenham Station and the Marrickville tunnel portal would be located in the suburb of Marrickville about 840 metres north of Sydenham Station (to the south of Bedwin Road).

The dive structure would comprise an initial length of open trough, which would then transition to a cut-and-cover structure (the tunnel portal). The dive structure has been designed to be protected from the probable maximum flood level to avoid floodwater flowing into the tunnel. A fire protection wall would be installed along the entire length of the dive structure to provide separation between the two metro tracks.

Figure 6-33 Marrickville dive structure and tunnel portal – indicative plan view

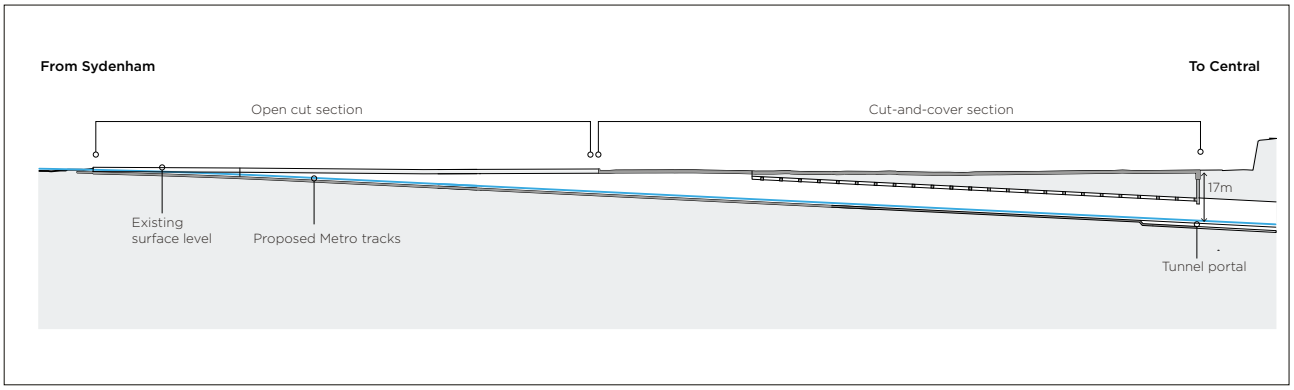


Figure 6-34 Marrickville dive structure and tunnel portal – indicative long section

6.8 Ancillary infrastructure

6.8.1 Artarmon substation

A substation would be required at Artarmon (between the northern tunnel portal and Crows Nest Station) to provide traction power to the tunnels. The substation would be part of the electrical power supply network for the project.

The substation would be located above the tunnels near the edge of the Gore Hill Freeway as shown in Figure 6-35. The traction substation and ancillary equipment would be housed in an aboveground building (around five metres above ground level) with a shaft (with a diameter of around three metres) to reticulate cables to the tunnels below.

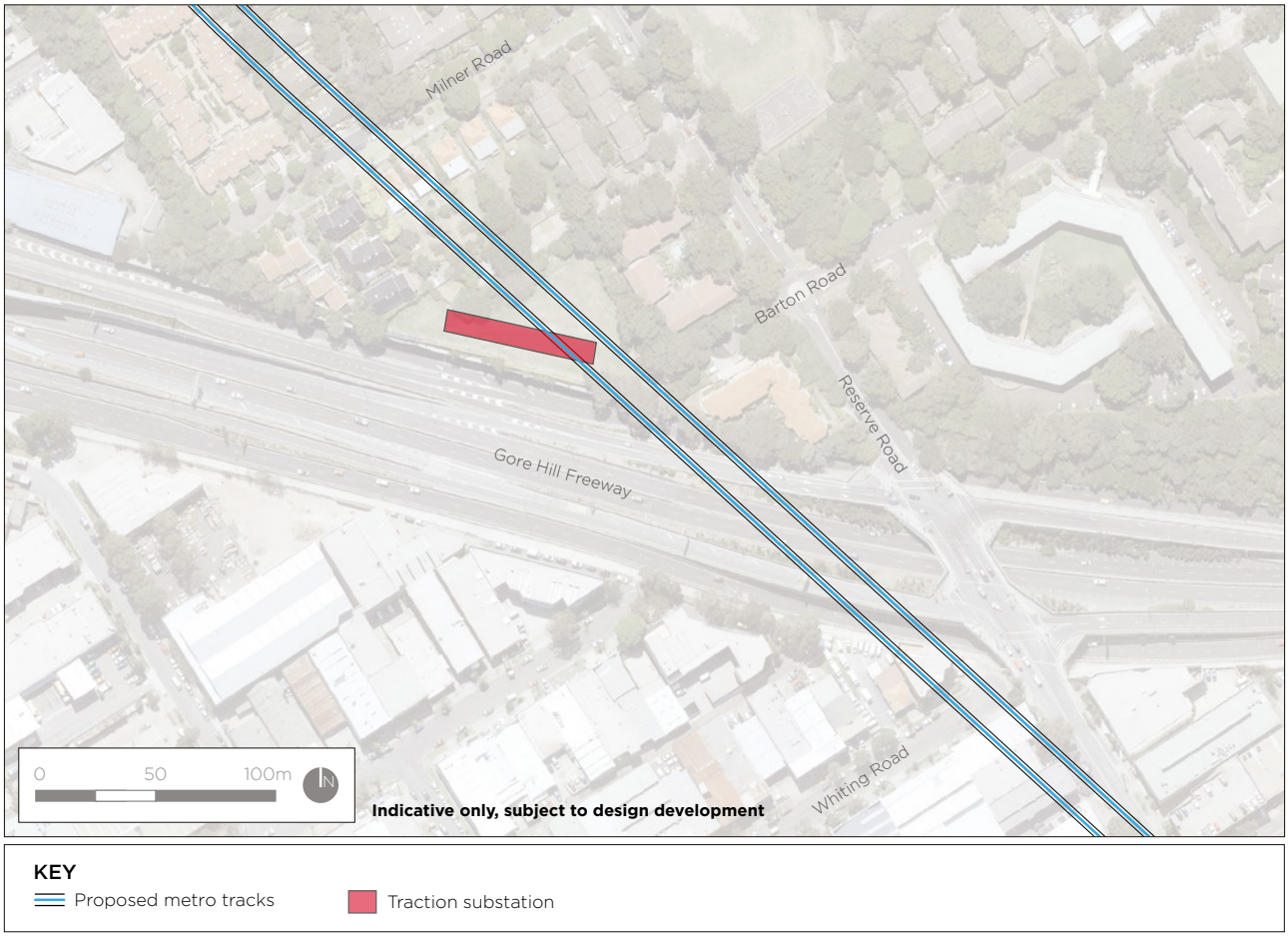


Figure 6-35 Artarmon substation – indicative plan view

6.8.2 Southern services facility

The southern services facility would be located adjacent to the Marrickville tunnel portal. It would include a tunnel water treatment plant and a traction substation. The indicative location of the water treatment plant and traction substation is shown in Figure 6-36.

The tunnel water treatment plant would treat wastewater pumped from the tunnels, stations and other underground facilities. The water treatment plant would be housed within a building about eight metres high and covering an area of about 500 square metres. The water treatment plant building would contain holding tanks, chemical treatment tanks and filters. Further information regarding the likely treatment methods, wastewater volumes and discharge points is provided in Chapter 18 (Soils, contamination and water quality).

An aboveground building (around five metres above ground level) for a traction substation and ancillary equipment would be provided, with cables reticulated into the tunnels.

Figure 6-36 Southern services facility – indicative plan view

6.9 Other key project features

6.9.1 Permanent closure of Nelson Street bridge

The Chatswood dive structure and tunnel portal would result in the demolition and permanent closure of the Nelson Street bridge. The primary role of the Nelson Street bridge is to enable motorists travelling south on the Pacific Highway to access Mowbray Road westbound via Orchard Road. Nelson Street also provides local vehicle access to residents of Nelson Street. To maintain this primary movement, it is proposed to construct an all vehicle right-turn movement 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.

Roads and Maritime Services are currently investigating further upgrades to the Pacific Highway / Mowbray Road intersection. Sydney Metro would continue to consult with Roads and Maritime in relation to coordination of these works and any opportunities to carry out these works concurrently.

Nelson Street also provides local access for properties located to the east of the T1 North Shore Rail Line. Following closure of the Nelson Street bridge, these residents would need to use alternative route to cross the rail line such as Mowbray Road or Albert Avenue.

As part of the project, Frank Channon Walk (a shared path currently connection Chatswood Station to Nelson Street) would be extended from Nelson Street to Mowbray Road on the western side of the rail line to provide an enhanced facility for pedestrians and cyclists and provide continued access between Chatswood Station and residential areas to the south. Those travelling from residential areas to the south-east of the rail line would need to use the underpass adjacent to Chatswood Oval to cross the rail line and access Frank Channon Walk. Orchard Road, running parallel to Frank Channon Walk on the eastern side of the rail line, could also be used as an alternative north-south route for journeys between the Chatswood retail areas and residential areas to the south.

6.9.2 Other bridges

T1 North Shore Line bridge over the metro dive structure

The realigned T1 North Shore Line 'down' (northbound) track would pass over the top of the metro Chatswood dive structure on a bridge. The track level across the bridge would be around two metres higher than the existing track level. The bridge is anticipated to be a single-span concrete structure around 60 metres long.

Sydney Yard Access Bridge

To provide access for Sydney Metro and Sydney Trains once the project is operational, an access bridge for maintenance vehicles at Central Station would be provided from Regent Street to 'Sydney Yard', located between the suburban and intercity rail lines. A plan view of the bridge is provided as Figure 6-37 and a long section as Figure 6-38.

The bridge would be about 170 metres long with a central span of about 50 metres, crossing the Intercity rail lines. The bridge deck would be about nine metres above the ground.

Because of the prominence of the bridge and the heritage sensitivity associated with its setting, the following principles would guide its detailed design:

- The bridge would be of high quality design and integrate with the industrial rail context
- The bridge architecture would draw reference from the existing forms, materials and colours of Sydney Yard
- The bridge structure and abutments would be of masonry construction
- Where throw screens are required they would be of largely transparent material and construction
- Lighting of the bridge would be inconspicuous and not cause nuisance in the public domain or spill towards Mortuary Station.

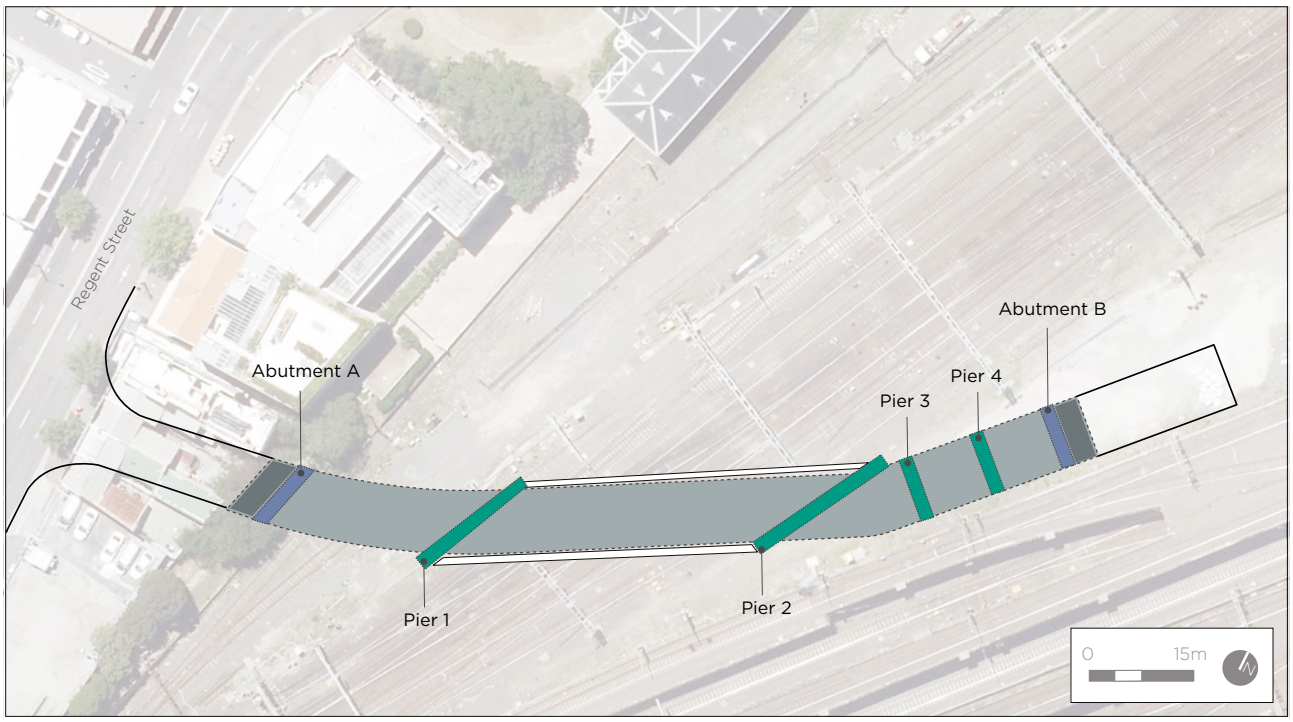


Figure 6-37 Sydney Yard Access Bridge – indicative plan view

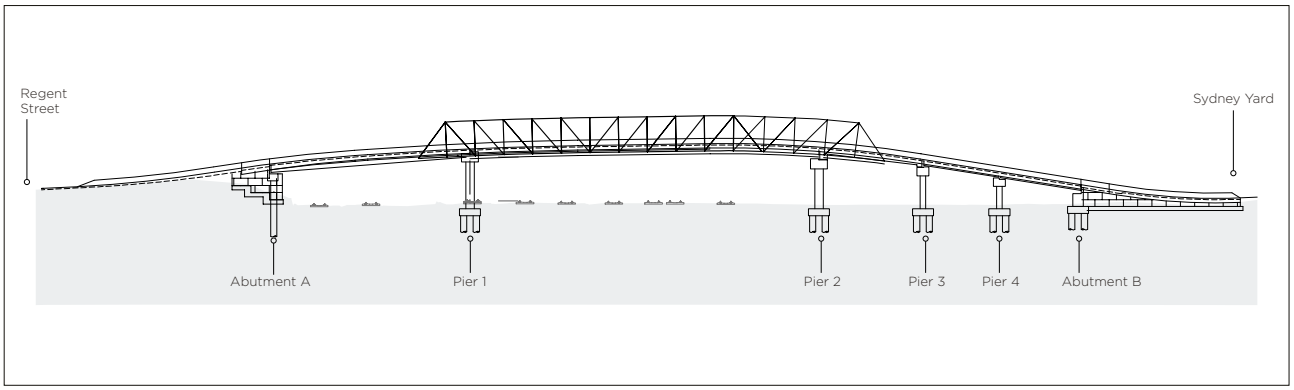


Figure 6-38 Sydney Yard Access Bridge – indicative long section

6.9.3 Noise barriers

Noise barriers at the northern end of the project would be relocated and increased in height in order to mitigate potential airborne noise impacts from operating trains. Specifically, the design at this stage has incorporated the following measures:

- An increase in the height (to four metres) of the noise barrier between Chapman Avenue and Nelson Street on the eastern side of the rail line
- An increase in the height (to four metres) of the noise barrier between the Frank Channon Walk pedestrian underpass and Albert Avenue on the western side the rail line
- An increase in the height (to four metres) of the noise barrier between Nelson Street and Gordon Avenue on the western side the rail line
- A two metre high noise barrier to the south of Mowbray Road on the western side of the rail line.

The heights noted above are indicative only with the exact height and extent of the noise barriers in these locations to be further refined during detailed design.

6.9.4 Retaining walls

The realignment of the T1 North Shore Line 'down' (northbound) track would require new retaining walls between around Ellis Street, Chatswood and around Drake Street, Artarmon. Retaining walls would generally be provided on either side of the 'down' track. Noise barriers (where required) would be located on top of this retaining wall.

6.9.5 Maintenance access

The realignment of the T1 North Shore Line 'up' (southbound) track would require the closure (in around 2019) of the existing Sydney Trains maintenance access from Hopetoun Avenue, Chatswood. There is alternative access for Sydney Trains from Drake Street, Artarmon. This access point would be upgraded to provide a new entrance and a Hi-Rail access pad adjacent to the rail track within the corridor.

Provisions would be made for new maintenance access near the Chatswood dive structure for Sydney Trains and Sydney Metro.

New maintenance access stairs for Sydney Trains would be provided from Albert Avenue on the eastern side of the rail line. New maintenance access may also be provided from Brand Street, Artarmon on the western side of the rail line.

6.10 Metro rail systems

6.10.1 Signalling and train control

All sections of the Sydney Metro network would use advanced signalling technology to support safe operations. The signalling system would include:

- Automatic Train Protection, which provides train spacing and speed monitoring and control functionality
- Automatic Train Regulation, which monitors and adjusts train speeds and station dwell times to maintain timetable and / or spacing between trains
- Automatic Train Operation, which provides automated train driving functionality.

The signalling system would control the stopping of trains at stations, ensure trains stop at the correct location on the platform (in line with platform screen doors), control train speed between stations, and initiate the opening and closing of doors on the correct side of the train.

The signalling system would allow for bi-directional operation (ie trains would run in either direction on either track) in special circumstances. This would provide functionality to respond to a range of incidents to support continuity of service. All control systems would be integrated with rail systems to provide consistent performance and high levels of safety.

The signalling system for the project would be linked via dedicated fibre optic cable and network switches to the Sydney Metro Trains Facility at Tallawong Road, Rouse Hill.

6.10.2 Communications

The project would include an integrated information system to communicate with customers or metro staff via audio and visual links at each station and on all trains. The communications equipment would be within the designated services area at each station and within the tunnel. The communications system would comprise:

- Radio communications systems for operator and emergency services
- Customer mobile telephone and other modern telecommunication methods
- Customer information display and public address
- Closed-circuit television system and video broadcasting system
- Digital voice video recording system
- Telephone system and personnel wireless terminal
- Trackside intruder detection system
- Emergency warning information system.

6.10.3 Traction power supply, substations and overhead wiring

The Sydney Metro network electrical power system would be designed to operate as an independent standalone system, which would be segregated from the Sydney Trains network, and would be designed with suitable redundancy to enable continued rail operations under 'fault conditions'. All Sydney Metro traction supply infrastructure would be controlled and monitored from the Sydney Metro Trains Facility at Tallawong Road, Rouse Hill.

The electrical power supply network for the project would comprise:

- Traction substations at Artarmon and adjacent to the Marrickville tunnel portal
- Traction substations at Victoria Cross, Barangaroo, Pitt Street and Waterloo stations. These substations would be integrated into the station buildings and located partly underground
- A high voltage (1500 volt) direct current traction power system (consisting of an in-tunnel conductor bar) that would be used to power the trains. The high voltage power system would be supplied by a 33 kilovolt high voltage network feeder connected to the Pitt Street Station traction substation. It would connect to the other project traction substations through the tunnels and to the Sydney Metro Northwest electrical supply network at the Chatswood North traction substation. The power supply route to the Pitt Street Station traction substation is shown in Chapter 7 (Project description – construction)
- A low voltage (415 volt) power system for electrical services at stations for tunnel services and ventilation and signalling and communications systems. The low voltage power system would be supplied by a number of services substations, which would generally be located in the services area of each station. Each services substation would transform the high voltage power supply to low voltage (415 volts).

6.11 Metro operations

This section provides a description of the operation of the project in the context of the broader Sydney Metro network. The Chatswood to Sydenham project would operate in conjunction with Sydney Metro Northwest and the Sydenham to Bankstown upgrade project. All Sydney Metro operations would be controlled and monitored from the Sydney Metro Trains Facility at Tallawong Road, Rouse Hill.

The Sydenham to Bankstown upgrade project is subject to a separate environmental assessment process and, subject to planning approvals, is expected to be completed and opened concurrently with the opening of this project in 2024. Should the construction timeframes of this project be advanced, there may be an opportunity to operate this project before completion of the Sydenham to Bankstown upgrade project. Should this occur, an additional track-turnback would be constructed between the Marrickville dive structure and Sydenham Station. A supplementary environmental assessment and appropriate community and stakeholder consultation would be carried out and the appropriate approvals obtained prior to this component being constructed.

To improve operational efficiency and flexibility in the event of an incident, a track crossover may be provided within the tunnel section of the project. Further investigation on the need and optimal location for the track crossover is currently being carried out.

6.11.1 Service frequency and reliability

The project is being designed as a 'turn up and go' service. The proposed service frequency at the time of opening would be:

- Weekday morning and evening peaks – a six car train at least every four minutes (20 trains per hour)
- Weekday daytime off-peak – a six car train every five minutes through the Sydney CBD (12 trains per hour)
- Weekday early mornings, late at night and on weekends – a six car train every ten minutes with options to increase based on level of demand (six trains per hour).

The indicative service frequency of the project through the Sydney CBD for a typical weekday is shown in Figure 6-39. The metro trains would operate independently of the existing rail network, with an expected target of 98 per cent on-time reliability.

At ultimate capacity the service frequency would be an eight car train every two minutes through the Sydney CBD. The assessment within this Environmental Impact Statement is based on this ultimate capacity.

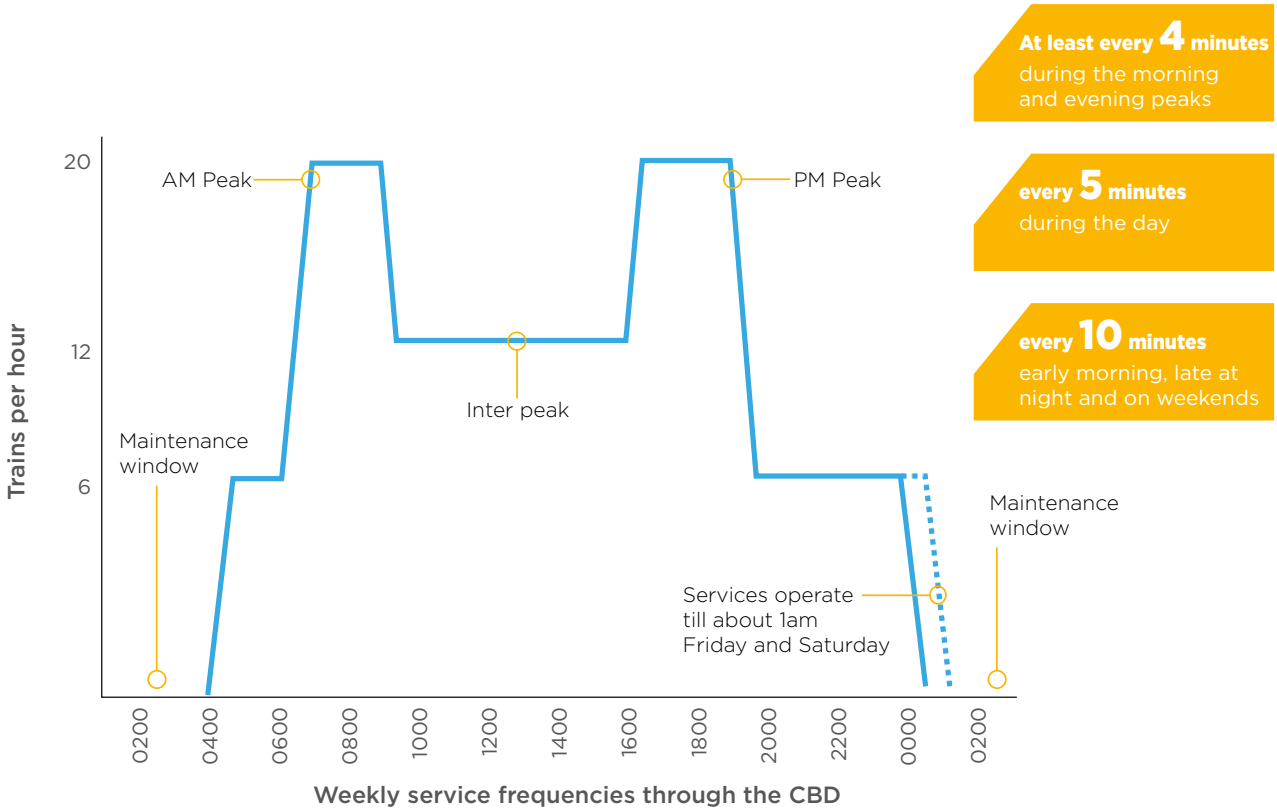


Figure 6-39 Indicative service frequency at opening of metro trains through the Sydney CBD on a typical weekday

6.11.2 Capacity and customer transfers

Initially, each train would have six carriages and would be capable of transporting up to 1,150 people. Based on the service frequency, the project would initially have the capacity to move around 23,000 people per hour in each direction in peak periods.

The project would be designed to cater for long term growth in travel demand. When required to meet increased demand, capacity would be increased to cater for more than 40,000 people per hour in each direction. This would be achieved by increasing from six car to eight car trains and increasing the service frequency from 20 trains per hour to up to 30 trains per hour through the Sydney CBD in peak periods. The assessment within this Environmental Impact Statement is based on this ultimate capacity.

The stations at Martin Place and Central would provide the key interchange points with the existing Sydney Trains network. By 2036 about 13,700 customers are expected to transfer between Sydney Metro and the Sydney Trains network at these stations during the morning peak hour, with the largest number of transfers at Central Station.

6.11.3 Indicative travel time savings

The project would substantially improve travel times for customers. The largest travel time savings would be experienced by customers travelling from new stations (such as Crows Nest) or where the project provides a more direct route of travel (such as Victoria Cross to Martin Place).
Some key forecast travel time savings associated with the project are:

- Martin Place to Chatswood – 19 minute savings
- Norwest Business Park to Central – 15 minute savings
- Martin Place to North Sydney (corner Miller Street and Pacific Highway) – 15 minute saving
- Macquarie Park to North Sydney (corner Miller Street and Pacific Highway) – 13 minute savings
- Crows Nest to Central – 21 minute saving
- Bondi Junction to North Sydney (corner Miller Street and Pacific Highway) – 11 minute saving.

Information on how indicative travel time savings have been calculated is provided in Chapter 3 (Strategic need and justification).

6.11.4 Hours of operation

The first metro service to depart Cudgegong Road Station (Sydney Metro Northwest) and Bankstown Station (as part of the Sydenham to Bankstown upgrade) would arrive at Central Station in the early morning and the last metro service to Cudgegong Road and Bankstown stations would depart Central Station late at night (around midnight and potentially later on weekends). The operating hours could be extended to accommodate for planned special events.

The operating hours would be determined as part of the development of the services schedules for the project taking into account customer and maintenance access requirements.

6.11.5 Train types

All trains would be single-deck metro trains (similar to those to be introduced on Sydney Metro Northwest). The trains would deliver a fast, safe and reliable journey for customers. An artist's impression of the type of train proposed is provided as Figure 6-40.

The single-deck metro trains would be able to carry more customers 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 than double-deck trains which reduces dwell times (the time a train is stopped at a station) and increases frequency. The modern signalling technology is also more efficient for running the trains, which increases the capacity of the metro network.

Metro trains would feature high performance standards and good customer amenities. These would include:

- Heating and air-conditioning in all metro trains
- Three doors per side per carriage for faster boarding and alighting
- Provision for customers in wheelchairs
- Accessible priority seating for mobility impaired, the elderly, people with prams or luggage
- Efficient seating and standing arrangements for access and alighting the metro
- On-board real time travel information and live electronic route maps
- Emergency intercoms inside trains
- Level access between the platform and train.

Figure 6-40 Indicative metro train and carriage

6.11.6 Ticketing

The Opal electronic ticketing system would be used on the Sydney Metro network. This system would be installed at all new stations.

6.11.7 Stabling and maintenance

Infrastructure maintenance

Maintenance planning for the project would generally allow routine and major periodic maintenance of infrastructure 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 those 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.

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. This approved facility forms part of the Sydney Metro Northwest project and is therefore not required to be addressed in this Environmental Impact Statement.

Stabling may also occur at a dedicated facility near the southern end of the project. Any additional facility required to support operations would be delivered and assessed as part of the Sydenham to Bankstown upgrade project.

6.11.8 Operational staff

It is anticipated that around 150 full-time equivalent staff would be required to operate and maintain the project, including the operation and maintenance of rolling stock, stations and tracks. Staffing would be subject to future operator requirements.

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