Chapter 6

Construction work

January 2020

6 Construction work

This chapter describes the proposed approach to construction of the project. It outlines the proposed construction program, footprint, methods, working hours, materials, equipment, traffic management, site access routes, and temporary construction support sites.

The construction works described in this chapter may be refined in response to submissions received during exhibition of this environmental impact statement and/or during further design development and construction planning, once a construction contractor has been appointed.

Detailed construction planning would be carried out before construction of the project begins. This would include further refinement of specific construction methods and the program.

The Secretary's environmental assessment requirements as they relate to construction works, and where in the environmental impact statement these have been addressed, are detailed in Table 6-1.

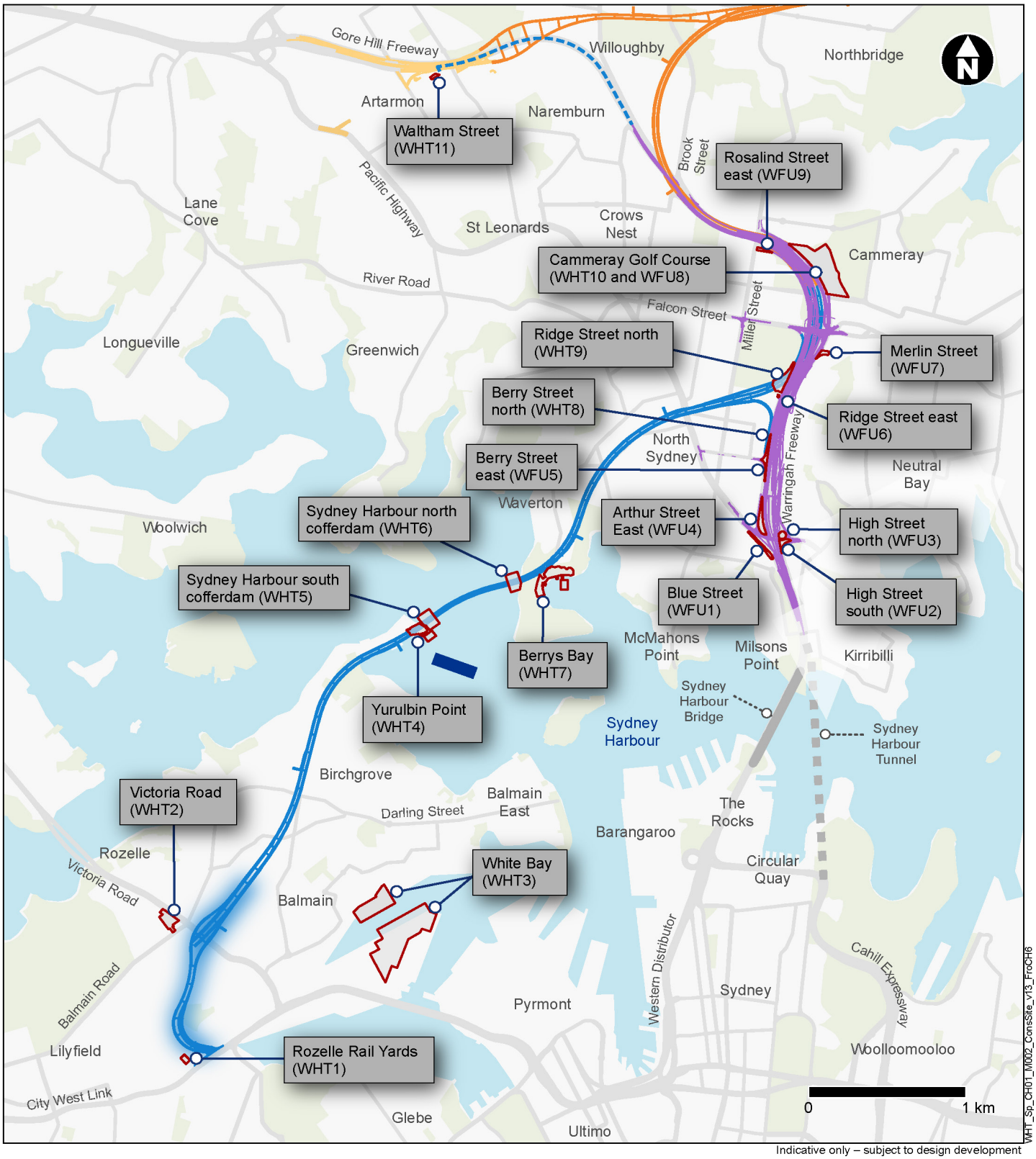
Table 6-1 Secretary's environmental assessment requirements – Construction work

Secretary's requirement	Where addressed in EIS
Environmental impact statement	
1. The EIS must include, but not necessarily be limited to, the following: b. description of the project and all components and activities (including ancillary components and activities) required to construct and operate it, including: - the proposed route;	**Section 6.7** shows the key construction activities and construction support sites along the proposed route. **Chapter 5** (Project description) describes the proposed route.
- Design of the tunnels, interchanges (inclusive of tunnel portals and entry and exit ramps), road user, pedestrian and cyclist facilities, and lighting	**Section 6.4** describes the tunnel construction method. **Section 6.5** describes the construction method for surface road works and associated infrastructure.
- Surface road upgrade works, including road widening, intersection treatment and grade separation works, property access, parking, pedestrian and cyclist facilities (including appropriate locations for overbridges) and public transport facilities	**Section 6.5** describes the construction method for surface road works and associated infrastructure, including bridgeworks and pedestrian facilities. Property access is described in **Chapter 21** (Socio-economics) and **Chapter 20** (Land use and property).
- Ancillary infrastructure and operational facilities, such as operational and maintenance facilities, ventilation structures and systems, and fire and emergency services and infrastructure for the proposal, including (if required) additional infrastructure (such as tolling infrastructure)	**Section 6.7** describes the construction support sites required to construct the project. Construction of operational facilities and ancillary infrastructure is described in **Section 6.4.6**.

Secretary's requirement	Where addressed in EIS
- Location and operational requirements of construction ancillary facilities and access	The location and hours of construction at each construction support site and their respective access arrangements are described in **Section 6.7.2.**
- Land use changes as a result of the proposal and the acquisition of privately owned, Council and Crown lands, and impacts to Council and Crown lands; and	Land use changes as a result of the project are described in **Chapter 20** (Land use and property).
- The relationship and/or integration of the project with existing and proposed public and freight transport services	Site access to the construction support sites and expected vehicle numbers is described in **Sections 6.7** and **Section 6.8**. The integration of the project with existing and public and freight services is described in **Chapter 8** (Construction traffic and transport) and **Chapter 9** (Operational traffic and transport).

6.1 Overview of construction works

An overview of the construction support sites required for the project is provided in Figure 6-1. Further detail on the key activities to be carried out at each site and typical construction hours for each location is provided in Section 6.7. An overview of the types of construction works required for the project is provided in Table 6-2. Detailed descriptions of each construction activity are provided in the sections which follow.



Indicative only – subject to design development

Legend

Construction features

- Western Harbour Tunnel
- Warringah Freeway Upgrade
- Communications cable for motorway control centre
- Fit out and commissioned as part of Western Harbour Tunnel, constructed as part of WestConnex M4-M5 Link
- Construction support sites
- Mooring site

Connecting projects

- Beaches Link
- Gore Hill Freeway Connection

Figure 6-1 Overview of the construction support sites for the project

Table 6-2 Overview of construction works

Component	Typical activities
Early works and site establishment	• Property acquisition and condition surveys • Vegetation clearing, earthworks and demolition of structures • Utilities installation, protection, adjustment and relocation • Land remediation and heritage salvage and/or conservation works (where required) • Installation of site fencing, environmental controls (including noise attenuation and project erosion and sediment controls) and traffic management controls • Construction of minor access roads and the provision of property access including the temporary relocation of pedestrian and cycle paths and adjustments to existing intersections, where required • Temporary relocation of swing moorings, where required • Relocation of bus stops • Establishment of construction support sites (including temporary site accesses) and acoustic sheds, where required.
Construction of Western Harbour Tunnel component	• Excavation of tunnel construction accesses • Construction of driven tunnels and surface connections • Construction of cut and cover and trough structures • Cofferdam construction and dredging activities in preparation for the installation of immersed tube tunnels • Casting and installation of immersed tube tunnels (crossing of Sydney Harbour) • Civil finishing works and tunnel fitout • Construction of operational facilities including: – A motorway control centre at Artarmon – Motorway facilities, tunnel support facilities and ventilation outlet at Cammeray for the Western Harbour Tunnel component. The civil construction of the Beaches Link ventilation outlet at the Warringah Freeway would be carried out as part of the project to minimise future disruption to the Warringah Freeway corridor and maximise construction efficiency. Fitout of the Beaches Link ventilation outlet would form part of the Beaches Link and Gore Hill Freeway Connection project (subject to separate environmental assessment and approval) – Construction and fitout of the Western Harbour Tunnel operational facilities that form part of the M4-M5 Link Rozelle East Motorway Operations Complex – A wastewater treatment plant at Rozelle – Installation of motorway tolling infrastructure.
Surface road works	• Earthworks • Bridgeworks • Construction of retaining walls • Construction and installation of stormwater and cross drainage • Pavement works and linemarking

Component	Typical activities
	• Utilities installation and relocation • Tolling gantries and associated infrastructure • Installation of road furniture, lighting, signage and noise barriers.
Testing, commissioning and site rehabilitation	• Testing of plant and equipment • Commissioning of the project • Backfill of access declines and shafts • Removal of construction support sites • Landscaping and rehabilitation of disturbed areas • Removal of temporary environmental and traffic controls.

6.2 Construction program

6.2.1 Program overview

Subject to planning approval, construction of the Western Harbour Tunnel and Warringah Freeway Upgrade project is planned to commence in 2020, with completion of construction in 2026. Early works and site establishment would be the first works carried out for the project, with substantial construction starting in 2021.

Construction associated with the Warringah Freeway upgrade component comprises early works and site establishment, surface works and bridgework activities, which would run concurrently from 2020 to 2025. The indicative construction program of the project, including the Warringah Freeway Upgrade component, is shown in Table 6-3.

Table 6-3 Western Harbour Tunnel and Warringah Freeway Upgrade project indicative construction program

Construction activity	Indicative construction program																							
	2020				2021				2022				2023				2024				2025				2026			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Western Harbour Tunnel and Warringah Freeway Upgrade early works and site establishment																												
Construction of the Warringah Freeway Upgrade component																												
Construction of driven tunnels																												
Immersed tube tunnel preparatory works, construction, installation, fitout and reinstatement works																												
Tunnel fitout and finishing																												
Construction of operational facilities																												
Testing and commissioning																												
Site clean-up and demobilisation																												

The final construction program for the project would depend on future project procurement and packaging decisions. It is possible that some aspects of the Western Harbour Tunnel component of the project could be delivered by the Warringah Freeway Upgrade construction contractor to minimise disruption to the Warringah Freeway.

It is assumed that the project would commence construction before the Beaches Link and Gore Hill Freeway Connection project, which is subject to separate assessment and approval. Should timeframes for the Beaches Link component of the Beaches Link and Gore Hill Freeway Connection project be advanced, some elements of the Beaches Link component may be delivered as part of the Western Harbour Tunnel and Warringah Freeway Upgrade project to safeguard delivery of either surface connections or tunnel-to-tunnel connections, maximise construction efficiency and minimise ongoing disruption in particular areas.

6.3 Enabling works and site establishment

6.3.1 Enabling works

Enabling works for major infrastructure projects are carried out prior to substantial construction in order to prepare sites to facilitate the main construction activities. Some early works would take place prior to the formal approval of construction management plans, and would include:

- Property acquisitions
- Carrying out existing condition surveys of buildings and infrastructure
- Land remediation (where required)
- Relocation, adjustment and protection of utilities and services affected by the project
- Carrying out of heritage investigations, protections, salvage and/or conservation works
- Temporary relocation of about 10 swing moorings at Berrys Bay, as close to their existing position as possible (refer to Chapter 8 (Construction traffic and transport) for more information)
- Relocation of the historic *Baragoola* and *M.V. Cape Don*, with reasonable notice for the vessel owners to find a suitable alternate berth within Sydney Harbour prior to the start of construction.

6.3.2 Site establishment

Site establishment would occur prior to the major construction activities commencing and would include:

- Vegetation clearing, chipping and mulching where required
- Installation of site environmental management controls (including site fencing, noise attenuation measures and erosion and sediment controls)
- Traffic management controls, including adjustments to road signage where required (showing changes to traffic movements and speed limits)
- Construction of minor access roads and the provision of property access including the temporary relocation of pedestrian and cycle paths and bus stops
- Earthworks to level the construction support sites in preparation for site work and installation of site facilities
- Building construction support sites (including temporary site access), acoustic sheds and associated access decline acoustic enclosures, where required
- Demolition of existing structures which require removal to enable construction of the project.

During site establishment works at the White Bay construction support site (WHT3), some piling would be required at the immersed tube tunnel casting facility (refer to Section 6.7.2 for more information about this construction support site).

6.4 Construction of Western Harbour Tunnel

Construction of the Western Harbour Tunnel component would involve the following activities:

- Excavation of the tunnel construction access declines or shafts
- Construction of driven tunnels
- Construction of cut and cover and trough structures
- Construction of transition structures between driven tunnel and immersed tube units
- Construction of immersed tube tunnel units
- Dredging to form trench for installation of immersed tube tunnel units
- Installation of immersed tube tunnels for the crossing of Sydney Harbour
- Civil finishing and fitout of the tunnels, including pavement works to tie-in to surface roads in Rozelle, North Sydney and Cammeray
- Construction of operational facilities
- Testing and commissioning.

More information on each of these activities is provided in the following sections.

6.4.1 Excavation of tunnel construction accesses

To enable construction of the driven tunnels, construction accesses need to be created from construction support sites to the mainline tunnel alignment. Tunnel construction access can be via an access shaft or an access decline.

Access shaft

A vertical access shaft would be required at the Yurulbin Point construction support site (WHT4), and would be constructed within a purpose-built acoustic shed. Excavation of the shaft would be carried out by excavators and rock hammers, with spoil removed using excavators and cranes. The top of the shaft would be supported with piles driven down to rock level. A gantry crane is typically installed over the shaft to deliver and remove plant, equipment and spoil from the tunnel. Temporary tunnel ventilation and services such as compressed air, potable water and drainage return lines would also be installed through the shaft. The permanent structure of the shaft would be backfilled at the completion of construction. A typical tunnel access shaft is shown in Figure 6-2.

Figure 6-2 Typical tunnel access shaft (Bexley Road New M5, 2017)

An acoustic shed is an enclosed noise mitigation structure constructed over access declines or shafts that access the tunnel for construction. Any noisy works required to support out of hours tunnelling, including spoil handling, would take place within the acoustic shed, reducing impacts on nearby receivers. Acoustic sheds would be designed with consideration of the activities that would occur within them and the noise management levels applicable at nearby receivers. They would also be designed to accommodate stockpiled tunnel spoil within the shed to prevent haulage during non-standard hours. An example of an acoustic shed is shown in Figure 6-3.

Figure 6-3 Example from within an acoustic shed constructed for the New M4 Tunnels

Excavated access decline

Excavated access declines would be required at the Victoria Road (WHT2), Berrys Bay (WHT7) and Cammeray Golf Course (WHT10) construction support sites and would be constructed within purpose-built acoustic sheds.

The access decline provides access for workers, equipment, material supply, and spoil removal, and would be big enough for construction vehicles, including roadheaders, concrete trucks, spoil removal trucks and other equipment to drive in and out of the tunnel. The temporary tunnel ventilation and services such as compressed air, potable water and drainage return lines would also be installed through the decline.

The decline would typically be sized to allow for two-way vehicular traffic and a separated walkway for construction workers. An example of an access decline is shown in Figure 6-4.

The access declines at Berrys Bay construction support site (WHT7) and Victoria Road construction support site (WHT2) would be backfilled at the completion of construction. The access decline at Cammeray Golf Course construction support site (WHT10) would be used for permanent ventilation tunnels connecting to the motorway facilities at the Warringah Freeway.

Figure 6-4 Example tunnel access decline (Arncliffe, 2017)

6.4.2 Construction of driven tunnels

The project would involve the construction of two mainline tunnels, as well as on and off ramps, cross passages and ventilation tunnels. The majority of this tunnelling work is expected to be carried out in Hawkesbury sandstone using electrically powered machines known as roadheaders.

A roadheader is an excavation machine that has a rotating, rock-cutting head on the front, mounted to a boom. When the underground rock is cut using a roadheader, a loading device typically transfers the rock onto a conveyor belt which runs the spoil onto haulage trucks. An example of a roadheader working underground to construct the New M4 tunnels is shown in Figure 6-5.

Ground support for tunnels excavated using roadheaders would typically consist of cement grouted rock anchors and/or rock bolts and shotcreting as shown in Figure 6-6. In areas which require control of higher levels of groundwater ingress, the permanent tunnel lining would include a thicker reinforced concrete lining and waterproofing membrane. Ground support would be installed progressively following tunnel excavation.

In addition to the mainline tunnels and on and off ramp tunnels, pedestrian cross passages would be excavated between the mainline tunnels at intervals to facilitate emergency egress. These cross passages would be excavated using small roadheaders or controlled blasting.

Figure 6-5 Example of a roadheader in the New M4 tunnels loading tunnel spoil into a spoil haulage truck

Figure 6-6 Example of tunnel shotcreting

It is anticipated that tunnel excavation would be carried out using a number of roadheaders, supported from multiple sites, including:

- Victoria Road (WHT2)
- Yurulbin Point (WHT4)
- Berrys Bay (WHT7)
- Cammeray Golf Course (WHT10).

Each of these construction support sites would require additional surface infrastructure to support tunnel construction, such as acoustic sheds, air intake facilities, power and water supply and wastewater treatment plants.

Temporary construction wastewater treatment plants would be designed to treat wastewater generated from tunnel construction activities and groundwater inflow (refer to Chapter 17 (Hydrodynamics and water quality) for more detail).

Rock hammering (see Figure 6-7) may be used in some areas for excavation of the mainline tunnels, cross passages and areas of sandstone within the cut and cover structures.

(Source: Transport for NSW (2016))

Figure 6-7 Example of rock hammering

Controlled underground blasting may also be used to improve the efficiency of excavation activities and shorten the overall excavation program. Areas likely to require controlled blasting would be confirmed during detailed construction planning.

6.4.3 Construction of cut and cover and trough structures

Cut and cover tunnels would typically be constructed at locations where the tunnel alignment connects to and from the surface and does not have enough rock cover for construction using roadheaders. Cut and cover is a tunnel excavation methodology that generally involves excavating downwards from the surface of the ground, and installing a tunnel structure including a base, walls and a roof. Once the roof is in place, the structure is generally covered over with soil and revegetated. These structures can also be constructed by installing the walls and roof and subsequently excavating out the material below from underneath the roof.

Cut and cover structures typically transition to open trough structures which connect to and from the surface (see Figure 6-8). Construction of trough structures is similar to cut and cover, except a cover is not installed (see Figure 6-9).

Figure 6-8 New M4 tunnel cut and cover structures

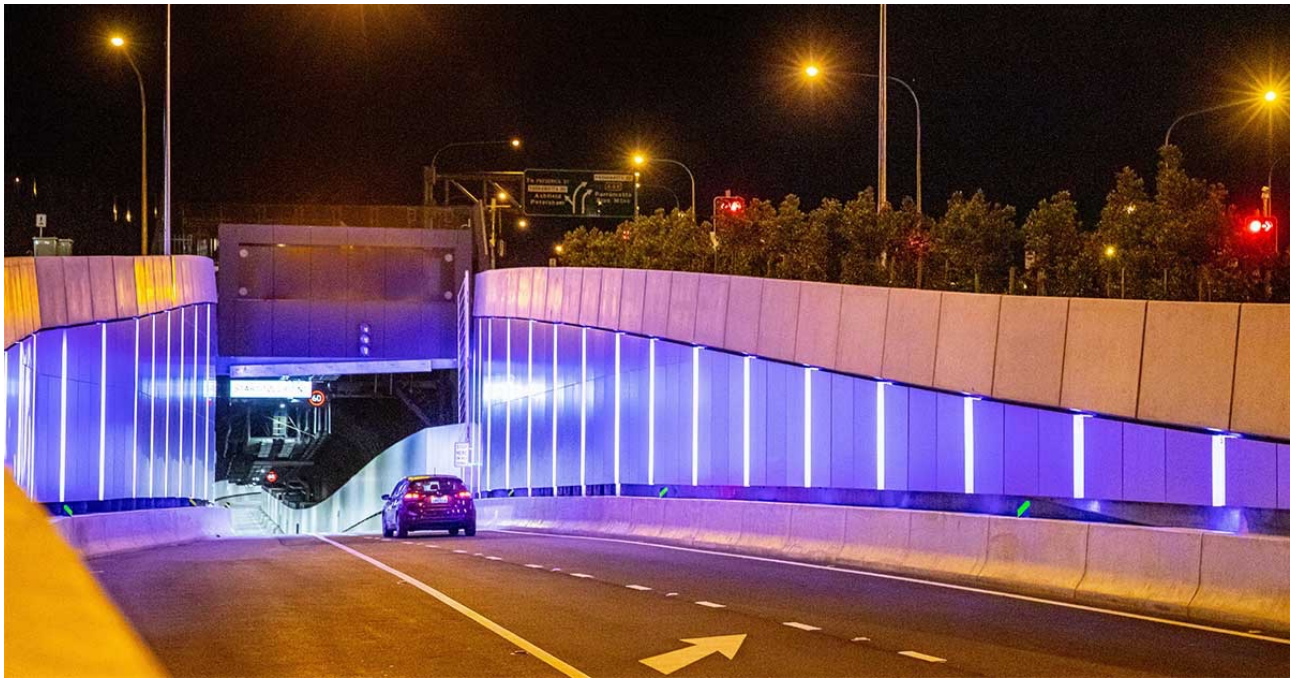


Figure 6-9 Trough structure for New M4 tunnel ramp at Haberfield

Cut and cover tunnels and trough structures are anticipated to be constructed at the following locations:

- Where the Western Harbour Tunnel connects to the Warringah Freeway, to the north of the Ernest Street overbridge
- The Western Harbour Tunnel off ramp to Falcon Street, beneath the south-eastern corner of St Leonards Park
- The on ramp to the Western Harbour Tunnel from the Berry Street ramp to the Warringah Freeway, North Sydney
- The Warringah Freeway to Beaches Link ramp, near the Ernest Street overbridge
- The Beaches Link to Warringah Freeway ramp, near the Ernest Street overbridge.

The Warringah Freeway Upgrade component of the project would provide the structural works for the cut and cover and trough structures for the Western Harbour Tunnel and Beaches Link ramps to and from the Warringah Freeway. The structural works would largely comprise the construction of the 'roof' and supporting piles for these structures. These works would be completed as part of the Warringah Freeway Upgrade component of the project to allow maximum utilisation of the road corridor to minimise disruption. The excavation of these structures would then be completed as part of the Western Harbour Tunnel tunnelling works.

The Western Harbour Tunnel component of the project would include the excavation and fitout (including pavement works to tie-in to the Warringah Freeway Upgrade) for the Western Harbour Tunnel on and off ramps to the Warringah Freeway. The Beaches Link and Gore Hill Freeway Connection project, which is subject to separate assessment and approval, would include the excavation and fitout (including pavement works to tie-in to the Warringah Freeway Upgrade) of the on and off ramps between the Beaches Link mainline tunnels and the Warringah Freeway.

6.4.4 Construction process for immersed tube tunnels

An overview of the construction process for the immersed tube tunnel crossing of Sydney Harbour is shown in Figure 6-10 and Figure 6-11.

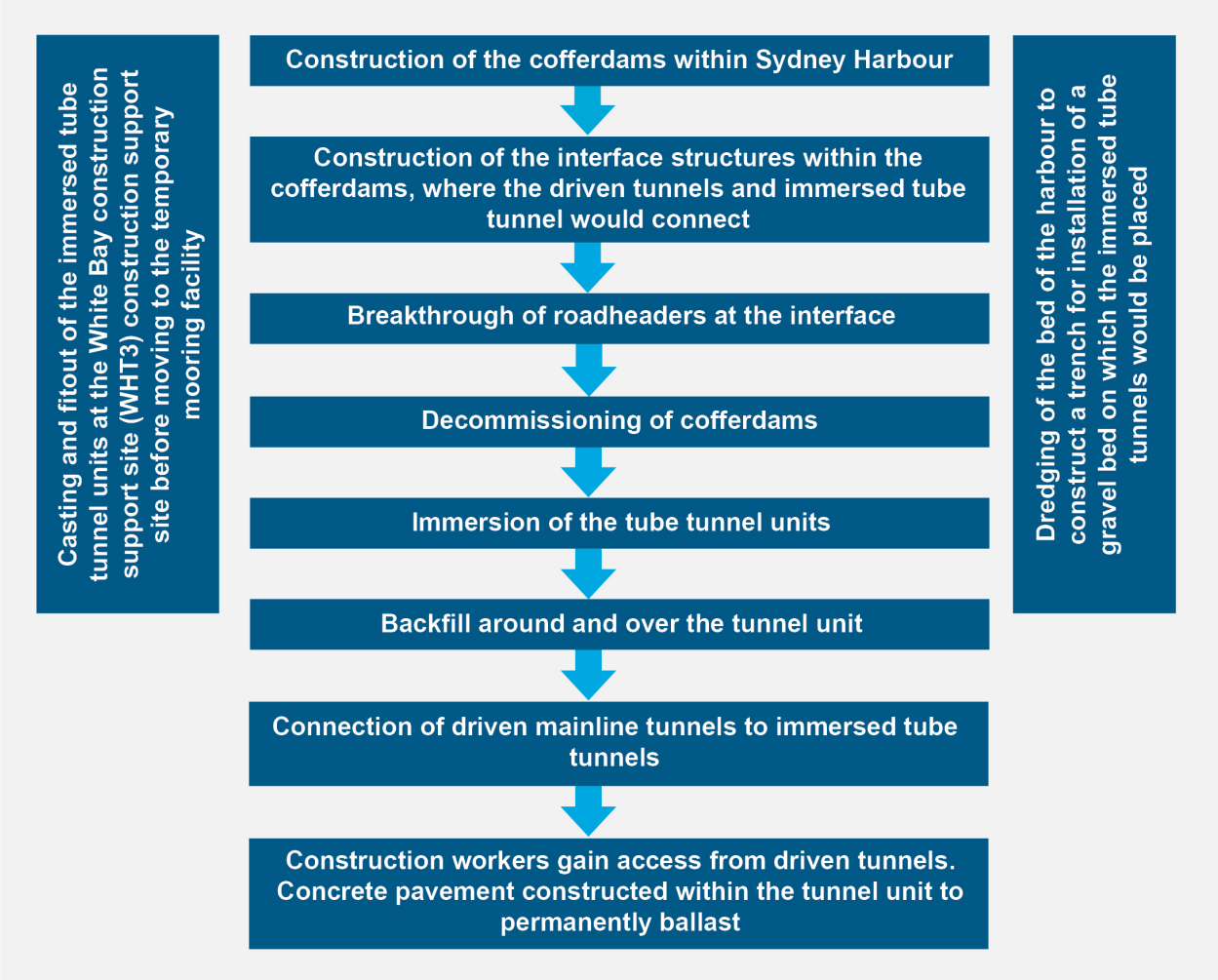
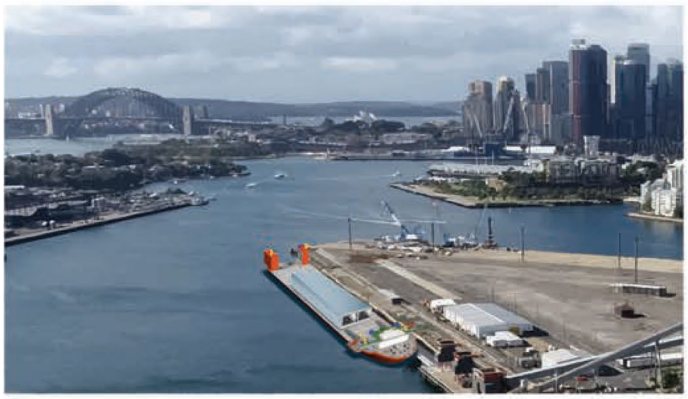
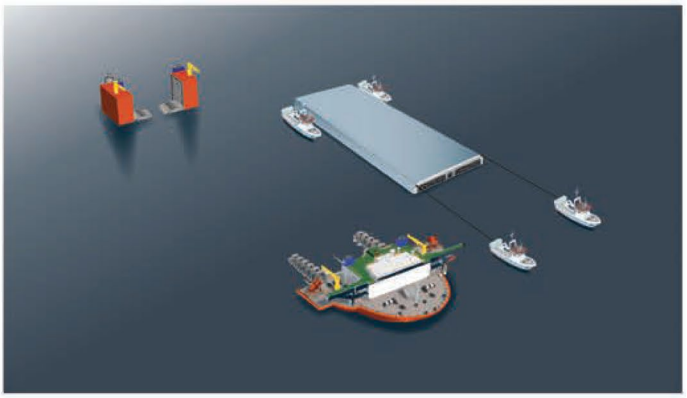


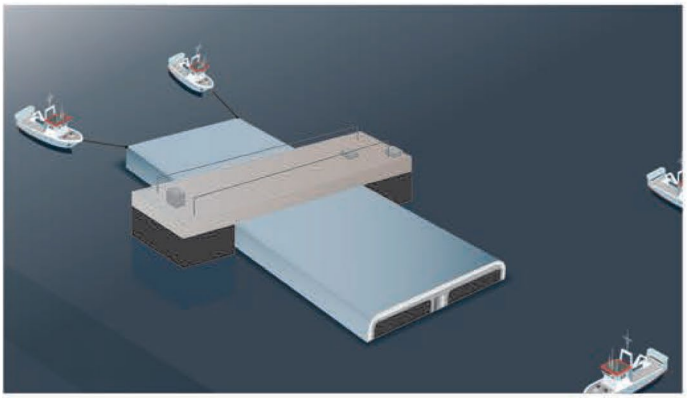
Figure 6-10 Indicative construction process for the immersed tube tunnels



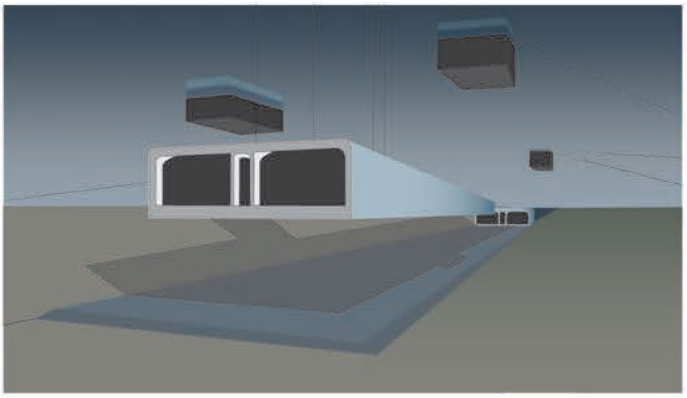
Construction and fitout of immersed tube tunnel units at White Bay



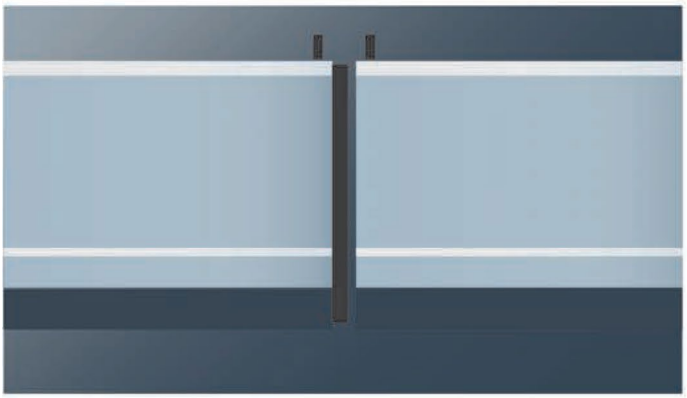
Tunnel unit floated in deep water in preparation for installation



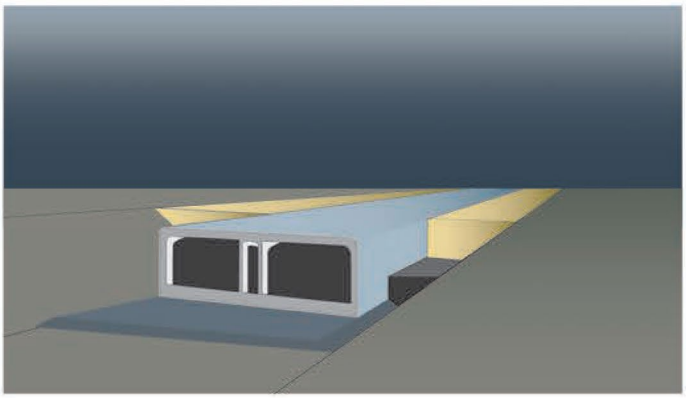
Tunnel unit transported to site by tug boats



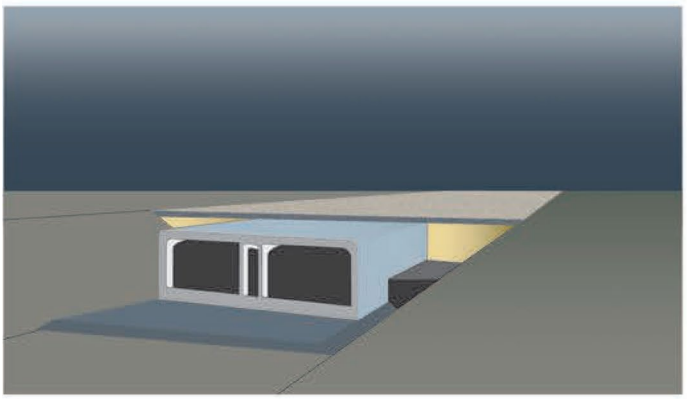
Immersion of tunnel unit



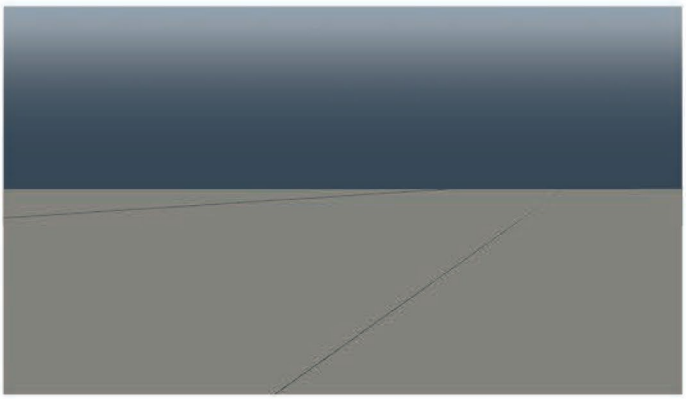
Water tight seal between tunnel units



Backfilling of trench



Rock armour placement over unit



Seabed restored following completion of immersed tube tunnel

Figure 6-11 Indicative construction sequence for the immersed tube tunnels

Cofferdam construction

A cofferdam is a temporary enclosure within a body of water that is constructed to allow dewatering of an enclosed area. The purpose of the cofferdams is to create a dry environment to allow the construction of the interface structures at each end of the Sydney Harbour crossing which would connect the driven tunnel and the immersed tube tunnel.

Two temporary cofferdams would be constructed to facilitate the connection of the immersed tube tunnel to the driven tunnels at Birchgrove and Waverton. The cofferdams would be about 50 metres wide and 25 metres long. The location and indicative layout of the Sydney Harbour cofferdams are shown on Figure 6-30. These cofferdams would be supported (with labour, plant, materials) from the construction support sites at White Bay (WHT3), Yurulbin Point (WHT4) and Berrys Bay (WHT7).

The method for the construction of the cofferdams within Sydney Harbour is summarised below:

- Ground treatment – before the construction of the cofferdam can occur, the upper layer of the bed of the harbour would be injected with a permanent grouting material to improve its strength and make water-tight. Ground treatment would be carried out by drilling holes into the bed of the harbour. These holes would then be injected with grout by a grouting machine located on a flat top barge. An example of a flat top barge is shown in Figure 6-12
- Piling – the cofferdam structure would be made up of a series of interlocking, tubular piles. Each pile would be driven into the underlying sandstone within the areas that were subject to ground treatment. Piling would take place from a flat top barge (or similar barge) using a crane fitted with a hydraulic vibrating hammer, offshore pile driving hammer and/or a similar piece of construction equipment
- Dewatering and installation of structural support – once all piles have been installed, the water level within the cofferdam would be progressively lowered (dewatered). Structural steel supports would be installed within the cofferdams from a flat top barge so the cofferdams remain structurally sound.

Figure 6-12 Example of a flat top work barge and cofferdam

Construction of the interface structures within the cofferdams

The immersed tube tunnels would be connected to the mainline driven tunnels by an interface structure, which would be built within the cofferdams. The interface structure is essentially a structural adaptor between the driven tunnel cross section and the rectangular immersed tube tunnel cross section. Construction of the interface structures within the cofferdams would require excavation of rock from within the cofferdam.

Excavation works within the cofferdams would be carried out using excavators, fitted with hydraulic hammers that would be lowered into the cofferdam to fracture the rock. The rock would be placed into bins within the cofferdam, and lifted out by a crane, which would be located on the cofferdam work platform. An application for offshore disposal of dredged material has been submitted to the Commonwealth Department of the Environment and Energy. It is proposed that suitable dredged material would be placed in a hopper barge and transported to the designated offshore disposal site (refer to Chapter 24 (Resource use and waste management) for further information). Any material not suitable for offshore disposal would be transferred by barge to the White Bay construction support site (WHT3).

Construction of the interface structure would be supported by work barges that would be moored at the cofferdams for the duration of construction works (refer to Section 6.7.2). A ferry barge would be used to transport the construction materials, plant and workforce from the White Bay construction support site (WHT3) for the construction of the interface structure.

The construction sequence of the interface structure is provided in Figure 6-13.

Decommissioning of cofferdams

Following completion of the interface structures the cofferdams would then be filled with water pumped in from Sydney Harbour. As the cofferdams are filled with water, the structural support within the cofferdams would be removed. Once the water levels inside the cofferdams match the water level outside, the tubular piles would be removed, and the marine environment rehabilitated, where required. Where the tubular piles remain fixed in the bed of the harbour they would be cut off at the harbour bed level and the marine environment rehabilitated where required.

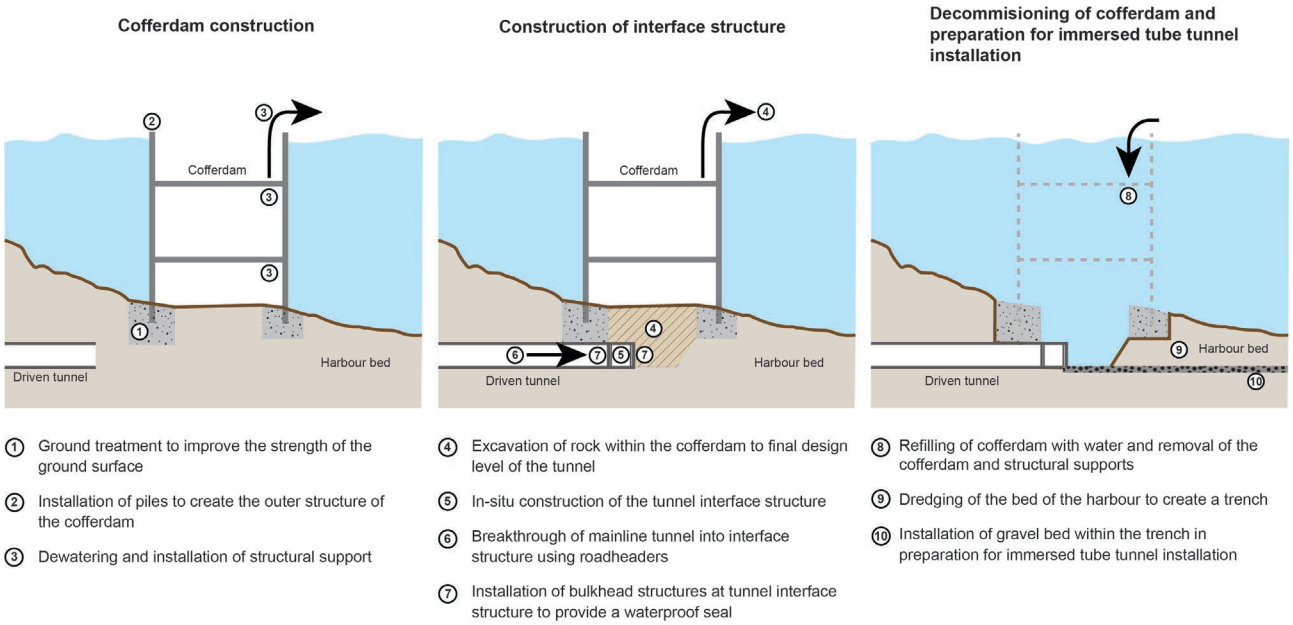


Figure 6-13 Indicative process for constructing the tunnel interface structures

Dredging

The construction of the immersed tube tunnels would require dredging of the bed of the harbour to create a trench for the installation of the immersed tube tunnel. The tunnel trench would be designed to provide a solid foundation for placement of the immersed tube tunnel units.

Dredging is a relatively common activity within New South Wales ports and coastal waters for capital and maintenance projects, with specialised contractors and equipment designed to meet project and environmental requirements in a variety of conditions. The method of dredging would depend on the material being dredged and would be carried out for the project using a combination of methods (refer to Table 6-4).

During dredging works, floating silt curtains would be used to minimise impacts on the surrounding marine environment. Dredging operations would be carried out within a floating silt curtain enclosure to a depth of two to three metres. An additional shallow silt curtain would also be installed adjacent to ecologically sensitive areas to provide additional protection.

Table 6-4 Dredging methods for installation of the immersed tube tunnels

Type of material to be dredged	Type of dredge to be used	Description
Soft sediments not suitable for offshore disposal (anticipated to be the top 1.5 metres of the bed of the harbour, subject to	Backhoe dredge with a closed environmental clamshell	A backhoe dredge consists of a hydraulic excavator that is fixed to a pontoon or work barge (refer to Figure 6-14). A closed environmental clamshell is a closed bucket which is used to avoid the spread of material into the water column (refer to Figure 6-15). This material would be loaded into hopper barges positioned next to the

Type of material to be dredged	Type of dredge to be used	Description
further testing (refer to Chapter 16, Geology, soils and groundwater))		dredge (with no overflow allowed), and transported to White Bay. This material would be made spadable through addition of a polymer or lime additive and loaded onto trucks and then disposed of at a land-based licensed facility.
Soft ground materials suitable for offshore disposal	Trailer suction hopper dredger	This type of dredge has one or two suction tubes which extend from the bottom of the dredge vessel. A pump system sucks up a mixture of sand, soil and water and discharges it into the 'hopper' or hold of the vessel. Once fully loaded, the vessel would dispose of the dredged material at the designated offshore disposal site.
Stiff ground materials suitable for offshore disposal	Backhoe dredge with clamshell or open bucket	A clamshell (or open bucket) would be used to bring stiff ground materials to the surface. This material would be loaded into hopper barges positioned next to the dredge and then disposed of at the designated offshore disposal site.
Rock layer suitable for offshore disposal	Backhoe dredge and cutter suction dredge	The underlying soft rock would be removed using a backhoe dredge with standard open bucket. A cutter suction dredge is a dredge vessel equipped with a rotating cutter head for cutting and fragmenting rock or hard materials. As material is cut using the cutter head, a backhoe dredge would be used to excavate the dredged materials and load them into a barge, which would dispose of the dredged material at the designated offshore disposal site.

Figure 6-14 Example of backhoe dredger with an open bucket working within Sydney Harbour

(Source: supplied by Royal Haskoning DHV, 2018)

Figure 6-15 Example of an excavator fitted with a closed environmental clamshell loading into a hopper barge

Construction of the immersed tube tunnel units

The immersed tube tunnel would be about 630 metres long and would consist of five individual units fabricated at the White Bay construction support site (WHT3). Refer to Figure 6-16 for an example of a completed immersed tube tunnel unit.

The immersed tube tunnel units would be fabricated on a submersible vessel moored at White Bay. Fabrication would include casting (ie concrete pouring into formwork for the units) and fitout works.

Once the casting and fitout of the immersed tube tunnel units is complete, the units would be towed by tug boats to the temporary mooring location at Snails Bay in Sydney Harbour (refer to Figure 6-21). The temporary mooring location would enable storage of the immersed tube tunnel units prior to installation.

(Source: (ITA n.d.))

Figure 6-16 Example of completed immersed tube tunnel unit for the Amsterdam Metro moored ahead of installation

Immersion of tube tunnels

The immersion of the immersed tube tunnel units would be performed using pontoons. Temporary anchors would be placed prior to the immersion process to position the tunnel units (refer to Figure 6-17).

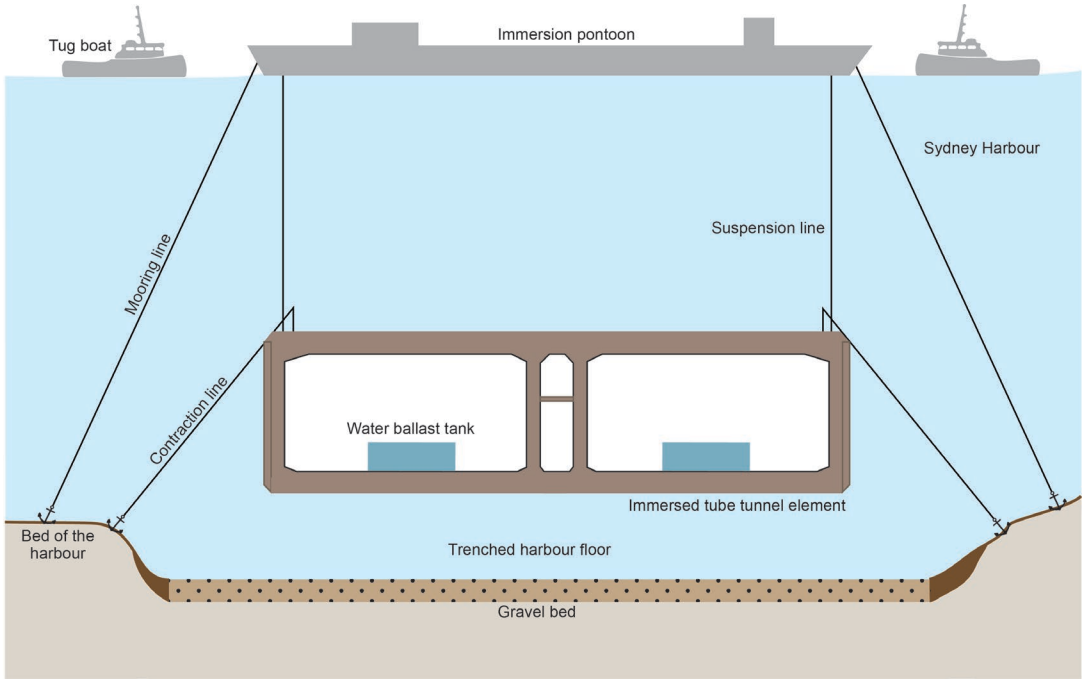


Figure 6-17 Positioning of immersed tube tunnel units in Sydney Harbour

Immersion is carried out by pumping water into temporary ballast tanks within the immersed tube tunnel unit. The water ballast tank is used to control the buoyancy (ie the amount they float) and balance of each unit. A guidance system would be installed on the pontoon deck to guide the immersed tube tunnel unit to the previous immersed unit and/or to the interface structure.

Once the immersed tube tunnel unit has been placed into its final location within the trench, locking fill would be placed around the tunnel units to provide initial stability and to prevent it from moving.

Following immersion, construction workers gain access to the immersed unit through the mainline tunnel. Concrete pavement is cast within the immersed tube tunnel unit to replace the weight provided by the temporary ballast tanks allowing them to be removed.

Backfill is installed to close the remainder of the void between the tunnel unit and the dredged trench. A rock protection layer would be installed to protect the concrete surface of the immersed tube tunnels from activities during operation, including falling or dragging anchors. The level of protection for the immersed tube tunnel units would be similar to that of the existing Sydney Harbour Tunnel. This configuration is shown schematically in Figure 6-18.

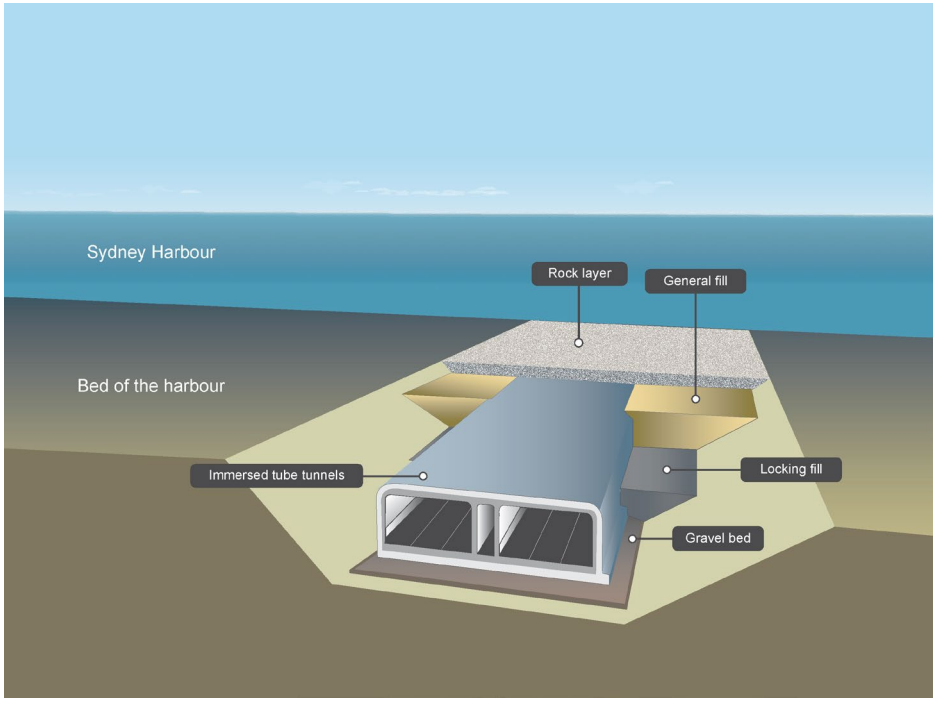


Figure 6-18 Example of an immersed tube tunnel

A typical immersion process for one immersed tube tunnel unit would take 24 to 48 hours. Partial harbour closures in the vicinity of the site would be required while each unit is immersed.

The installation sequence for the immersed tube tunnels is shown in Figure 6-19.

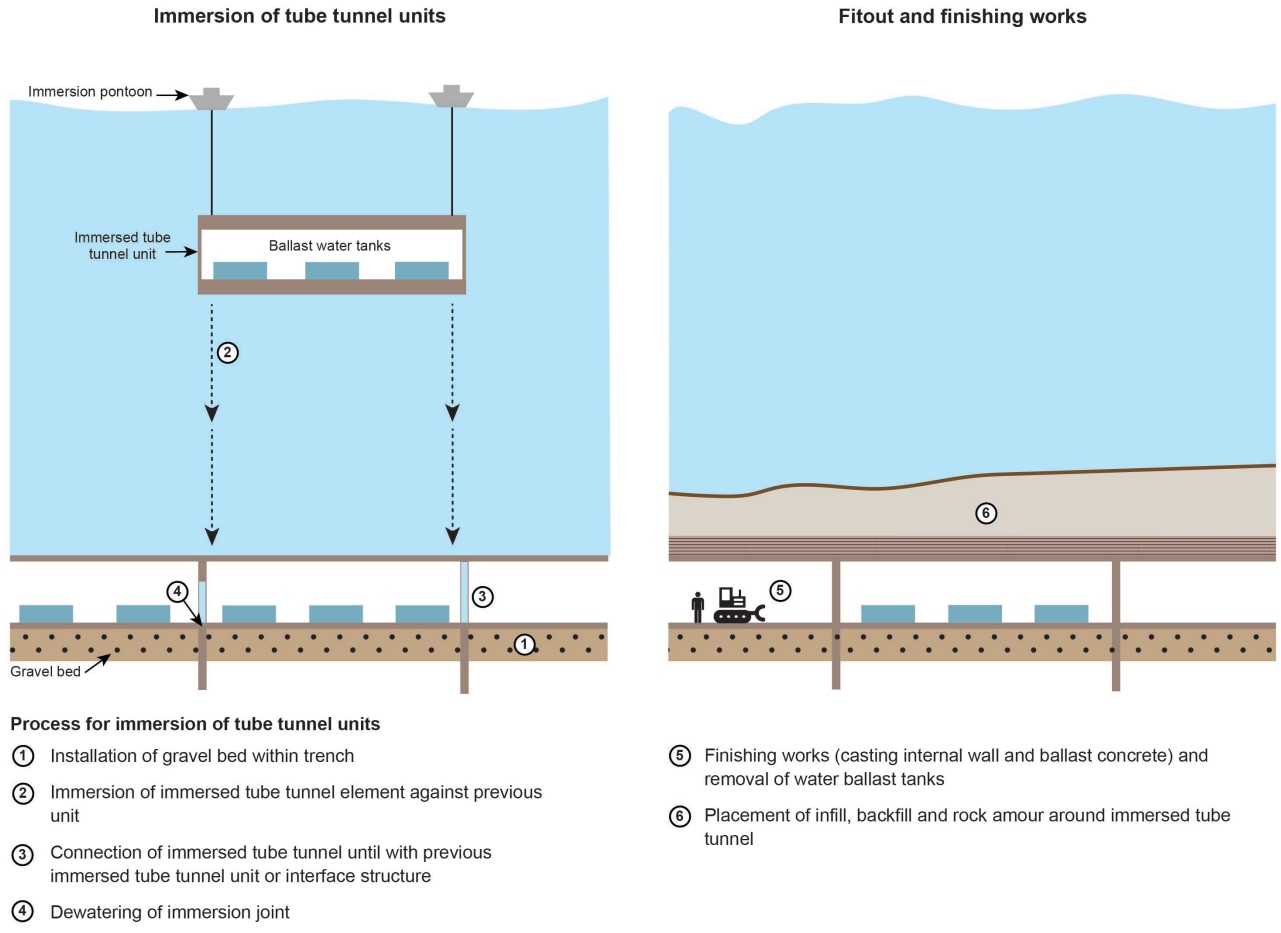


Figure 6-19 Indicative immersed tube tunnel installation sequence

6.4.5 Tunnel fitout and finishing works

On completion of the tunnelling works, a variety of fitout and finishing works would be required.

Fitout refers to the construction works that need to be carried out after excavation of the mainline tunnels. Fitout and finishing works to be completed within the mainline tunnels are described in Table 6-5.

Table 6-5 Tunnel fitout and finishing works

Construction activity	Description
Service conduits	Trenches would be constructed along the inner wall of the mainline and ramp tunnels under the shoulder of the roadway using a saw mounted on an excavator. Rock would be broken up by an excavator with a hydraulic hammer and loaded out for disposal. Conduits would then be installed within the trench and then backfilled to cover the conduits.
Roadway drainage	Trenches would be constructed in the same way as the service conduits but positioned on the low side of the road pavement where water runoff would be directed during operation. Drainage pipes would be placed within the trench and held in place, and the trench would then be backfilled with concrete.
Pavement works and asphalting	Continuously reinforced concrete pavement would be installed within the mainline tunnels and caverns.
Traffic barriers	Constructed from concrete using a specialised barrier placement machine or alternative methods where the machine is unable to access that location.
Mechanical and electrical infrastructure	This would include the installation of: • Tunnel lighting and surveillance cameras • Operations management and traffic management equipment • Toll points within the mainline tunnels • Cross passages and equipment rooms, including lighting, power, exit lights and signage • Emergency and surveillance systems • Fire systems and protection equipment • Underground pump stations • Ventilation system, jet fans and support frames • Cabling including high voltage and low voltage cables, power supply cables from substations, power and control cables from jet fans to substations and communications cables • Substation equipment.
Finishing works	Finishing works within the mainline tunnels would include: • Testing and commissioning all equipment and systems • Installation of architectural wall panels above the concrete traffic barriers • Painting of all other sections of the mainline tunnels and ramps not covered by a traffic barrier or wall panel with black paint • Linemarking.

6.4.6 Construction of operational facilities and ancillary infrastructure

Permanent operational infrastructure would be required for the ongoing management and operation of the project. Operational infrastructure would be mainly located near the surface connections at Rozelle, Cammeray and Artarmon. The typical construction method for operational facilities and ancillary infrastructure is summarised in Table 6-6.

Table 6-6 Construction of operational facilities and ancillary infrastructure

Operational facilities	Construction method
Tunnel ventilation systems	Construction of the tunnel ventilation systems would involve: • Excavation and fitout of the ventilation tunnels to the mainline tunnels • Construction and fitout of the Western Harbour Tunnel motorway facilities building at the Warringah Freeway, which would include erecting precast concrete panels, block walls and an enclosed roof • Construction of ventilation outlets (including the Beaches Link and Gore Hill Freeway Connection project ventilation outlet at the Warringah Freeway) • Internal fitout of plant areas and motorway facilities, equipment installation and commissioning. The project would construct the Beaches Link and Gore Hill Freeway Connection project ventilation outlet at the Warringah Freeway. Fitout of the ventilation outlet would be carried out as part of the Beaches Link and Gore Hill Freeway Connection project, which is subject to separate assessment and approval. The construction of the ventilation outlet and motorway facilities for the project at the Rozelle Interchange is to be carried out as part of the M4-M5 Link project. The excavation of ventilation tunnels to the motorway facilities and ventilation outlet would be carried out as part of this project. The project would also be responsible for the internal fitout of the motorway facilities and ventilation outlet.
Motorway control centre	Construction of the motorway control centre at Artarmon would include: • Excavation, footing and base slab installation • Erection of concrete columns, deck and roof • Enclosure of the building • External architectural treatments • Internal fitout of control rooms, computer rooms, offices and workshop and associated staff amenities • Utilities connections including power, potable water, sewerage • Security fencing. A communication cable would be required between the Western Harbour Tunnel mainline tunnel at Cammeray and the motorway control centre at Waltham Street, Artarmon. The preferred construction method would be through the use of existing conduits within the Warringah and Gore Hill Freeway corridors. Where the use of existing conduits is not feasible, trenching within the road corridor may be required.

Operational facilities	Construction method
Tunnel support facilities	Construction of the tunnel support facilities at Cammeray would include: • Excavation, footing and base slab installation • Construction of columns and deck to the first floor • Construction of columns to support the roof • External architectural treatments • Utilities connections including power, potable water, sewerage • Internal fitout of control rooms, computer rooms, offices and workshop and associated staff amenities • Security fencing.
Wastewater treatment plant	The operational wastewater treatment plant would be constructed at the Rozelle Interchange using prefabricated components which would be assembled as follows: • Mechanical assembly of operational wastewater treatment plant components, including rising main from tunnel and discharge pipework • Complete electrical connections between the operational wastewater treatment plant components and incoming power supply • Commission the operational wastewater treatment plant • Connection of the wastewater treatment plant to the local stormwater network.
Substations	The above ground substation required for the operation of the Western Harbour Tunnel component of the project would be located at the Rozelle Interchange, and would be constructed using predominantly prefabricated components where feasible.

6.5 Surface road works

Surface road works are required to connect and integrate the new tunnels with the existing road network. The main areas of surface road works for the project include:

- Connection and integration to City West Link Road at the Rozelle Interchange
- Connections of the Western Harbour Tunnel to Falcon Street and Berry Street, North Sydney
- The Warringah Freeway Upgrade.

The construction of the surface road works would involve the following activities:

- Demolition of existing kerbs, structures and pavements
- Earthworks
- Relocation and/or protection of utilities
- New operational equipment and signage
- Bridgeworks at North Sydney and Cammeray
- Construction of noise barriers
- Construction of retaining walls

- Stormwater drainage
- Road pavement works
- Surface finishing works (eg landscaping).

Further information on these activities is provided in the following sections.

6.5.1 Earthworks

Earthworks would be required for the above ground sections of the project including:

- Upgrading local and arterial roads connecting to the Warringah Freeway Upgrade
- Widening works on the Warringah Freeway
- High Street intersection with Pacific Highway and Alfred Street North
- Site establishment works at various construction support sites, to achieve the desired level across the site.

Earthworks would include bulk excavation, excavation for new pavement or pavement widening, and placement and compaction of general fill and select fill. Excavation work would generally be carried out using excavators.

Where earthworks are required, excavated material would be loaded directly into trucks and removed from site or stockpiled for future reuse on the project.

It is expected that excavated material would consist of a combination of:

- Virgin excavated natural material
- Roadbuilding materials from within existing road corridors, such as concrete and asphalt.

Material required for filling and compaction works would typically be imported to construction support sites as this material is required to have specific engineering properties. There is the potential that tunnelling spoil may be used as fill material if it is available at the time required for surface earthworks.

Should excavated tunnel spoil be available for use in the earthworks and pavement construction of the surface roads, material would require crushing and screening in order to meet specified geotechnical parameters, including material grading. Crushing and screening activities for the project, should they occur, would be carried out within an acoustic shed located on the Cammeray Golf Course construction support site (WHT10) (refer to Section 6.7.2 for more information).

Fill material imported to site would be placed directly from trucks and would be spread with a grader and/or excavator and compacted using vibratory rollers. Watercarts would be used to add moisture during compaction and control the generation of dust.

6.5.2 Bridgeworks

Bridgeworks required for the project include:

- New, modified and widened road bridges at:
  - High Street in North Sydney
  - Mount Street in North Sydney
  - Falcon Street in North Sydney
  - Ernest Street in Cammeray
- New underpasses beneath Mount Street in North Sydney and Ernest Street in Cammeray
- New overpass bridges at:
  - Alfred Street North connection to Mount Street and High Street in North Sydney
  - Brook Street/Miller Street on ramp to Warringah Freeway southbound in Cammeray
- Construction of new and upgraded shared user bridges at Ridge Street and Falcon Street in North Sydney, and Ernest Street in Cammeray. Demolition of existing structures at Ridge Street and Falcon Street would be required.

Typical bridge construction methods are described in Table 6-7. The construction of new bridges would require the implementation of detours or lane closures along the Warringah Freeway, typically for short-term periods (for example nights or weekends), to allow the bridgeworks to be constructed in a safe and efficient manner. The majority of demolition works for bridge modification works would also need to be carried out at night (refer to Section 6.8.1 for more information about construction hours). Chapter 5 (Project description) provides more information on the types of new, modified and relocated bridges.

Table 6-7 Bridge construction methods

Bridgeworks	Construction method
Bridge modification and widening works (Mount Street bridge, Falcon Street bridge)	Bridge modification works would require: • Relocation of utilities as required • Existing bridge lane closures as required • Demolition of road pavement and bridge barriers down to the existing slab, at locations where bridges are to be upgraded and/or widened • Existing asphalt removed from the bridge deck • New precast sections positioned with the use of cranes and fixed to the bridge deck • Cast in-situ concrete deck over new precast section and to tie into the existing concrete deck • Asphalt applied to the bridge deck to form the roadway surface and associated linemarking carried out • Installation of any required barriers, drainage infrastructure and road furniture • Bridge lanes reopen to traffic.
Construction of new bridges, widened and replacement bridges (High Street bridge widening, Mount Street underpass, Alfred Street North overpass, Ernest	Construction of new bridges for the project would require: • Preparation works, including utilities protection and/or relocation, establishment of traffic pedestrian and cyclist diversions and installation of traffic and environmental controls • Demolition of existing structure, in stages, where bridge is being completely removed and replaced (in some cases the demolition would occur after the new bridge is substantially complete)

Bridgeworks	Construction method
Street underpass, Brook Street/Miller Street on ramp bridge, Ridge Street shared user bridge, Falcon Street shared user bridge, Ernest Street shared user bridge)	• Construction of bridge foundations and footings • Construction of bridge abutments and piers • Construction and/or installation of bridge spans • Construction of the cast in-situ reinforced concrete deck • Installation of bridge barriers and safety screens • Installation of road furniture • Finishing works, including asphalting and linemarking • Removal of detours and environmental and traffic controls • Opening/reopening of bridges.

6.5.3 Retaining walls

A number of retaining walls would be required for the project particularly for the Warringah Freeway Upgrade component.

The type of retaining wall required would depend on the location and the ground conditions and would be determined during detailed design development, and would consider the urban design principles and objectives developed for the project. The type of retaining wall could include:

- Piled retaining wall – generally used in areas where the face of the retaining wall is within an area of softer ground that has been excavated or is to be excavated
- Reinforced soil wall – used where retaining walls would be constructed in areas of fill
- L-shape retaining wall – used where retaining walls are lower in height and reinforced soil walls are not suitable for structural and/or geometric reasons
- Soil nail retaining wall – used in areas with stable ground conditions and installed to provide additional stabilisation and support other project structures, such as bridge abutments.

The method for constructing retaining walls would vary depending on the type of wall required but could include:

- Excavation
- Piling, installation of concrete footings, provision of structural support (ie rock anchors or soil nails)
- Shotcreting
- Drainage at the base or behind the retaining wall
- Installation of either pre-cast or cast in-situ panels or segments
- Backfilling of the retaining walls and architectural finishes.

6.5.4 Stormwater drainage

The project would require construction of new drainage infrastructure and alterations to existing drainage infrastructure, including:

- Construction of new pits, pipes and culverts for the surface roads
- Adjustment of existing pits to suit new road alignments on existing surface roads
- Alterations to the existing drainage infrastructure near tunnel connections to the Warringah Freeway
- Upgrade of the two existing box culverts which cross beneath the Warringah Freeway between ANZAC Park and the Cammeray Golf Course site
- Upgrade or capacity improvements of other cross drainage structures which cross underneath the Warringah Freeway
- Upgrade and capacity improvements to the drainage pipelines along the on and off ramps connecting the Warringah Freeway with the existing culvert crossing near Brook Street at Cammeray/Crows Nest.

Stormwater drainage would generally consist of precast concrete pipes or culverts which would be placed in trenches that would then be backfilled with select material that meets engineering specifications. Where pipes and culverts need to be installed under existing roadways, underboring or pipejacking may be used to avoid the need to trench across live traffic lanes, where this work cannot be feasibly carried out in stages across existing carriageways. In this instance, a trench would be excavated to one side of the roadway, and the drainage pipes installed by drilling horizontally underneath the roadway. Floodwalls would be constructed to prevent the ingress of water into the tunnels during significant storm events.

Indicative construction methods for stormwater drainage are outlined in Table 6-8.

Table 6-8 Indicative stormwater drainage construction methods

Drainage type	Construction method
Drainage pipes	• Excavation of a trench in the existing ground surface • Installation of precast concrete pipes placed in sections onto a bedding layer • Placement and compaction of select material around the pipes using hand-propelled compaction equipment, such as rammers or vibrating plates.
Installation of drainage pits and lids	• Excavation of pit location • Installation of precast concrete pits, or casting the pit in-situ • Connection of pipes into concrete pits, which would be backfilled similar to the drainage pipes • Lids and inlets would be installed onto the pits and later incorporated into the kerbs and slabs.
Construction of box culverts	• Excavation of a trench in the existing ground surface • Concrete casting of culvert base slab in-situ • Installation of precast culvert units • Backfilling, where required, using select material around the culverts and hand-propelled compaction equipment, such as rammers or vibrating plates.

Drainage type	Construction method
Installation of flood walls	• Excavation of a foundation for the floodwall • Pour concrete foundation • Form, reinforce and pour concrete floodwall in panel sections.

North Sydney Council stormwater harvesting scheme

As part of the rehabilitation works, a new, relocated storage dam within the Cammeray Golf Course would be constructed to replace the existing storage dam which forms part of the North Sydney Council stormwater harvesting scheme. The indicative location and description of the storage dam is provided in Section 5.3.9 of Chapter 5 (Project description).

6.5.5 Road pavement works

In areas where existing road pavements would be widened, pavements would be constructed to consist of similar pavement types to the existing road, and to meet Transport for NSW design standards.

Construction of areas of new surface roads would generally consist of flexible or rigid pavements. Flexible pavements generally comprise the installation of an upper asphalt base layer (including an asphalt wearing course), placed on a granular or concrete sub-base. Installation of the sub-base pavement layer would involve the placement of material using trucks, excavators and graders, and compacted by vibratory rollers. A sprayed bitumen seal would be sprayed onto this layer of material, and aggregate would then be spread and rolled on top of the sprayed bitumen to create a waterproof seal.

Asphalt would be laid on top of the aggregate. Hot asphalt material would be transported to site in trucks from an off-site batching plant. Asphalt would be unloaded into paving machines, which would spread the asphalt to the required thickness. The asphalt surface is then compacted and cooled.

Rigid pavements generally comprise a concrete base (this may also include an asphalt wearing course), placed on a granular sub-base or concrete sub-base. The base or sub-base could be constructed using concrete pavers or they could be formed, with fixed forms set at the required pavement levels. Reinforcement would also be placed if required by the design. The concrete would be poured directly from agitator trucks into the concrete paver or into the forms.

Existing road pavements would be modified to integrate with the project where required. This may require milling and resurfacing of the existing pavements to tie-in with new road surfaces. These works are often required to be carried out at night when traffic numbers are reduced to enable the required lane closures.

Shared user path and cycleway pavements would be constructed to consist of similar pavement types to the existing paths, and to meet Transport for NSW design standards.

6.5.6 Surface finishing works

Surface finishing works would be carried out towards the completion of construction and would include:

- Linemarking of new road pavement
- Installation of directional signage and other roadside furniture
- Final landscape treatments and rehabilitation works.

6.6 Testing, commissioning and demobilisation

Testing and commissioning works would be carried out towards the completion of construction to validate the correct operation and integration of tunnel systems prior to road opening.

Site clean-up and demobilisation works would be carried out once construction activities have been completed at that location. This would include:

- Site demobilisation and rehabilitation of construction support sites
- Post construction condition surveys
- Removal of construction-related signage
- Removal of construction-related environmental controls and traffic management infrastructure.

Remaining lands (also referred to as surplus lands) are those lots that would be wholly or partially occupied during construction of the project but would not be required for operational infrastructure or other operational activities. Where land is leased for construction of the project, reinstatement and rehabilitation of the site would be carried out as part of demobilisation works, in consultation with and to meet the requirements of the relevant landowner.

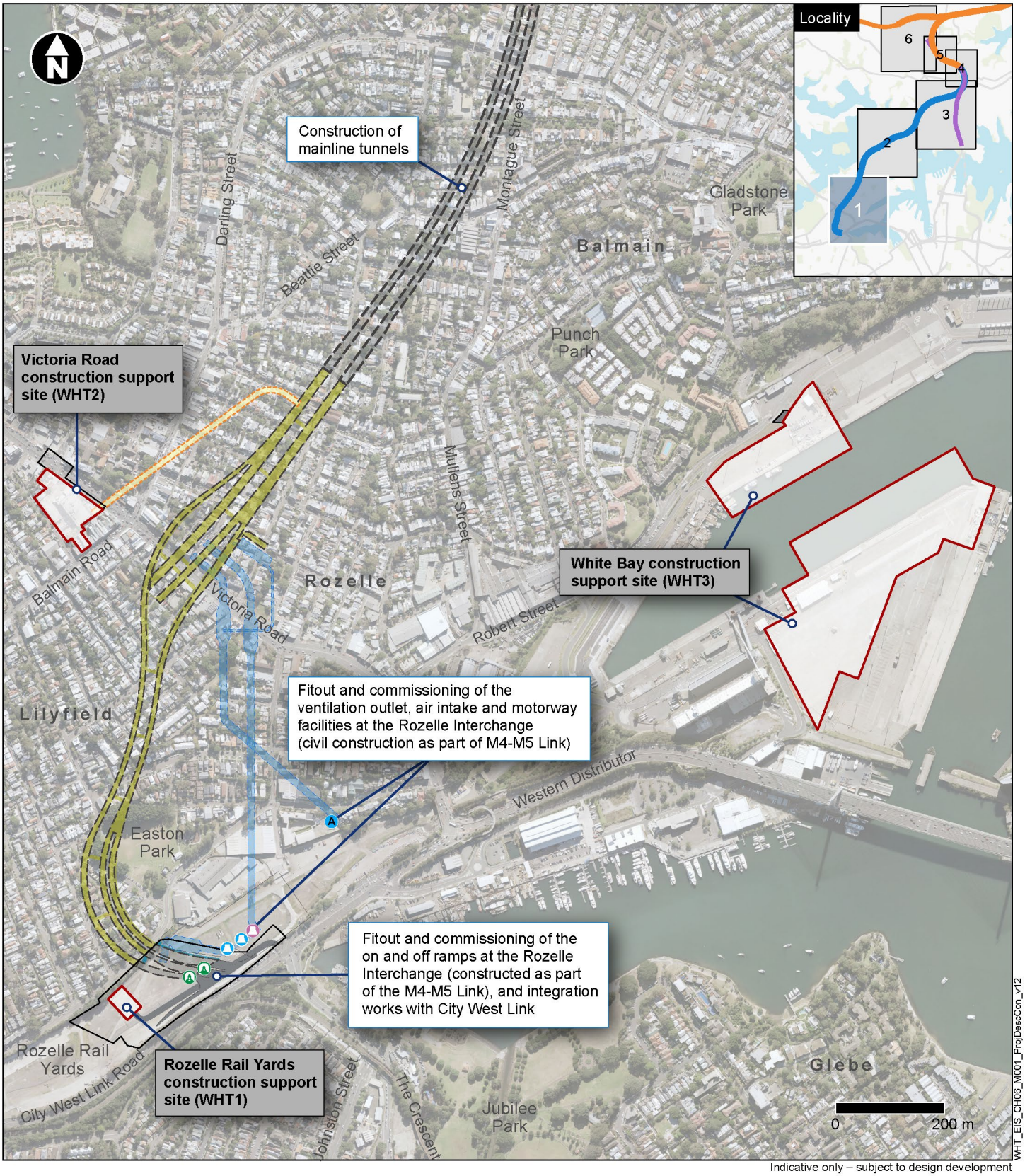
Any future development of remaining lands would be subject to separate assessment and approval in accordance with the *Environmental Planning and Assessment Act 1979*. Additional detail about remaining lands not required following construction of the project and anticipated future treatment of the land is provided in Chapter 20 (Land use and property).

6.7 Construction footprint and construction support sites

6.7.1 Construction footprint

The total area required for construction of the project is referred to as the construction footprint. The construction footprint consists of the anticipated area needed for the project and includes construction support sites and additional areas where work would be required to construct the project. Construction support sites required for the project are discussed in Section 6.7.2 and Section 6.7.3.

Most of the construction would be underground (the mainline and ramp tunnels). However, surface areas would be required to support tunnelling activities and to construct the surface connections, tunnel portals, surface road works, active transport facilities (pedestrian and cyclist facilities) and operational facilities. An overview of construction activities and the construction footprint is shown in Figure 6-20 to Figure 6-25.



Legend

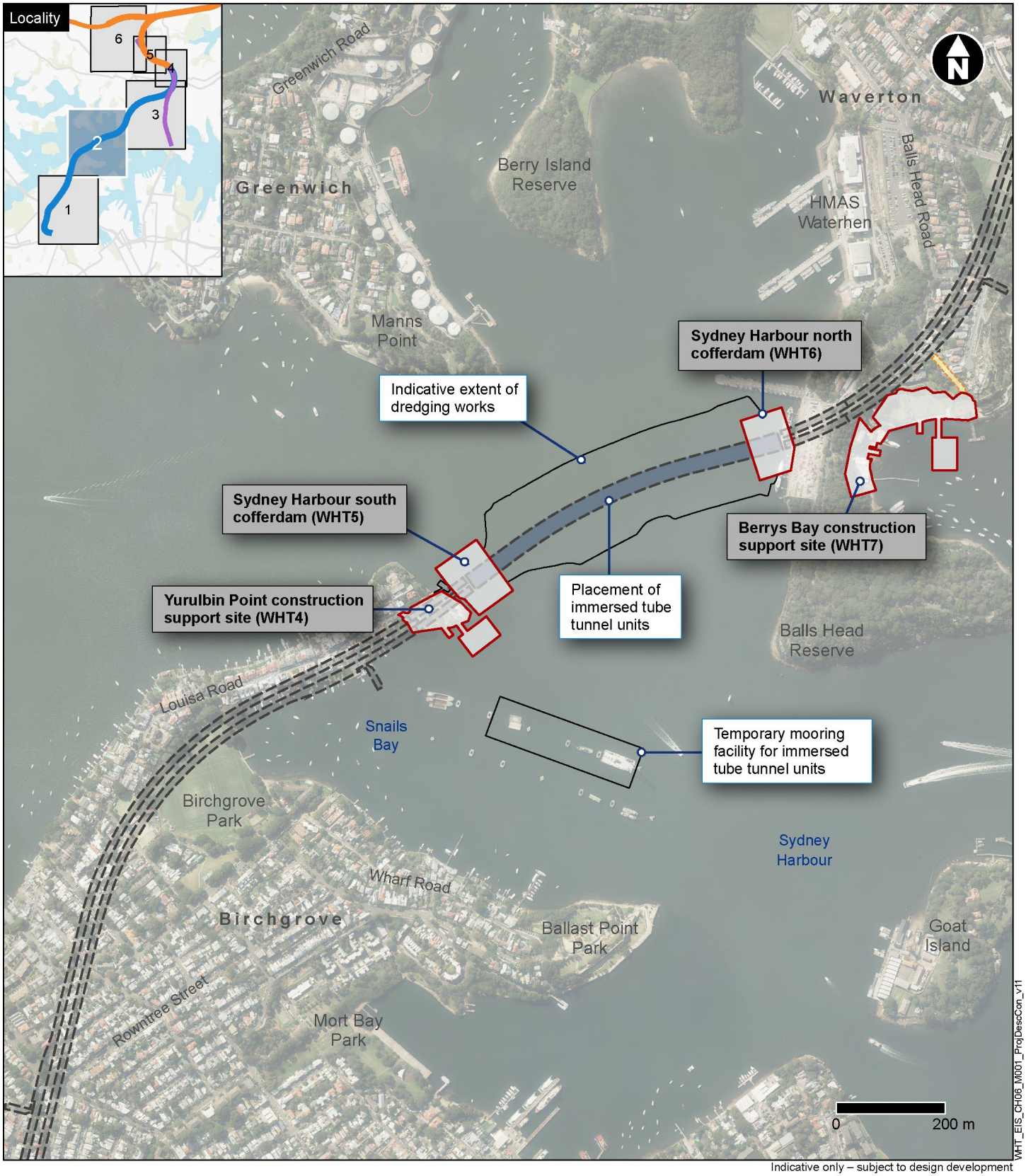
Construction
- Construction footprint
- Construction support site
- Access decline
- Ventilation tunnel

Alignment
- Surface connections
- Driven tunnel
- M4-M5 Link driven tunnel (fitout only)
- Surface works

Permanent features
- Ventilation outlet

M4-M5 Link project
- Ventilation outlet
- Air intake facility

Figure 6-20 Overview of construction activities and construction footprint (map 1)



Legend

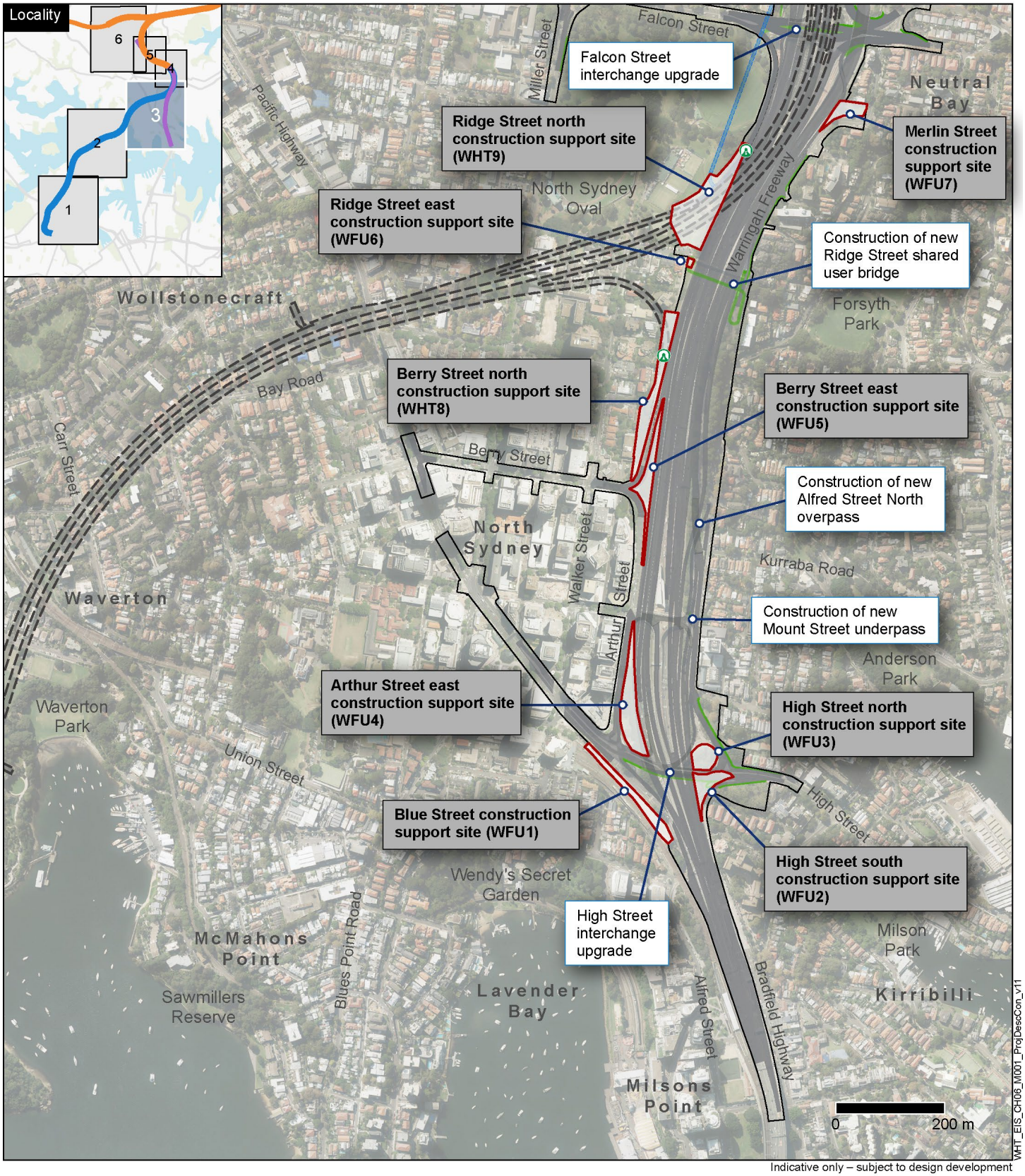
Construction

- Construction footprint
- Construction support site
- Access decline

Alignment

- Driven tunnel
- Immersed tube tunnel

Figure 6-21 Overview of construction activities and construction footprint (map 2)



Indicative only – subject to design development

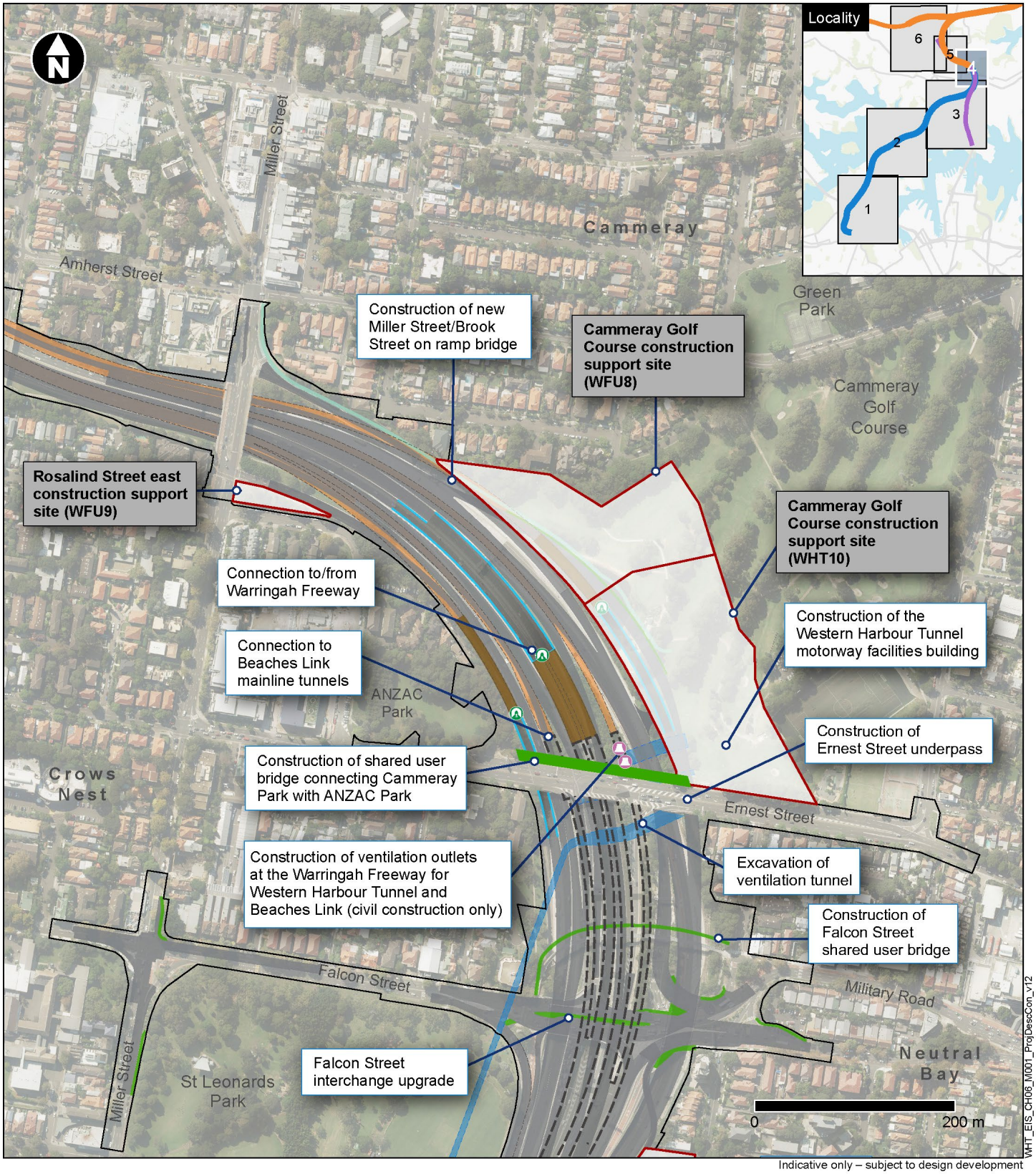
Legend

Construction
- Construction footprint
- Construction support site

Alignment
- Surface connections
- Driven tunnel
- Surface works

Permanent features
- Ventilation tunnel
- Pedestrian / shared user path

Figure 6-22 Overview of construction activities and construction footprint (map 3)



Legend

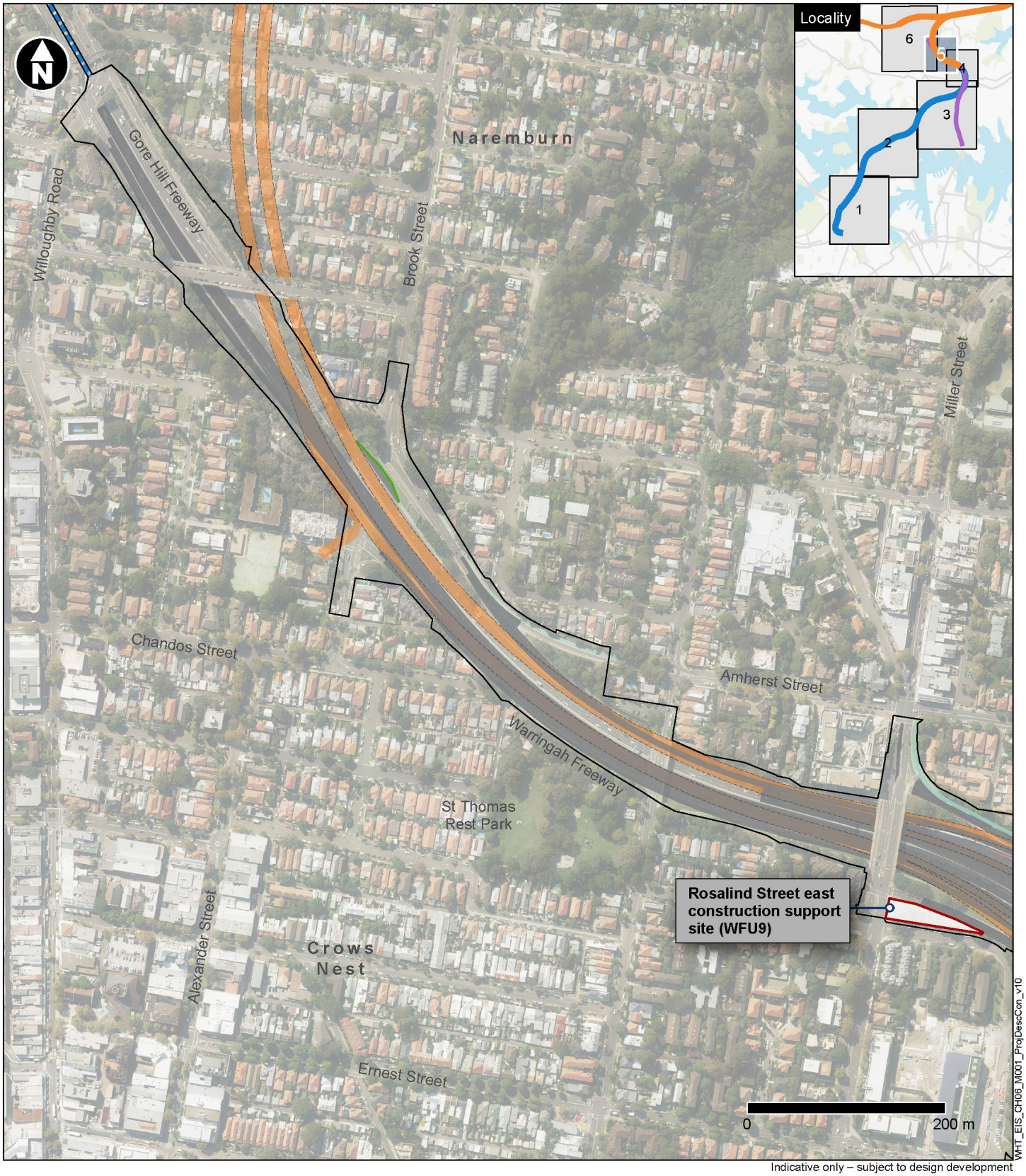
Construction
- Construction footprint
- Construction support site

Alignment
- Surface connections
- Driven tunnel
- Trough structure
- Cut and cover
- Surface works

Permanent features
- Pedestrian / shared user path
- Cycleway
- Western Harbour Tunnel ventilation tunnel
- Ventilation outlet

Connecting projects
- Beaches Link and Gore Hill Freeway Connection project

Figure 6-23 Overview of construction activities and construction footprint (map 4)



Indicative only – subject to design development

Legend

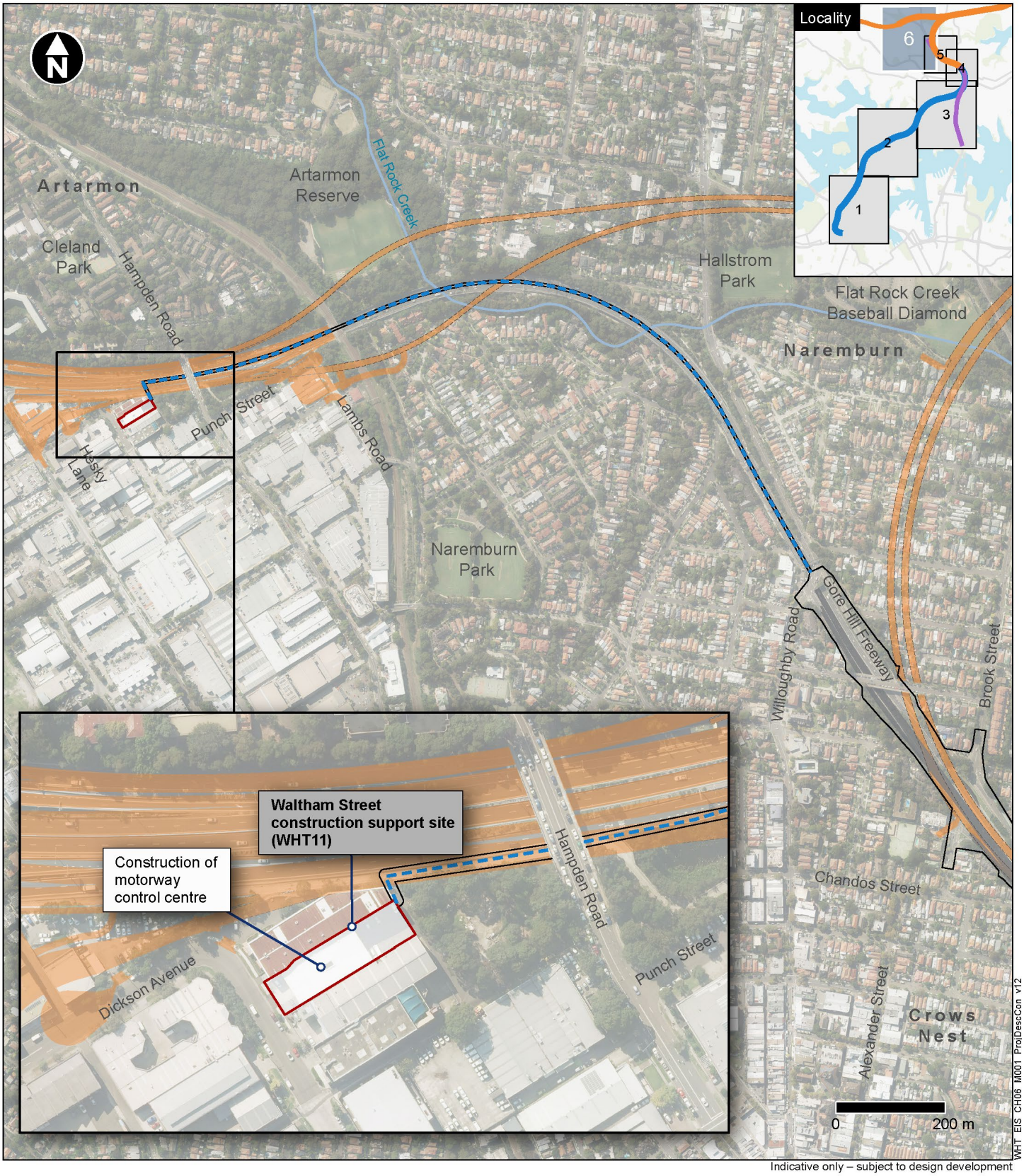
Construction
- Construction footprint
- Construction support site

Alignment
- Surface works

Permanent features
- Pedestrian / shared user path
- Cycleway
- Communications cable for motorway control centre

Connecting projects
- Beaches Link and Gore Hill Freeway Connection project

Figure 6-24 Overview of construction activities and construction footprint (map 5)



Legend

Construction
- Construction footprint
- Construction support site

Alignment
- Surface works

Permanent features
- Communications cable for motorway control centre

Connecting projects
- Beaches Link and Gore Hill Freeway Connection project

Figure 6-25 Overview of construction activities and construction footprint (map 6)

6.7.2 Western Harbour Tunnel construction support sites

Temporary construction support sites for the Western Harbour Tunnel component of the project would include tunnelling and tunnelling support sites, surface civil works sites, cofferdams, mooring sites, wharf and berthing facilities, construction storage (laydown) areas, parking and workforce amenities.

All construction support sites would have appropriate boundary fencing. This would be typical construction hoarding or security fencing. Where required, temporary noise barriers would be installed on the site boundary (where this is proposed it is shown on the construction support site figures).

To support operation of the sites, high voltage power, potable water supply and a suitable connection for water discharge would be required (refer to Section 6.8.4).

Construction hours at construction support sites would vary depending on the type of construction activity being carried out. Proposed hours for each construction support site are outlined below and construction work hours associated with specific activities are detailed in Section 6.8.1.

The following sections describe the proposed Western Harbour Tunnel construction support sites and their anticipated functions during construction. Construction support sites required for the Warringah Freeway Upgrade component are discussed in Section 6.7.3.

Rozelle Rail Yards (WHT1)

A summary of the key features of the Rozelle Rail Yards construction support site is included in Table 6-9. An indicative layout for the construction support site, and construction site access routes, is shown in Figure 6-26. An indicative program for construction activities is provided in Table 6-10.

Construction works at the Rozelle Rail Yards construction support site may overlap with construction of the approved M4-M5 Link, which uses part of the Rozelle Rail Yards. Should this occur, construction works for the project at this location would be carried out in coordination with the construction contractors of the approved M4-M5 Link to ensure all interfaces are effectively managed, including the construction and operation of M4-M5 Link operational infrastructure.

Table 6-9 Key features of the Rozelle Rail Yards construction support site (WHT1)

Key feature	Summary
Site area	1000 m^2
Site description	Located within the Rozelle Rail Yards at Rozelle, which is bound by Lilyfield Road to the north and the City West Link to the south. The western extent of the site borders a proposed ramp for the approved M4-M5 Link and vacant, cleared land located to the east. The nearest residences are located immediately north of the construction support site on the northern side of Lilyfield Road. The site is relatively flat and largely vacant. Vegetation across the site comprises a mixture of urban exotic/native species as well as weed species. The vegetation across the site is located within the area assessed for the M4-M5 Link, and vegetation would be removed under that approval prior to the construction of the project. As such, no vegetation clearance would be required at this site for the project.

Key feature	Summary
Key activities	The construction support site would support mechanical and electrical fitout of the mainline tunnels. The site would also support construction and fitout of the ventilation outlet and motorway facilities, as well as surface roads connecting the ramp tunnels to the City West Link. Key activities that would occur on, or be supported by this site would include: • Construction of operational facilities for the Western Harbour Tunnel component at the Rozelle Interchange, including a water treatment plant, as well as construction and fitout of the Western Harbour Tunnel motorway facilities at the Rozelle Interchange, including tunnels (located underground) • Fitout of the ventilation outlet and air intake facilities for the project (constructed as part of the M4-M5 Link Rozelle East Motorway Operations Complex) • Mechanical and electrical fitout of the ramp tunnels • Treatment of wastewater from construction activities • Integration works to connect the on and off ramps at the Western Harbour Tunnel component to City West Link. These integration works would involve pavement works, linemarking and road furniture adjustments.
Hours of construction	Spoil haulage would be carried out during standard construction hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays). Underground works and deliveries to the tunnel would be carried out up to 24 hours per day, seven days per week.
Access arrangements	Access in and out of the site would be via City West Link Road.

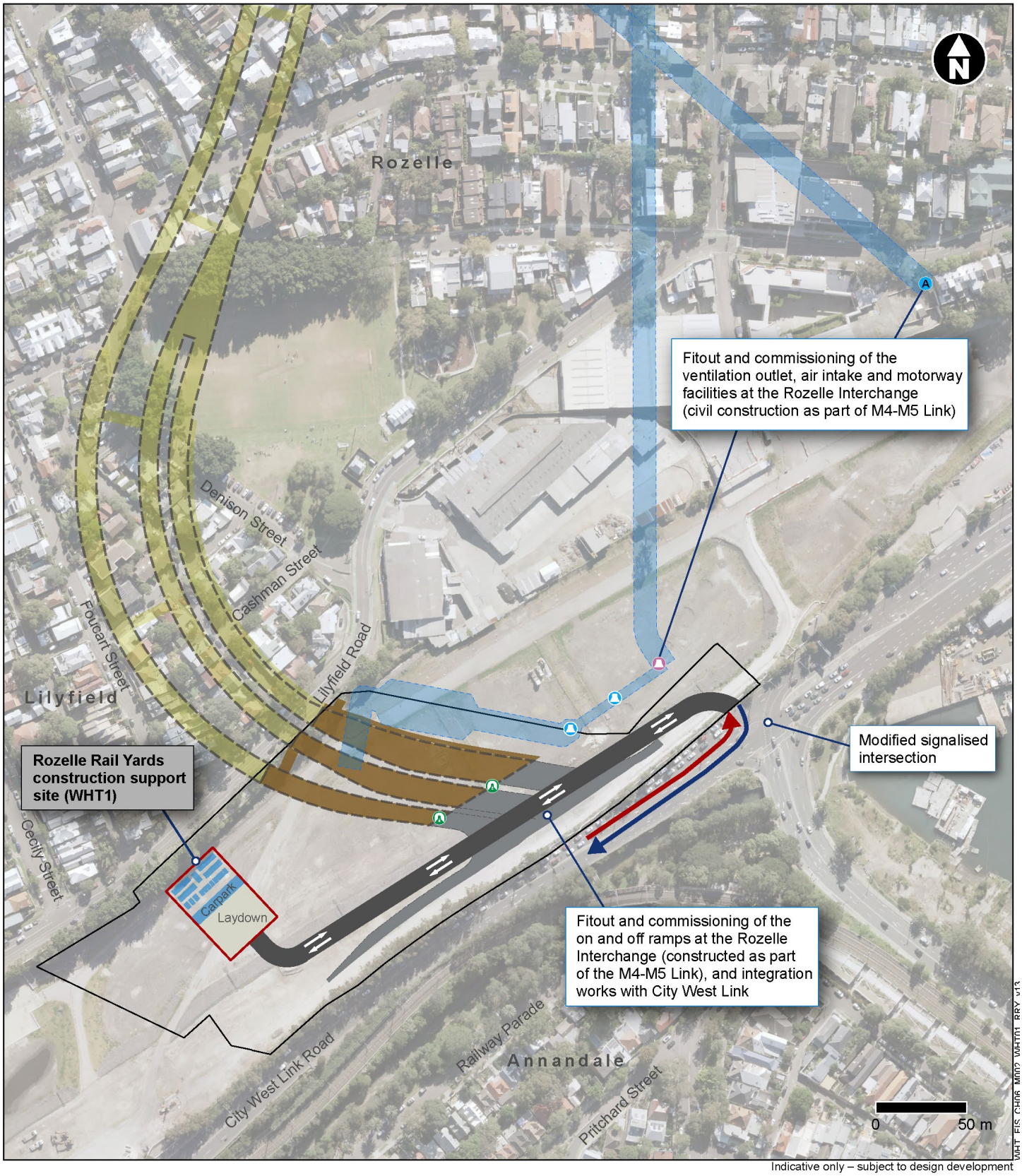


Figure 6-26 Indicative layout – Rozelle Rail Yards construction support site

Table 6-10 Rozelle Rail Yards construction support site indicative construction program

Construction activity	Indicative construction program															
	2023				2024				2025				2026			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Early works and site establishment																
Tunnel fitout and finishing																
Testing and commissioning																
Connection to the Rozelle Interchange																
Site clean-up and demobilisation																

Victoria Road (WHT2)

A summary of the key features of the Victoria Road construction support site is included in Table 6-11. An indicative layout for the construction support site and construction site access routes is shown in Figure 6-27. An indicative program for construction activities is provided in Table 6-12.

Table 6-11 Key features of the Victoria Road construction support site (WHT2)

Key feature	Summary
Site area	8500 m^2
Site description	Located within the former Balmain Leagues Club site at Rozelle, bound by Victoria Road to the north-east and Waterloo Street to the south-west. The eastern and western extents of the construction support site border a mixture of commercial properties. Residential properties are located immediately south-west of the construction support site along Waterloo Street. Rozelle Public School is located north-east of the construction support site on the north-eastern side of Victoria Road, and a number of commercial and retail premises are to the north-west and south-east of the construction support site. A number of vacant commercial premises as well as a residence currently occupy the site, which slopes downward towards the north.
Key activities	The construction support site would support excavation of the mainline tunnels. Access for plant and equipment required to excavate the tunnels would be via an access decline constructed in the south-east corner of the site. The mainline tunnels would be excavated in both directions from this site. Key activities that would occur on, or be supported by this site would include: • Demolition of existing vacant structures on the construction support site during early works and site establishment • Excavation of an access decline for tunnel construction access to connect the construction support site at the surface to the mainline tunnels • Excavation of driven mainline tunnels, including cross passages • Treatment of wastewater from tunnelling activities • Excavation, handling and stockpiling of tunnel spoil (within acoustic shed) • Tunnel civil, mechanical and electrical fitout.

Key feature	Summary
Hours of construction	Spoil haulage would be carried out during standard construction hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays). Tunnel construction and fitout would be carried out up to 24 hours per day, seven days per week either within an acoustic shed or underground. Night time deliveries would be required to support the tunnelling activities.
Access arrangements	Access in and out of the site would be via Victoria Road.

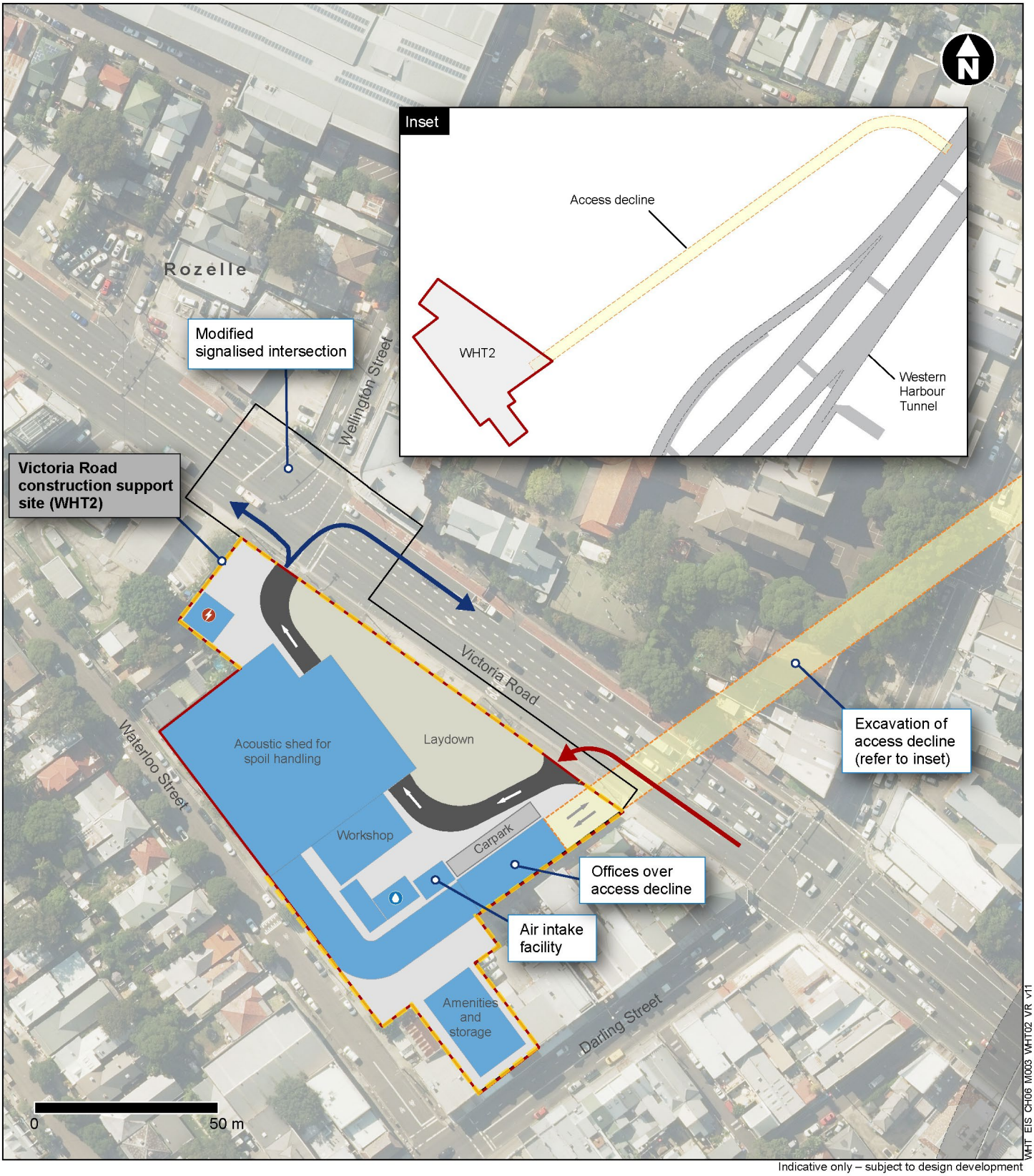


Figure 6-27 Indicative layout – Victoria Road construction support site

Table 6-12 Victoria Road construction support site indicative construction program

Construction activity	Indicative construction program																			
	2021				2022				2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Early works and site establishment																				
Construction of tunnel access decline																				
Tunnel construction																				
Tunnel fitout and finishing																				
Testing and commissioning																				
Site clean-up and demobilisation																				

White Bay (WHT3)

A summary of the key features of the White Bay construction support site is included in Table 6-13. An indicative layout for the construction support site, and construction site access routes, is shown in Figure 6-28. An indicative program for construction activities is provided in Table 6-14.

Table 6-13 Key features of the White Bay construction support site (WHT3)

Key feature	Summary
Site area	112,000 m^2
Site description	Located in White Bay at Rozelle, the site is bound by a mixture of industrial and high density residential properties to the north, Jones Bay/Johnstons Bay to the east, Rozelle Bay/Blackwattle Bay to the south and a mixture of industrial and high density residential properties to the west. The northern part of the site is next to the White Bay Cruise Terminal. The construction support site would consist of a combined land and water-based site, and would make use of the existing wharf areas to the north and south of White Bay as well as the berthing facilities. The construction support site is currently an operating port facility.
Key activities	The northern portion of White Bay would primarily support dredging activities for the construction of the immersed tube tunnels. The southern area of White Bay would be used to support the casting and fitout of the immersed tube tunnel units, and the handling and transport of spoil from the Yurulbin Point (WHT4) and Berrys Bay (WHT7) construction support sites, along with providing ancillary facilities and support to works on the southern side of the harbour, for the harbour crossing works, and the Berrys Bay site. This site would also be used to store plant and equipment until it is required at the Yurulbin Point (WHT4) and Berrys Bay (WHT7) construction support sites. Key activities that would occur on, or be supported by this site would include: • Early works and site establishment, which would include demolition of structures within the boundary of the construction support site, piling to establish a wharf structure and moorings, as part of the establishment of the casting and fitout facility and establishment of a

Key feature	Summary
	treatment area for dredged material that is not suitable for offshore disposal • Casting and fitout of the immersed tube tunnel units • Transport of immersed tube tunnel units to the mooring location at Snails Bay • Spoil handling, treatment and transport of dredged material not suitable for offshore disposal within the designated offshore disposal site • Spoil handling and transport of excavated material from tunnelling at the Yurulbin Point (WHT4) and Berrys Bay (WHT7) construction support sites • Storage and transport of major plant and equipment for the Yurulbin Point (WHT4) and Berrys Bay (WHT7) construction support sites as well as the harbour crossing works.
Hours of construction	General site activities (including casting and fitout of the immersed tube tunnel units) and spoil haulage would be carried out during standard construction hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays). Some deliveries to and from the site would be required during the evening and night time to support casting of immersed tube tunnel units and construction activities at the Yurulbin Point (WHT4) and Berrys Bay (WHT7) construction support sites.
Access arrangements	Access in and out of the northern portion of the site would be via Port Access Road and access in and out of the southern portion of the site would be via James Craig Road. Robert Street would not be used to access the construction support site.

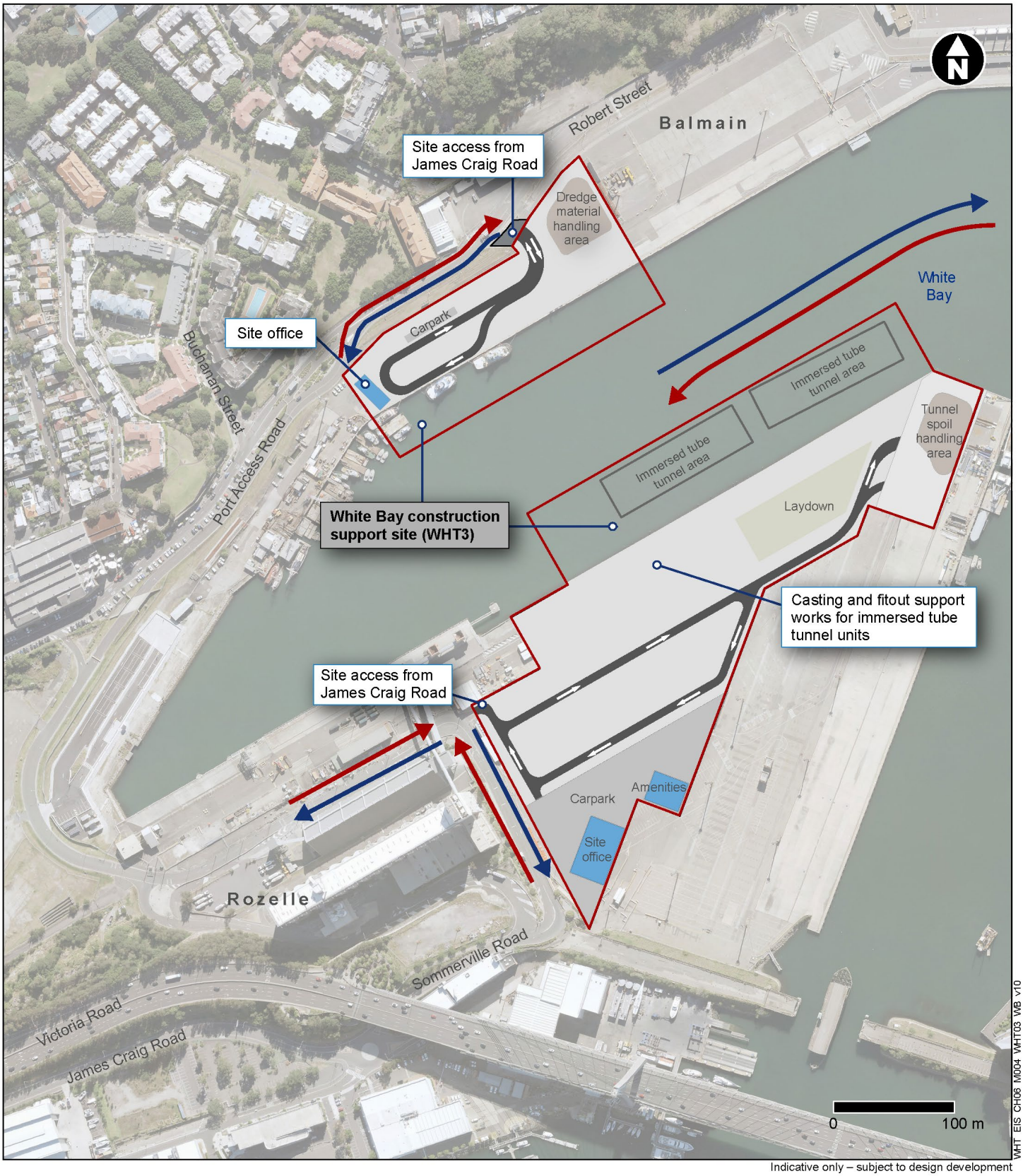


Figure 6-28 Indicative layout – White Bay construction support site

Table 6-14 White Bay construction support site indicative construction program

Construction activity	Indicative construction program																			
	2021				2022				2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Early works and site establishment																				
Casting of immersed tube tunnel units																				
Spoil handling and treatment																				
Site clean-up and demobilisation																				

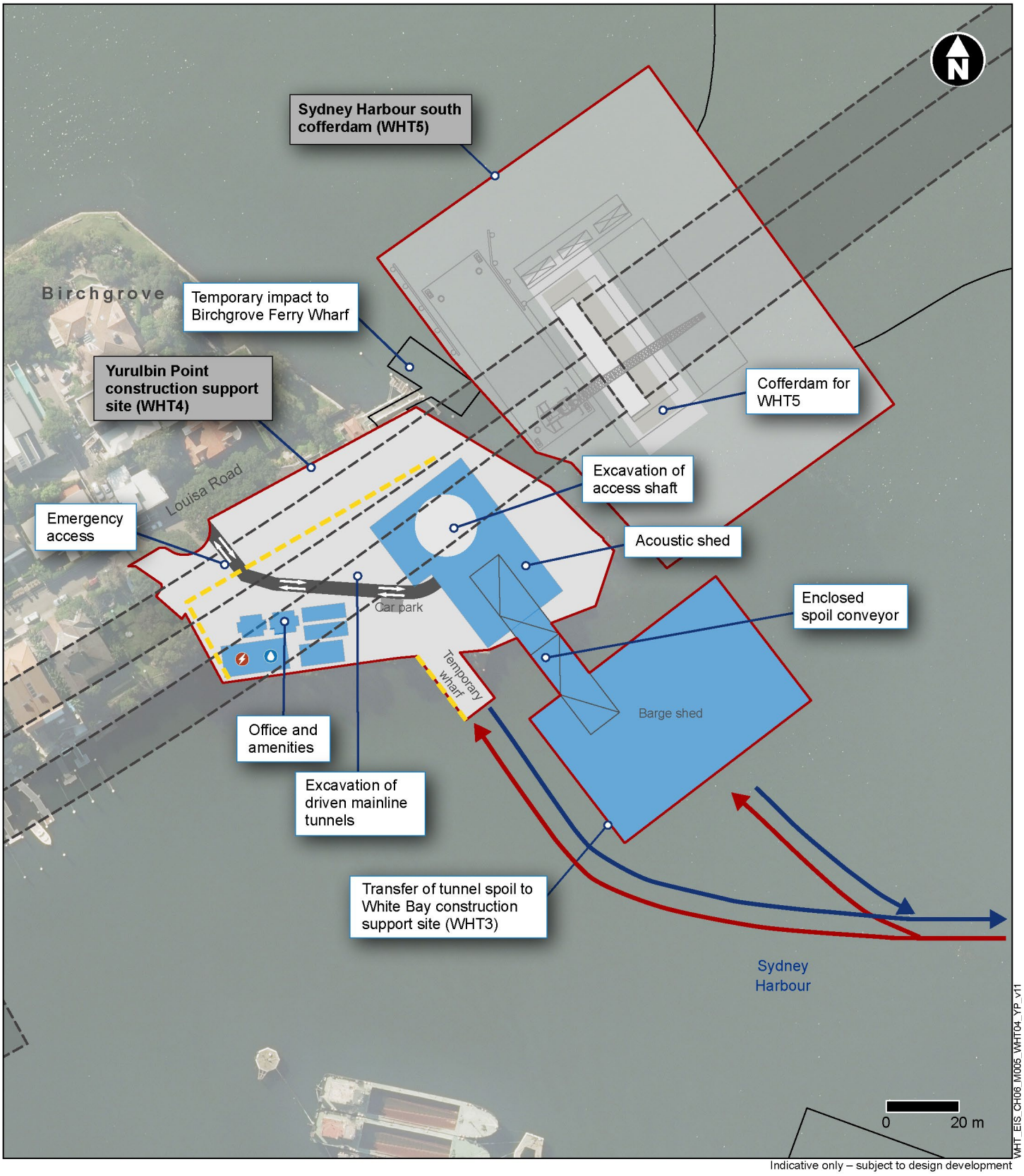
Yurulbin Point (WHT4)

A summary of the key features of the Yurulbin Point construction support site is included in Table 6-15. An indicative layout for the construction support site is shown in Figure 6-29. An indicative program for construction activities is provided in Table 6-16. Marine transport routes are shown in Figure 6-38.

Table 6-15 Key features of the Yurulbin Point construction support site (WHT4)

Key feature	Summary
Site area	9100 m^2
Site description	This site would consist of a combined land and water-based site, located at the end of Louisa Road in Yurulbin Park, Birchgrove. The site is bound by Sydney Harbour to the south and east and Yurulbin Park to the north and west. Residential properties are located north and west of the construction support site on Numa Street and Louisa Road, respectively. Areas of Yurulbin Park within the construction footprint, as well as an existing carpark would be closed during construction. This would also result in the temporary (around two years) closure of access to Birchgrove Wharf (ferry customers would be notified of alternative travel arrangements in advance of the temporary wharf closure (refer to Chapter 8 (Construction traffic and transport) for additional information).
Key activities	The construction support site would support excavation of the mainline tunnels (including for connection to the immersed tube tunnel crossing). Access for plant and equipment required to excavate the tunnels would be via an access shaft constructed on the lower portion of the site. The mainline tunnels would be excavated in both directions from this construction support site. Key activities that would occur on, or be supported by, this site would include: • Vegetation clearing and earthworks as part of early works and site establishment • Construction of temporary wharves for transport of tunnel spoil material, to avoid heavy vehicle movements on Louisa Road • Excavation of access shaft • Excavation of driven mainline tunnels, including cross passages and breakthrough into the Sydney Harbour south cofferdam for connection to

Key feature	Summary
	the immersed tube tunnel • Treatment of wastewater from tunnelling activities • Tunnel civil, mechanical and electrical fitout • Transfer of spoil from the mainline tunnels excavations to barges, for transfer to the White Bay construction support site (WHT3) • Reinstatement of the site on completion of construction. To minimise the size of this construction support site, an area at the White Bay construction support site (WHT3) would be used for the storage of plant and equipment until it is required at the Yurulbin Point construction support site (WHT4).
Hours of construction	Shaft construction, spoil haulage and major deliveries would be carried out during standard construction hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays). Spoil handling and loading of the barges within the acoustic shed on the site would be carried out outside of standard construction hours. Tunnel construction would be carried out up to 24 hours per day, seven days a week either within an acoustic shed or underground. There would be limited deliveries to site at night, via barge, to support the tunnelling works.
Access arrangements	Access to the site would be via Sydney Harbour only. Marine transport between the site and White Bay would be the primary transport mode for this site, and would be used for site establishment works, spoil haulage, material and construction equipment delivery. An access route to Louisa Road has been provided for emergency use only.



Legend

- Construction footprint
- Construction support site
- Construction site buildings
- Driven tunnel
- Temporary site access
- Wastewater treament plant
- Aboveground substation
- Indicative temporary noise barrier
- Site access - in
- Site access - out

Figure 6-29 Indicative layout – Yurulbin Point construction support site

Table 6-16 Yurulbin Point construction support site indicative construction program

Construction activity	Indicative construction program																			
	2021				2022				2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Early works and site establishment																				
Shaft construction																				
Tunnel construction																				
Tunnel fitout and finishing																				
Testing, commissioning and site rehabilitation																				

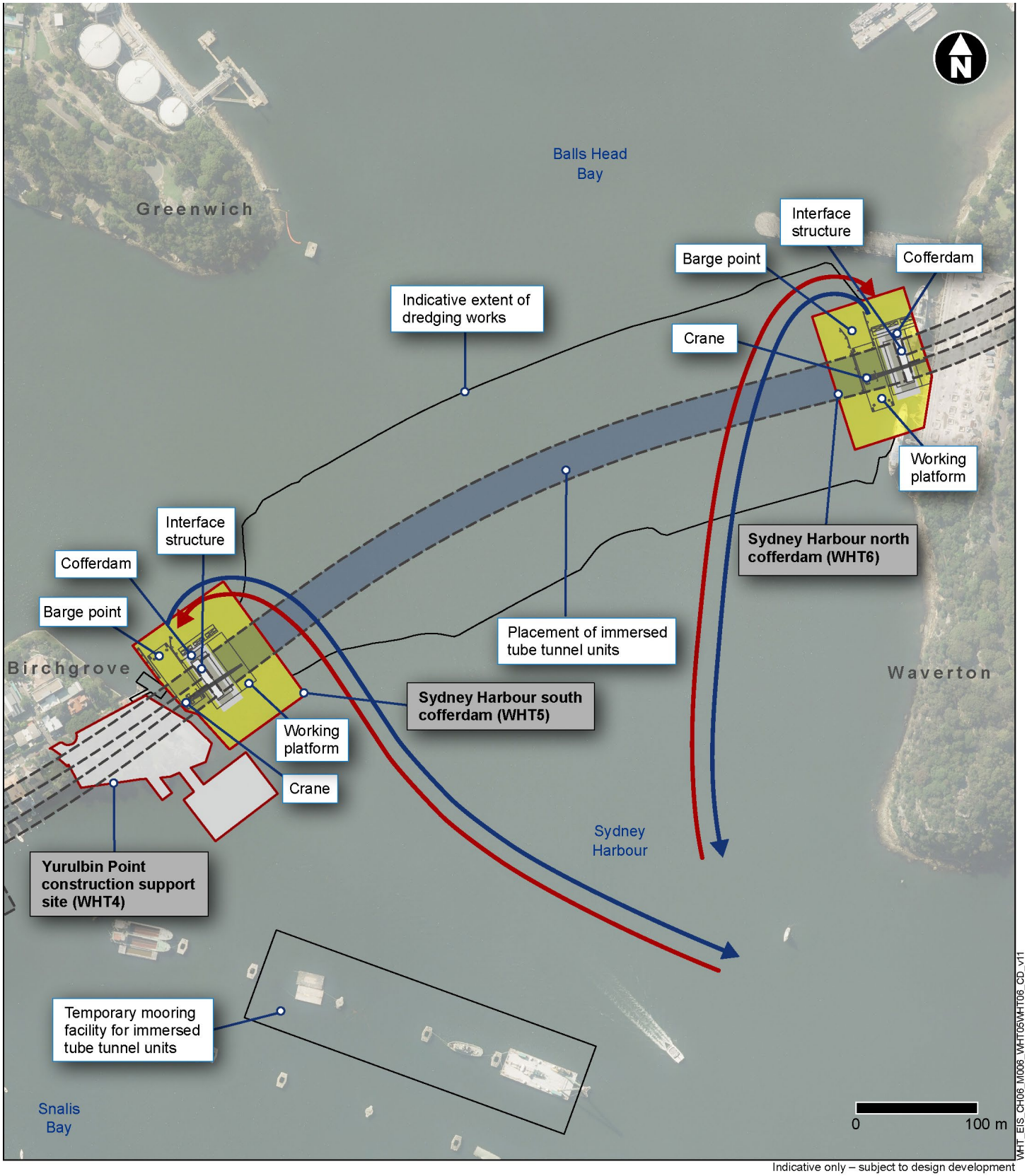
Sydney Harbour south cofferdam (WHT5), Sydney Harbour north cofferdam (WHT6) and Sydney Harbour crossing

A summary of the key features of the Sydney Harbour cofferdams is included in Table 6-17. An indicative layout for the cofferdams is shown in Figure 6-30. An indicative program for construction activities at this site is provided in Table 6-18. Marine transport routes are shown in Figure 6-38.

Table 6-17 Key features of the Sydney Harbour cofferdams (WHT5 and WHT6) and Sydney Harbour crossing

Key feature	Summary
Site area	WHT5 10,000 m^2 and WHT6 9000 m^2
Site description	Temporary cofferdams would be located at either end of the immersed tube tunnel crossing of Sydney Harbour, at Yurulbin Point, Birchgrove next to Yurulbin Park in the west, and at Waverton, next to the disused Balls Head coal loader in the east. The closest residential properties to the cofferdams are: • Along Louisa Road, Birchgrove • Along Balls Head Road, Wood Street and Larkin Street, Waverton. The closest commercial property to the site is the Coal Loader Café, located to the north-east of Sydney Harbour north cofferdam (WHT6). The cofferdams have been located offshore to minimise landside and shoreline impacts. Deliveries and spoil handling for these sites would be via water to minimise road haulage through narrow harbourside streets.
Key activities	The cofferdams are temporary structures that would facilitate construction of the underwater interface structures between the driven mainline tunnels and the immersed tube tunnel elements. Key activities that would occur on, or be supported by these sites would include: • Construction of temporary cofferdam structure, including ground treatment, piling, dewatering and excavation • Construction of the interface structure (connection between the driven tunnels and the immersed tube tunnels, refer to Section 6.4.4) within the cofferdams • Removal of cofferdam structure and site rehabilitation • Construction support from the water, including the use of moored work

Key feature	Summary
	barges (such as a flat top barge as shown in Figure 6-12), as well as barge movements for removal and transfer of dredged marine sediment and rock, deliveries and staff transport • Dredging and gravel placement • Installation of immersed tube tunnel units.
Hours of construction	Construction would be carried out primarily during standard construction hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays). Certain activities may be carried out up to 24 hours per day, seven days per week. These activities would include: • Dewatering of cofferdams • Dredging • Removal of cofferdam structure • Immersed tube tunnel installation (immersed tube tunnel installation would take between 24 to 48 hours for each unit). Rock hammering and piling would be carried out during standard construction hours only.



Legend

- Construction footprint
- Construction support site
- Driven tunnel
- Immersed tube tunnel
- Indicative marine exclusion zone
- Site access - in
- Site access - out

Figure 6-30 Indicative layout – Sydney Harbour cofferdams

Table 6-18 Sydney Harbour cofferdams and other activities indicative construction program

Construction activity	Indicative construction program																			
	2021				2022				2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Site establishment and installation of temporary cofferdam structure																				
Excavation of rock within cofferdams																				
Construction of interface structures																				
Reinstatement works to cofferdam areas																				
Dredging of trench for the immersed tube tunnels																				
Installation of immersed tube tunnel units																				

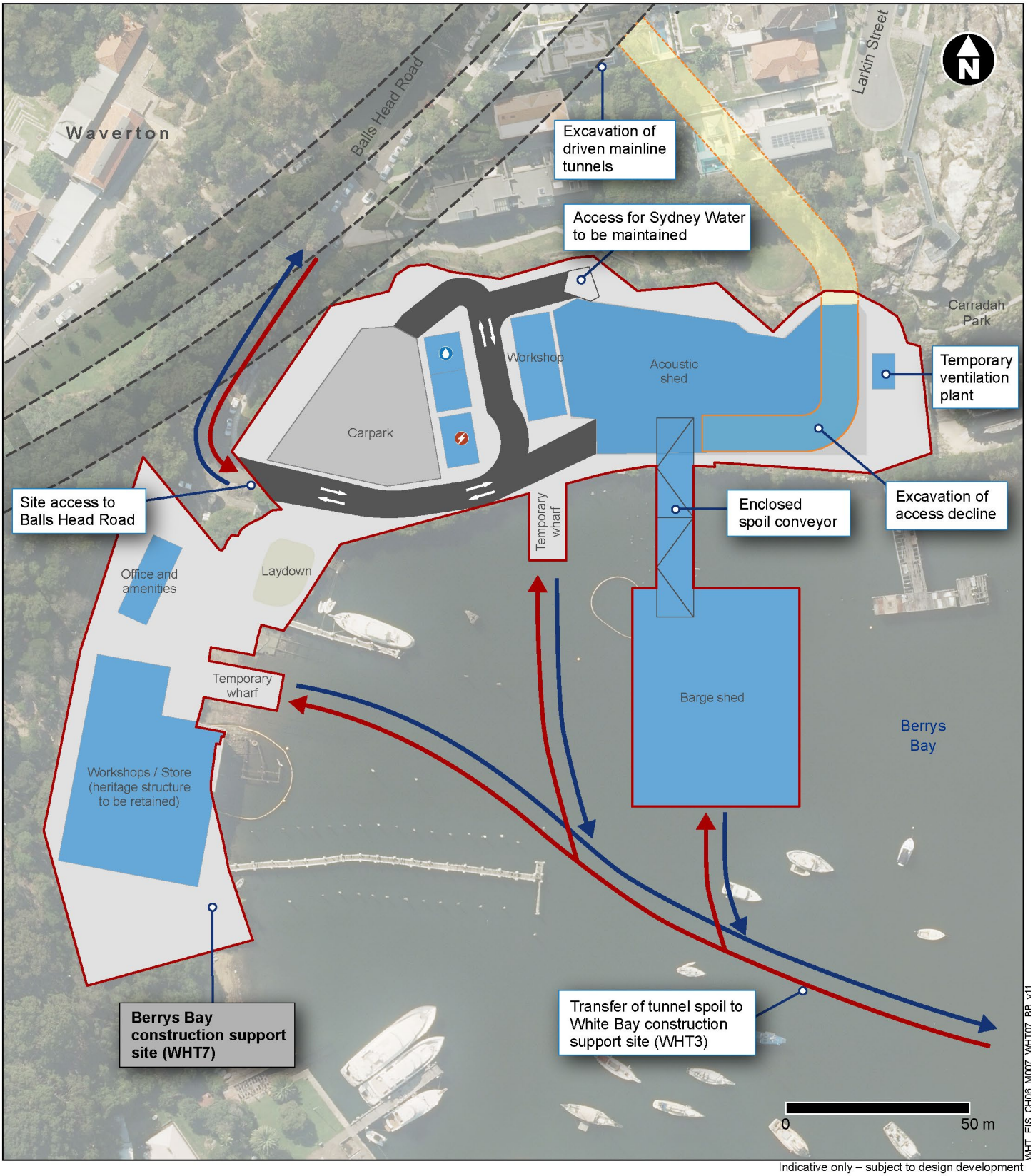
Berrys Bay (WHT7)

A summary of the key features of the Berrys Bay construction support site is included in Table 6-19. An indicative layout for the construction support site, and construction site access routes, is shown in Figure 6-31. An indicative program for construction activities at this site is provided in Table 6-20.

Table 6-19 Key features of the Berrys Bay construction support site (WHT7)

Key feature	Summary
Site area	19,000 m^2
Site description	This would be a combined land and water-based site at Berrys Bay, Waverton. The site is bound by Sydney Harbour (Berrys Bay) to the south and residential properties and parkland to the north, east and west. The construction support site is relatively level with a large rock cutting along the northern boundary. The following items are currently located within the construction support site: • A number of commercial buildings and sheds in the southern half of the site. Where feasible, the existing structures within the construction support site would be retained and reused. These structures include a number of locally listed heritage structures, including Woodley's Shed and a stone retaining wall. Where feasible, the construction support site has been designed to retain and protect these structures (refer to Chapter 14 (Non-Aboriginal heritage) for additional information) • Vacant open space in the northern area of the site • An existing Sydney Water asset. Access to this by Sydney Water would need to be retained throughout construction.
Key activities	The construction support site would be used to establish a tunnel construction access decline to support excavation of the mainline tunnels (including for connection to the immersed tube tunnel crossing). The mainline tunnels would be excavated in both directions from this site. Key activities that would occur on, or be supported by this site would include:

Key feature	Summary
	• Vegetation clearing and earthworks as part of early works and site establishment • Construction of temporary wharves for transport of tunnel spoil material, to minimise vehicle movements on Balls Head Road • Excavation of an access decline for tunnel construction • Excavation of driven mainline tunnels and cross passages • Treatment of wastewater from tunnelling activities • Tunnel civil and mechanical and electrical fitout • Transfer of tunnel spoil from the mainline tunnels to barges, for transfer to the White Bay construction support site (WHT3) • Reinstatement works at the completion of construction. The Berrys Bay construction support site would require the temporary relocation of about 10 swing moorings in Sydney Harbour which would be impacted by the works. Relocations would be required for the duration of construction.
Hours of construction	Spoil haulage via barge would be carried out during standard construction hours only (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays). Spoil handling and loading of the barges within the acoustic shed on the site would be carried out outside of standard construction hours. Tunnel construction would be carried out up to 24 hours per day, seven days a week either within an acoustic shed or underground. There would also be limited deliveries to the site at night, via Balls Head Road.
Access arrangements	Access to the site would be via Balls Head Road for road traffic and Sydney Harbour for marine construction vessels used for major deliveries and spoil haulage.



Legend

- Construction footprint
- Construction support site
- Construction site buildings
- Driven tunnel
- Temporary site access
- Access decline
- Wastewater treament plant
- Aboveground substation
- Site access - in
- Site access - out

Figure 6-31 Indicative layout – Berrys Bay construction support site

Table 6-20 Berrys Bay construction support site indicative construction program

Construction activity	Indicative construction program																			
	2021				2022				2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Early works and site establishment																				
Construction of tunnel access decline																				
Tunnel construction																				
Tunnel fitout and finishing																				
Testing and commissioning and site rehabilitation																				

Berry Street north (WHT8)

A summary of the key features of the Berry Street north construction support site is included in Table 6-21. An indicative layout for the construction support site, and construction site access routes, is shown in Figure 6-32. The Berry Street north construction support site is expected to be used for the duration of construction.

Table 6-21 Key features of the Berry Street north construction support site (WHT8)

Key feature	Summary
Site area	5600 m^2
Site description	The site is located within the Warringah Freeway corridor at North Sydney between the Berry Street on ramp and Warringah Freeway to the east and high rise residential buildings to the west. The site slopes from the west down towards the Warringah Freeway and comprises a mixture of planted native vegetation and maintained grass verges.
Key activities	The site would provide support for construction of the Berry Street on ramp to the Western Harbour Tunnel, including cut and cover structures, tunnel portal and widening of the northbound carriageway of the Warringah Freeway. Its use in conjunction with the Cammeray Golf Course construction support site (WHT10), would allow the size of this site to be minimised.
Hours of construction	The majority of construction activities at this site would be carried out during standard construction hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays). Some construction activities supported by this site would require out of hours work (eg during connection of new works to the existing road). This means that there would be limited periods throughout the construction program where construction would occur outside of standard construction hours.
Access arrangements	Access into the site would be via Berry Street and out of the site via Warringah Freeway.

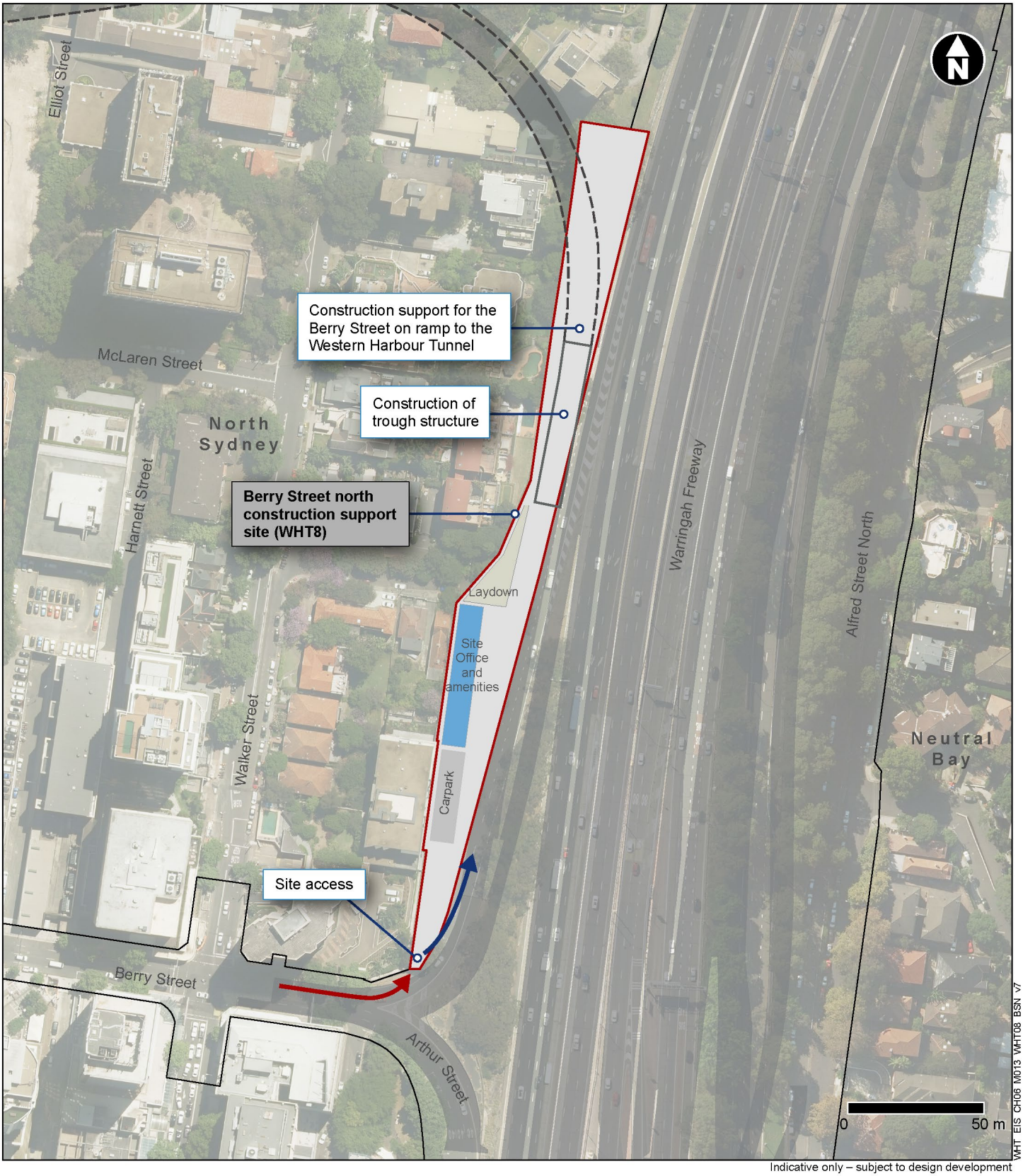


Figure 6-32 Indicative layout – Berry Street north construction support site

Ridge Street north (WHT9)

A summary of the key features of the Ridge Street north construction support site is included in Table 6-22. An indicative layout for the construction support site, and construction site access routes, is shown in Figure 6-33. The Ridge Street north construction support site is expected to be used for the duration of construction.

Table 6-22 Key features of the Ridge Street north construction support site (WHT9)

Key feature	Summary
Site area	10,200m^2
Site description	The site is located in the south-eastern corner of St Leonards Park, North Sydney and is bound by the Warringah Freeway to the east and Ridge Street to the south. The site is heavily sloped from west to east towards the Warringah Freeway and incorporates some planted trees as well as large areas of maintained lawn. The nearest residential properties are located on Ridge Street, about 30 metres from the southern boundary of the construction support site. Other sensitive receivers nearby include the North Sydney Bowling Club, St Mary's Catholic Primary School, Wenona Girls School, and the general public using the park for recreational purposes. The construction support site is within St Leonards Park which is listed as a State significant heritage item (refer to Chapter 14 (Non-Aboriginal heritage) for additional information).
Key activities	The site would enable construction of: • The cut and cover and trough portion of the Western Harbour Tunnel off ramp to Falcon Street • Surface works required to integrate the Falcon Street off ramp • Ridge Street shared user bridge. The construction support site would connect with the Ridge Street east construction support site (WFU6) (refer to Section 6.7.3 for more information about Warringah Freeway Upgrade construction support sites), which would allow the movement of construction equipment and materials between the sites. Utilisation of this site in conjunction with the Cammeray Golf Course construction support site (WHT10), would allow the size of this site to be minimised.
Hours of construction	Cut and cover construction would generally be carried out during standard construction hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays). Some construction activities supported by this site would require out of hours work on occasion (eg connection of new works to the existing network). This means that there would be discrete periods throughout the construction program where construction works at this site occur outside of standard construction hours.
Access arrangements	Access in and out of the site would be primarily via Warringah Freeway. Access to the site via Ridge Street would be provided for light vehicles and used during establishment of the site. There would be limited use of this access once the site is established.

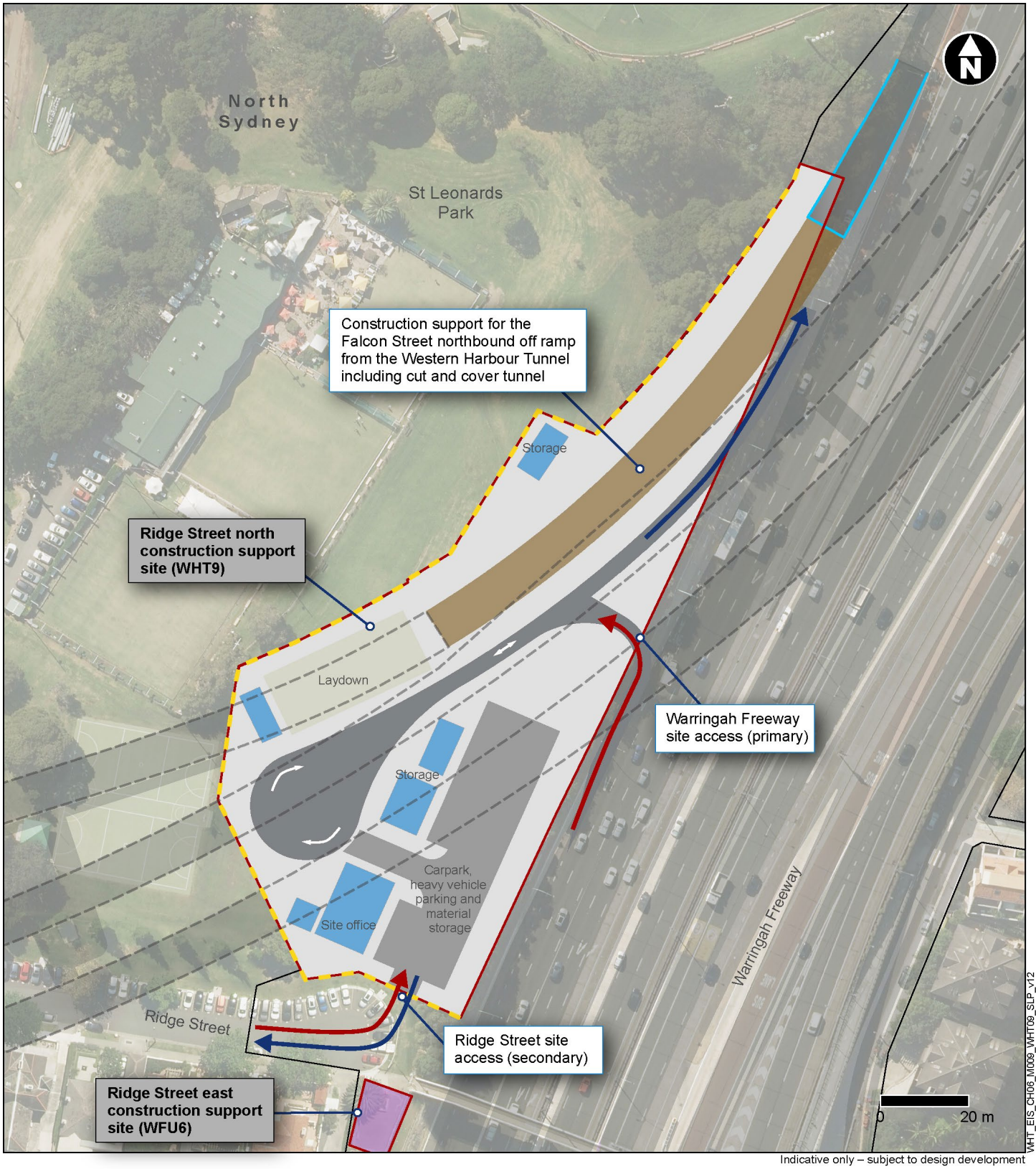


Figure 6-33 Indicative layout – Ridge Street north construction support site

Cammeray Golf Course (WHT10)

A summary of the key features of the Cammeray Golf Course construction support site is included in Table 6-23. An indicative layout for the construction support site, and construction site access routes, is shown in Figure 6-34. An indicative program for construction activities is provided in Table 6-24.

Table 6-23 Key features of the Cammeray Golf Course construction support site (WHT10)

Key feature	Summary
Site area	30,300 m^2
Site description	The site is located within the south-west portion of the Cammeray Golf Course at Cammeray. The construction support site is bound by residential properties to the north, Cammeray Golf Course and Cammeray Park to the east, Warringah Freeway to the west and Ernest Street to the south. Residential properties are located to the north of the construction support site on Warringah Road and Morden Street and to the south across Ernest Street. The Cammeray Golf Course site would be located next to a separate construction support site for the Warringah Freeway Upgrade works (WFU8 refer to Section 6.7.3). The construction support site has been designed to avoid impacts to the football pitch, skate park, croquet club and tennis courts at Cammeray Park. These would all remain open during construction. The golf course would also remain operational during construction. Additional information around the use of the golf course and sports fields during construction and operation is discussed in Chapter 20 (Land use and property).
Key activities	This site would support the majority of tunnel excavation north of Sydney Harbour for the Western Harbour Tunnel. This would include excavation of a tunnel construction access decline, ramp tunnels, mainline tunnels and ventilation tunnels. Key activities that would occur on, or be supported by, this site would include: • Excavation of an access decline • Excavation of driven mainline tunnels from Cammeray towards Sydney Harbour • Excavation of ramp tunnels • Excavation of shafts and ventilation tunnels for the ventilation outlet and motorway facilities at the Warringah Freeway • Construction and fitout of the Western Harbour Tunnel motorway facilities • Civil construction only of the Beaches Link ventilation outlet at the Warringah Freeway (fitout to be completed as part of the Beaches Link and Gore Hill Freeway Connection project (subject to separate assessment and approval)) • Construction of the substation and operational support facilities • Treatment of wastewater from tunnelling activities • Excavation, handling and stockpiling of tunnel spoil • Tunnel civil and mechanical and electrical fitout • Crushing of materials for filling and compaction works

Key feature	Summary
	• Decommissioning and replacement of existing water harvesting dam within the Cammeray Golf Course which forms part of the North Sydney Council stormwater harvesting scheme • Utility relocations.
Hours of construction	Spoil haulage would be carried out during standard construction hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays). Tunnel construction and fitout would be carried out up to 24 hours per day, seven days per week either within an acoustic shed or underground. Night time deliveries would be required to support the tunnelling activities. Crushing and screening activities would also be carried out within the acoustic shed.
Access arrangements	Access in and out of the site would be primarily via Warringah Freeway, a secondary access would be provided at Ernest Street.

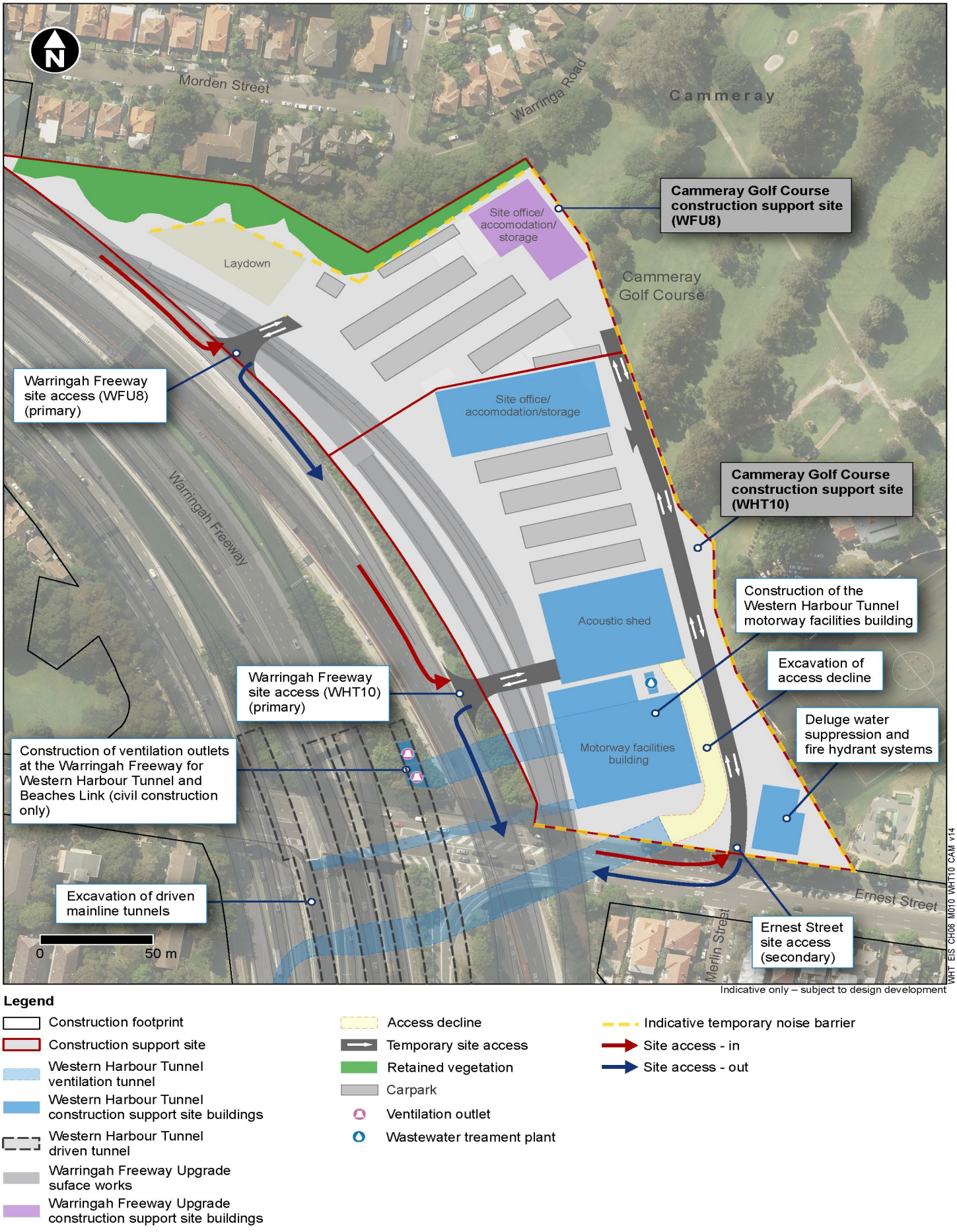


Figure 6-34 Indicative layout – Cammeray Golf Course construction support site

Table 6-24 Cammeray Golf Course construction support site indicative construction program

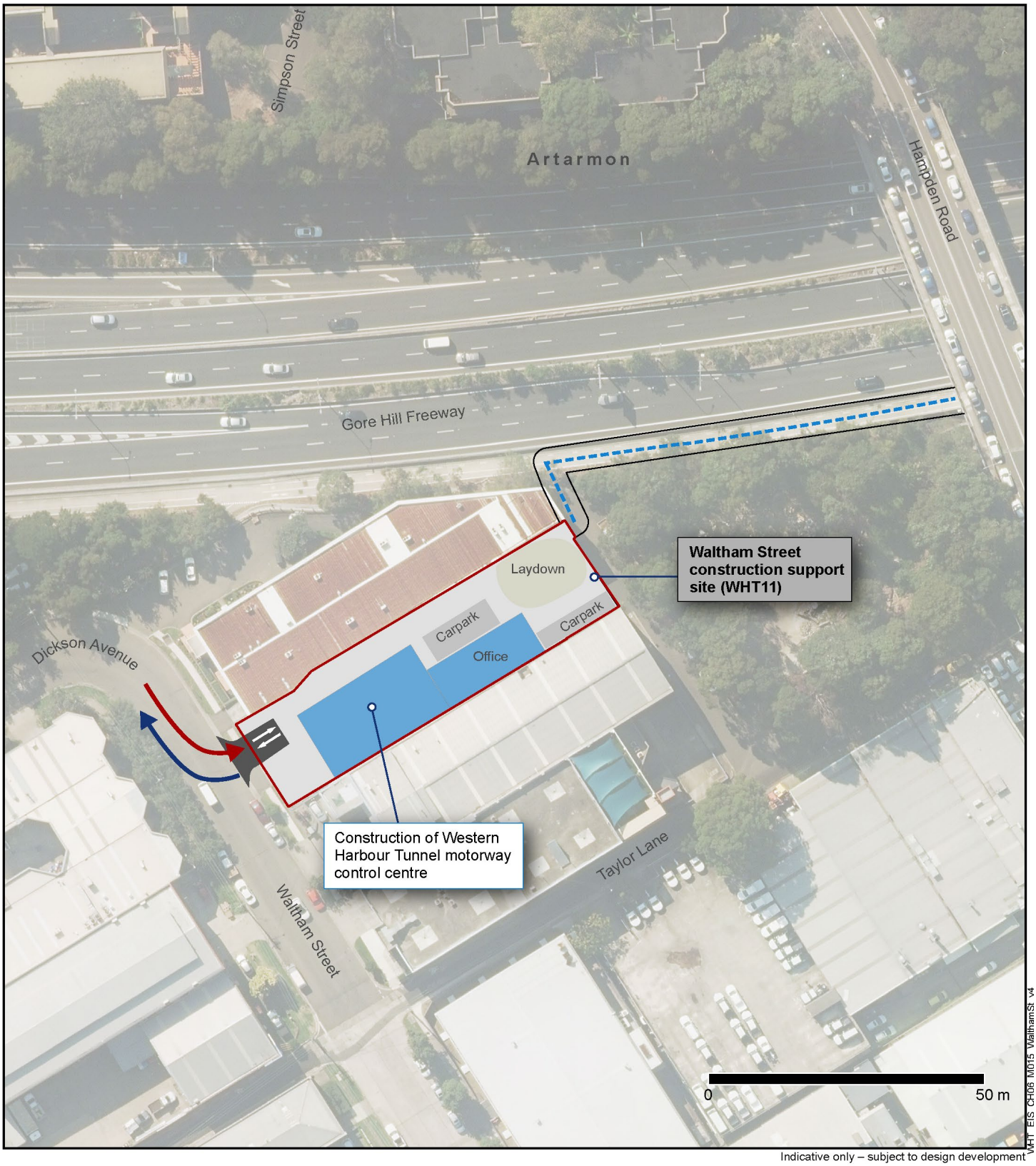
Construction activity	Indicative construction program																			
	2021				2022				2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Early works and site establishment																				
Construction of tunnel access decline																				
Tunnel construction																				
Tunnel fitout and finishing																				
Construction of operational facilities																				
Testing, commissioning and site rehabilitation																				

Waltham Street (WHT11)

A summary of the key features of the Waltham Street (WHT11) construction support site is included in Table 6-25. An indicative layout for the construction support site, and construction site access routes, is shown in Figure 6-35. An indicative program for construction activities is provided in Table 6-26.

Table 6-25 Key features of the Waltham Street construction support site (WHT11)

Key feature	Summary
Site area	1300 m^2
Site description	Located within the Artarmon industrial area, between Waltham Street to the west, Gore Hill Freeway to the north, Hampden Road to the east and industrial buildings to the south. The site is currently occupied by industrial buildings.
Key activities	The site would be used to construct the motorway control centre for Western Harbour Tunnel. The site would also be used for equipment laydown, car parking for construction workers and temporary site office buildings.
Hours of construction	Where feasible, works would be scheduled to be carried out during standard construction hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays).
Access arrangements	Access in and out of the site would be via Waltham Street.



Legend

- Construction footprint
- Construction support site
- Construction support site buildings
- Communications cable for motorway control centre
- Temporary site access
- Site access - in
- Site access - out

Figure 6-35 Indicative layout – Waltham Street construction support site

Table 6-26 Waltham Street construction support site indicative construction program

Construction activity	Indicative construction program											
	2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Early works and site establishment												
Construction of operational facilities												
Testing and commissioning and site rehabilitation												

6.7.3 Warringah Freeway Upgrade construction support sites

Temporary construction support sites for construction of the Warringah Freeway Upgrade would include sites required for activities such as surface earthworks, bridgeworks, construction of retaining walls, utilities relocation and protection works, noise barrier construction, traffic staging, installation of motorway facilities, installation of stormwater drainage, and pavement construction. The location of construction support sites for the Warringah Freeway Upgrade are shown in Figure 6-36 and Figure 6-37 and described in the following sections.

To support the use of the Warringah Freeway construction support sites, high voltage power, potable water supply and a suitable connection for water discharge would be required at some sites (refer to Section 6.8.4).

Construction hours at construction support sites would vary depending on the type of construction activity being carried out. Some construction works would be required outside of standard construction hours to reduce construction duration, disruption to critical road corridors, and to ensure the safety of both construction works and the public along the Warringah Freeway.

The following sections describe the proposed Warringah Freeway Upgrade construction support sites and their uses during construction. Construction support sites required for the Western Harbour Tunnel component are discussed in Section 6.7.2.

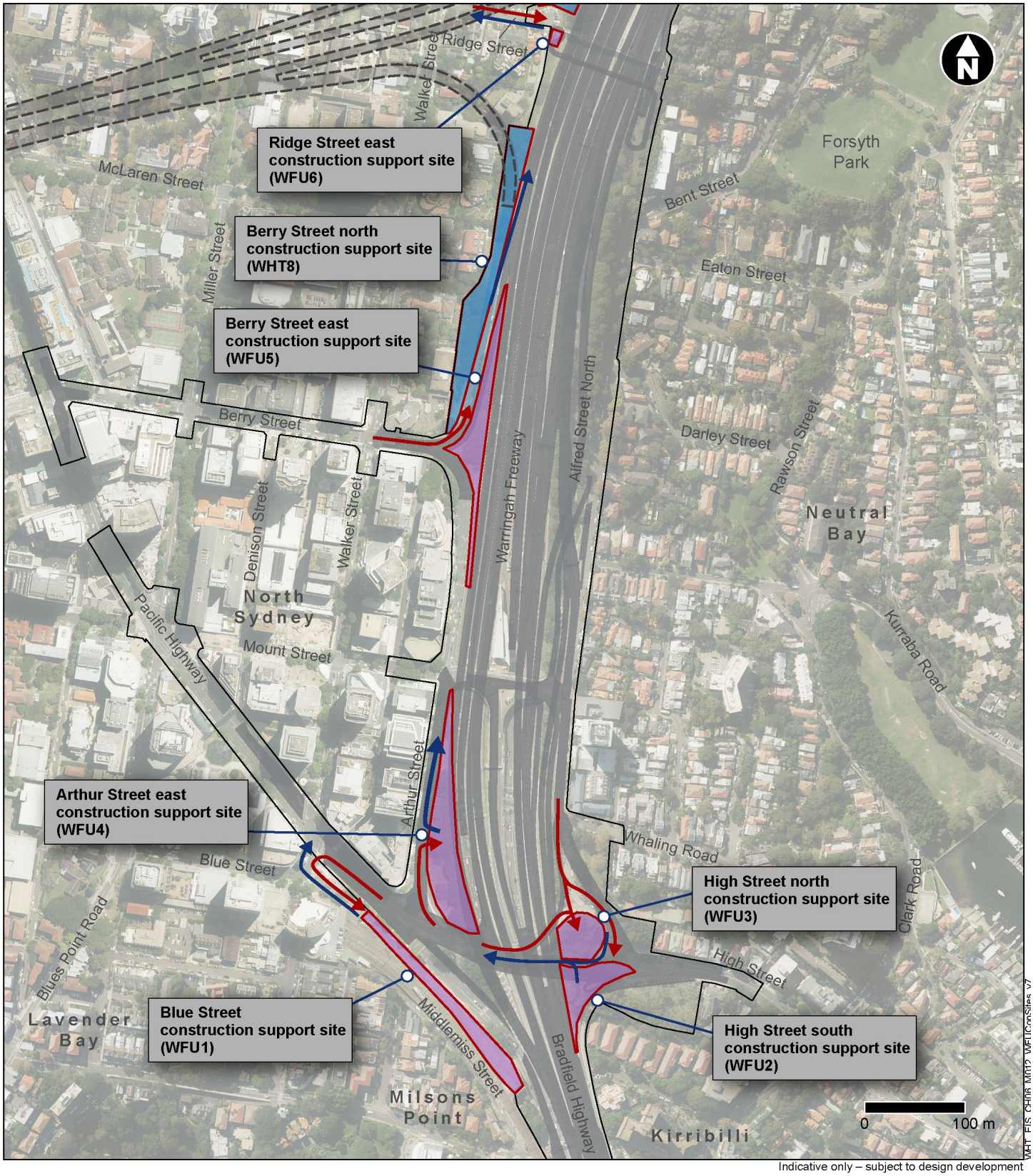
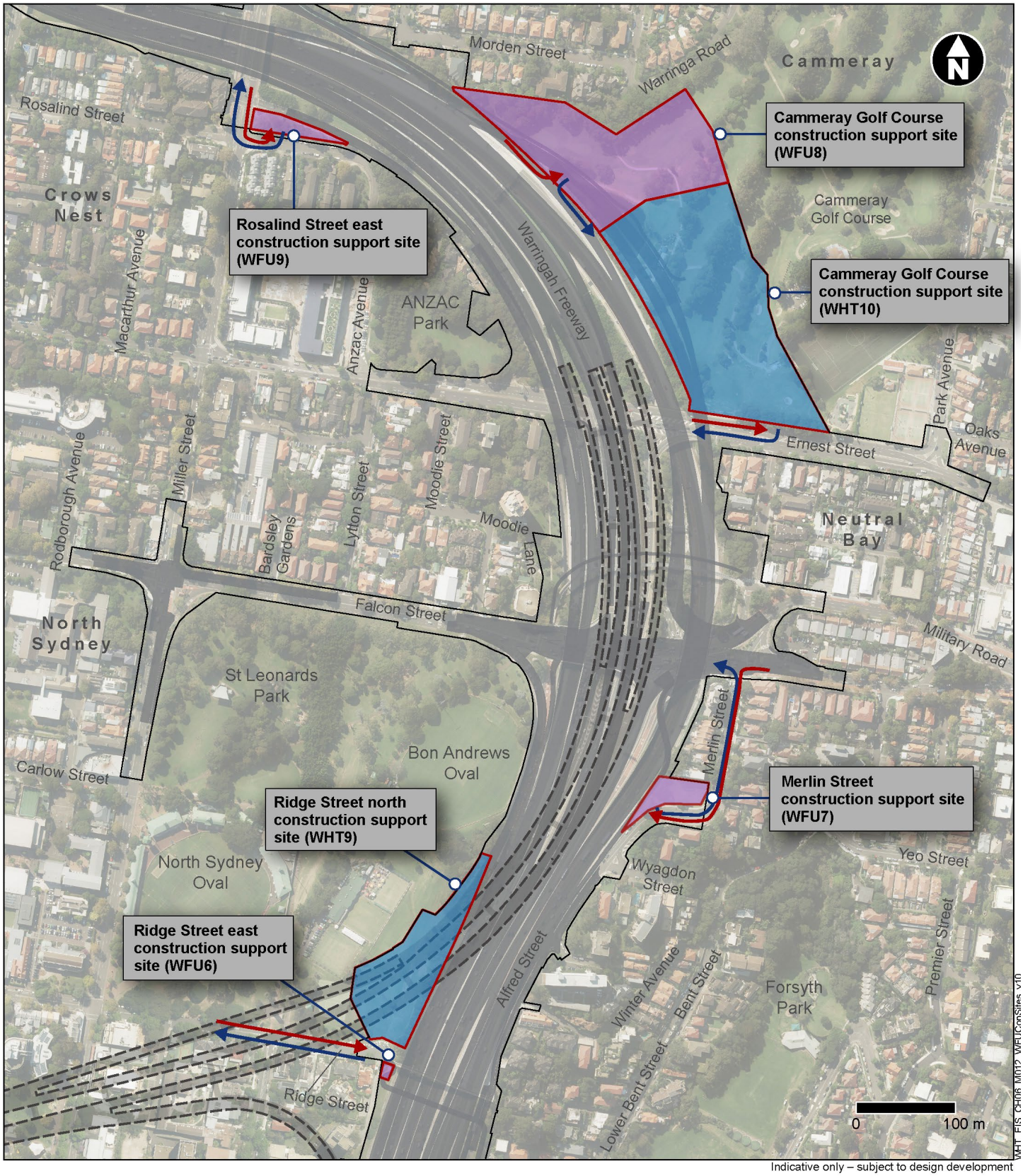


Figure 6-36 Warringah Freeway Upgrade construction support sites (map 1)



Indicative only – subject to design development

Legend

- Construction footprint
- Warringah Freeway Upgrade construction support site
- Western Harbour Tunnel construction support site boundary
- Warringah Freeway Upgrade surface works
- Western Harbour Tunnel driven tunnel
- Site access - in
- Site access - out

Figure 6-37 Warringah Freeway Upgrade construction support sites (map 2)

Blue Street (WFU1)

The location of the Blue Street construction support site (WFU1) is shown in Figure 6-36. A summary of the key features of the Blue Street construction support site is included in Table 6-27.

The Blue Street construction support site would be used for the duration of construction of the Warringah Freeway Upgrade.

Table 6-27 Key features of the Blue Street construction support site (WFU1)

Key feature	Summary
Site area	3300 m^2
Site description	The Blue Street construction support site is located in North Sydney. It is bound by the Pacific Highway to the east and south, North Shore railway line to west and Blue Street to the north. The construction support site currently comprises a flat, asphalted surface surrounded by security fencing. It is located next to local and State significant heritage items associated with the Sydney Harbour Bridge approaches, arches and viaducts and Milsons Point Railway Group (refer to Chapter 14 (Non-Aboriginal heritage)). The nearest residential properties are located on Middlemiss Street, about 60 metres to the south-west of the construction support site.
Key activities	The site would support various construction activities at the southern end of the Warringah Freeway Upgrade, including bridgeworks and surface and pavement works.
Hours of construction	General site activities would be carried out during standard construction hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays). Some construction activities (eg bridgeworks and surface works) supported by this site would require out of hours work. This means that there would be periods throughout the construction program where works at this site would occur outside of standard construction hours.
Temporary facilities	Site offices, project management compound, staff amenities, car park, laydown facilities.
Access arrangements	Access to the construction support site would be per the existing access to this site, via the Pacific Highway and a left or right turn into Blue Street. Vehicles leaving the site travelling north and/or south would be able to turn directly off Blue Street onto the Pacific Highway. The construction support site would maintain access to the rail corridor for all Sydney Trains contractors during the construction period.

High Street south (WFU2)

The location of the High Street south construction support site (WFU2) is shown in Figure 6-36. A summary of the key features of the High Street south construction support site is included in Table 6-28.

The High Street south construction support site would be used for the duration of construction of the Warringah Freeway Upgrade.

Table 6-28 Key features of the High Street south construction support site (WFU2)

Key feature	Summary
Site area	2100 m^2
Site description	The High Street south construction support site is located within the Warringah Freeway corridor at North Sydney on land bound by the Cahill Expressway to the west and south, the High Street off ramp to the east, and High Street to the north. The construction support site currently consists of a mixture of planted native vegetation and maintained grass verges. The nearest residential receivers are located 40 metres north of the construction support site on High Street and 60 metres south on McDougall Street.
Key activities	The construction support site would be used to support construction activities for the High Street interchange upgrade, including bridge and surface works, as well as for the widening and surface works in the southern portion of the Warringah Freeway Upgrade.
Hours of construction	General site activities would be carried out during standard construction hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays). Some construction activities (eg bridgeworks and surface works) supported by this site would require out of hours work. This means that there would be periods throughout the construction program where works at this site would occur outside of standard construction hours.
Access arrangements	Access in and out of the site would be via High Street.

High Street north (WFU3)

The location of the High Street north construction support site (WFU3) is shown in Figure 6-36. A summary of the key features of the High Street south construction support site is included in Table 6-29.

The High Street south construction support site would be used for the duration of construction of the Warringah Freeway Upgrade.

Table 6-29 Key features of the High Street north construction support site (WFU3)

Key feature	Summary
Site area	1800 m^2
Site description	The High Street north construction support site is located within the Warringah Freeway corridor at North Sydney on land bound by Alfred Street North/Cahill Expressway to the west and High Street to the north, south and east. The construction support site currently consists of a mixture of planted vegetation and maintained grass verges. The nearest residential receivers are located 40 metres east of the construction support site on High Street and 60 metres south on Whaling Street.

Key feature	Summary
Key activities	The construction support site would be used to support construction activities for the High Street interchange upgrade, including bridgeworks, as well as for the widening and surface works in the southern portion of the Warringah Freeway Upgrade.
Hours of construction	General site activities would be carried out during standard construction hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays). Some construction activities (eg bridgeworks and surface works) supported by this site would require out of hours work. This means that there would be periods throughout the construction program where works at this site would occur outside of standard construction hours.
Access arrangements	Access in and out of the site would be via Alfred Street North to the north or Pacific Highway via High Street to the west.

Arthur Street east (WFU4)

The location of the Arthur Street east construction support site (WFU4) is shown in in Figure 6-36. A summary of the key features of the Arthur Street east construction support site is included in Table 6-30.

The Arthur Street east construction support site would be used for the duration of construction of the Warringah Freeway Upgrade.

Table 6-30 Key features of the Arthur Street east construction support site (WFU4)

Key feature	Summary
Site area	5100 m^2
Site description	The Arthur Street east construction support site is located within the Warringah Freeway corridor at North Sydney and is bound by the Warringah Freeway to the east, Arthur Street to the west, Mount Street to the north and High Street in the south. The construction support site currently consists of a mixture of planted vegetation and maintained grass verges. The Meriton Suites North Sydney Hotel and Serviced Apartments is located across the road from the construction support site on Arthur Street.
Key activities	The construction support site would be used to support construction activities for the widening of the Warringah Freeway, and local road and intersection works along and near Arthur Street.
Hours of construction	General site activities would be carried out during standard construction hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays). Some construction activities (eg bridgeworks and surface works) supported by this site would require out of hours work. This means that there would be periods throughout the construction program where works at this site would occur outside of standard construction hours.

Key feature	Summary
Access arrangements	Access in and out of the site would be via Arthur Street to the west. Pedestrian access for construction workers would be provided from Arthur Street.

Berry Street east (WFU5)

The location of the Berry Street east construction support site (WFU5) is shown in Figure 6-36. A summary of the key features of the Berry Street east construction support site is included in Table 6-31.

The Berry Street east construction support site would be used for the duration of construction of the Warringah Freeway Upgrade.

Table 6-31 Key features of the Berry Street east construction support site (WFU5)

Key feature	Summary
Site area	3200 m^2
Site description	The Berry Street east construction support site is located within the Warringah Freeway corridor at North Sydney on land bound by the Warringah Freeway to the east, Arthur Street and Berry Street/Warringah Freeway on ramp to the west and Doris Fitton Park to the south along Arthur Street to the west. The site slopes heavily from the west down towards the Warringah Freeway and comprises a mixture of planted vegetation and maintained grass verges. High density residential apartments are located to the north-west of the construction support site (Ridgemont Apartments) on the opposite side of Berry Street.
Key activities	The construction support site would be used to support construction activities for the widening of the Warringah Freeway and surface road works associated with the Berry Street on ramp to the Western Harbour Tunnel.
Hours of construction	General site activities would be carried out during standard construction hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays). Some construction activities (eg surface works) supported by this site would require out of hours work. This means that there would be periods throughout the construction program where works at this site would occur outside of standard construction hours.
Access arrangements	Access in and out of the site would be via Berry Street to the west and vehicles exiting the site would be able to travel north via an access onto the Warringah Freeway.

Ridge Street east (WFU6)

The location of the Ridge Street east construction support site (WFU6) is shown in in Figure 6-36 and Figure 6-33. A summary of the key features of the Ridge Street east construction support site is included in Table 6-32.

The Ridge Street east construction support site would be used for the duration of works associated with the Ridge Street shared user bridge.

Table 6-32 Key features of the Ridge Street east construction support site (WFU6)

Key feature	Summary
Site area	300 m^2
Site description	The Ridge Street east construction support site is located within the Warringah Freeway corridor at North Sydney on land bound by the Warringah Freeway to the east, residential properties on Ridge Street to the south and west and St Leonards Park to the north. The construction support site currently consists of a combination of vegetated and paved surfaces. The closest residential properties are next to the southern and western boundaries of the construction support site along Ridge Street.
Key activities	The construction support site would be used to support construction activities for the demolition of the existing Ridge Street pedestrian bridge and construction of an upgraded Ridge Street shared user bridge.
Hours of construction	General site activities would be carried out during standard construction hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays). Some construction activities (eg bridgeworks) supported by this site would require out of hours work. This means that there would be periods throughout the construction program where works at this site would occur outside of standard construction hours.
Access arrangements	Access in and out of the site would be via Ridge Street to the north. Pedestrian and cyclist access across the Warringah Freeway would be maintained via the old bridge, until the new upgraded crossing is completed.

Merlin Street (WFU7)

The location of the Merlin Street construction support site (WFU7) is shown in Figure 6-37. A summary of the key features of the Merlin Street construction support site is included in Table 6-33.

The Merlin Street construction support site would be used for the duration of construction of the Warringah Freeway Upgrade.

Table 6-33 Key features of the Merlin Street construction support site (WFU7)

Key feature	Summary
Site area	1700 m^2
Site description	The Merlin Street construction support site is located in Neutral Bay on the eastern side of Warringah Freeway within Merlin Street Reserve (owned by Transport for NSW). The site is bound by residential properties to the north, Merlin Street to the east, Alfred Street to the south and McIntosh Lane and Warringah Freeway to the west. The site slopes from north-west to south-east towards Merlin Street and is covered in a mixture of planted native vegetation and areas of maintained lawn. A public footpath runs along the east and south of Merlin Street reserve and an electrical substation is located on the southern boundary. The nearest residences are located next to the construction support site

Key feature	Summary
	along Merlin Street to the north, and Wyagdon Street to the south.
Key construction support activities	The construction support site would be used to support construction activities for the realignment of Alfred Street North and construction of the new southbound bus lane bridge off Falcon Street.
Hours of construction	General site activities would be carried out during standard construction hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays). Some construction activities (eg bridgeworks and surface works) supported by this site would require out of hours work. This means that there would be periods throughout the construction program where works at this site would occur outside of standard construction hours.
Access arrangements	The site would be accessed via Military Road and Merlin Street. Some construction works associated with the construction of the new southbound bus lane bridge would result in temporary disruptions to access to the residential property at 1 McIntosh Lane (refer to Chapter 8 (Construction traffic and transport) for more information about construction traffic impacts).

Cammeray Golf Course (WFU8)

The location of the Cammeray Golf Course construction support site (WFU8) is shown in Figure 6-37 and Figure 6-34. A summary of the key features of the Cammeray Golf Course construction support site is included in Table 6-34. The indicative layout of the Cammeray Golf Course construction support site is shown in Figure 6-34.

The Cammeray Golf Course construction support site would be used for the duration of construction of the Warringah Freeway Upgrade.

Table 6-34 Key features of the Cammeray Golf Course construction support site (WFU8)

Key feature	Summary
Site area	18,000 m^2
Site description	The Cammeray Golf Course construction support site is located within the north-west portion of the Cammeray Golf Course, next to the Warringah Freeway at Cammeray. The construction support site is bound by residential properties to the north, Cammeray Golf Course to the east, Warringah Freeway to the west and the Cammeray Golf Course construction support site (WHT10) (for the Western Harbour Tunnel) to the south. The construction support site currently consists of an operational nine-hole golf course. The golf course would remain operational during construction. The nearest residences are located to the north of the construction support site on Warringah Road and Morden Street and along the eastern edge of Cammeray Golf Course on Park Avenue.
Key activities	The construction support site would act as the main construction compound for the Warringah Freeway Upgrade. It would support the use of the other Warringah Freeway Upgrade construction

Key feature	Summary
	support sites, and would also provide a temporary bus layover area during the construction period when the existing Warringah Freeway bus layover area is removed and relocated.
Hours of construction	General site activities would be carried out during standard construction hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays). Some construction activities (eg bridgeworks and surface works) supported by this site would require out of hours work. This means that there would be periods throughout the construction program where works at this site would occur outside of standard construction hours.
Access arrangement	Two access points would be established at the site: • Western access would be directly off the southbound lanes of Warringah Freeway • Southern access would be directly off Ernest Street.

Rosalind Street east (WFU9)

The location of the Rosalind Street east construction support site (WFU9) is shown in Figure 6-37. A summary of the key features of the Rosalind Street east construction support site is included in Table 6-35.

The Rosalind Street east construction support site would be used for the duration of construction of the Warringah Freeway Upgrade.

Table 6-35 Key features of the Rosalind Street east construction support site (WFU9)

Key feature	Summary
Site area	1300 m^2
Site description	The Rosalind Street east construction support site is located within the Warringah Freeway corridor at Cammeray. The site is bound by the Warringah Freeway northbound off ramp at Miller Street to the north and east, Rosalind Street to the south and Miller Street to the west. The site is situated on flat land and comprises a mixture of planted native vegetation and maintained grass verges. The nearest residential receivers are located to the south on Rosalind Street.
Key activities	Construction of the northern portion of the Warringah Freeway Upgrade, as well as local road and intersection upgrades and changes near Miller Street and Amherst Street.
Hours of construction	General site activities would be carried out during standard construction hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no construction works on Sundays or public holidays). Some construction activities (eg surface works) supported by this site would require out of hours work. This means that there would be periods throughout the construction program where works at this site would occur outside of standard construction hours.
Access arrangements	The site would be accessed via Miller Street (to the east) and then Rosalind Street to the south. No access to the site would be permitted via Anzac Avenue.

6.8 Construction management and resources

6.8.1 Construction workforce and hours

Construction workforce

The project would be expected to support up to 7500 full time equivalent jobs (direct employment) during the five years of construction. About 2600 full time equivalent jobs (2000 for Western Harbour Tunnel and 600 for Warringah Freeway Upgrade) would be expected to be supported during peak construction.

Construction work hours

Construction work hours required for the project would generally fall within the following categories:

- Early works and site establishment
- Tunnelling, tunnelling support and underground activities
- Construction traffic for material supply and spoil movement
- Surface construction activities (not covered by the other categories)
- Blasting and rock breaking
- Other activities.

The proposed construction hours for various construction activities are provided in Table 6-36. Standard construction hours are:

- 7am to 6pm Monday to Friday
- 8am to 1pm Saturday
- No construction works on Sundays or public holidays.

Indicative timeframes for construction activities are provided in Table 6-3. The proposed construction hours at each of the construction support sites are summarised in Section 6.7.

Table 6-36 Proposed construction hours

Activity	Construction hours	Comments or exceptions
Tunnelling, tunnelling support and underground activities		
Tunnelling, underground excavation and tunnel fitout	Up to 24 hours per day, seven days per week	Activities that support tunnelling works and fitout, including above ground work supporting underground activities, may need to occur 24 hours per day, up to seven days per week. Tunnel excavation and spoil handling outside of standard construction hours would be carried out within acoustic sheds at tunnel construction support sites.
Dredging and excavation of the bed of the harbour, and barge movements for associated marine spoil transportation	Up to 24 hours per day, seven days a week	Backhoe dredging and gravel placement would occur during standard construction hours. Trailer suction hopper dredges would operate on a 24-hour basis. Some transport by barge to the designated

Activity	Construction hours	Comments or exceptions
		offshore disposal site may take place outside of standard construction hours.
Piling works in Sydney Harbour	Standard construction hours	Required for construction of the cofferdams.
Barge movements for transport of immersed tube tunnel units	24 hours per day, for discrete periods	Barges to transport immersed tube tunnel units from the casting facility in White Bay to a temporary mooring location in Snails Bay.
Immersed tube tunnel installation	24 hours per day, for discrete periods	Carried out during localised closures of Sydney Harbour. About seven partial closures at the crossing location, each for a period of 24 to 48 hours. Minor increases in travel times are possible during immersed tube tunnel installation (refer to Chapter 8 (Construction traffic and transport) for further details).
Construction traffic for material supply and spoil removal		
Construction traffic for material deliveries and spoil removal	Standard construction hours	Spoil haulage would be carried out during standard construction hours. Some deliveries to and from the construction support sites would be required outside of standard construction hours to support construction activities.
Barge movements for terrestrial spoil transportation and disposal (from Berrys Bay and Yurulbin Point)	Up to 24 hours per day, seven days per week	Loading of hopper barges for the purpose of spoil transportation may be carried out at night within a barge shed.
Surface construction activities (not specified elsewhere)		
Warringah Freeway Upgrade	Up to 24 hours per day, seven days per week	Works would be required outside of standard construction hours to ensure the safety of both construction workers and the public and to minimise operational impacts to critical road corridors.
Demolition and surface construction activities including major surface road upgrades (including major traffic switches), infrastructure construction and utility relocations.	Standard construction hours where feasible	Non-disruptive (low noise intensive activities) preparatory work, repairs or maintenance may be carried out outside standard construction hours. Activities requiring the temporary possession of roads, or to accommodate road network requirements would at times need to be carried out outside of standard construction hours.

Activity	Construction hours	Comments or exceptions
Early works and site establishment activities	Standard construction hours where feasible	Non-disruptive (low noise intensive activities) preparatory work, repairs or maintenance may be carried out outside standard construction hours.
Blasting and rock breaking		
Controlled blasting (driven tunnels)	9am to 5pm Monday to Friday 9am to 1pm Saturdays No blasting on Sundays or public holidays	Controlled blasting may be used for cross passage excavation and bench removal in mainline and ramp tunnels. Controlled blasts would be limited to one single detonation in any one day per receiver group, unless otherwise agreed with the NSW Environment Protection Authority.
Rock breaking (with potential for impulsive or tonal noise impact at a sensitive receiver)	Standard construction hours, and outside standard construction hours when required as part of approved surface construction activities	Respite periods would be provided and scheduled to minimise the frequency and duration of extended rock breaking activities with the potential for impulsive or tonal noise emissions. Rock breaking and other high impact noise activities could also occur outside standard construction hours if authorised by an environment protection licence.
Other activities		
Minor activities	At any time	Includes activities that do not lead to an exceedance of the applicable noise management level at a noise sensitive receiver.
Activities authorised by an Environment Protection Licence	As specified in the Environment Protection Licence	Construction activities would be managed as required by the Environment Protection Licence issued by the NSW Environment Protection Authority.
Out of hours works for safety and public infrastructure operational reasons (ie to minimise traffic disruptions)	At any time, subject to individual requirements	Specific management measures would be developed for each relevant activity or group of activities to manage potential impacts on sensitive receivers. This would include use of respite periods.
Emergency or directed activities	At any time	Activities carried out if required to prevent an imminent loss of life or environmental damage.

6.8.2 Traffic management and access

Road transport

The construction of the project would be subject to comprehensive traffic management measures to ensure the ongoing functionality of surrounding roads, and the safety of members of the public, motorists and construction workers.

A number of stages of traffic management and traffic switches would be required around the tunnel connections and for the Warringah Freeway Upgrade to facilitate the construction of the on and off ramps and tie-ins to arterial and local roads.

At locations where temporary and/or permanent road closures are required, access to properties would be maintained or alternative arrangements made in agreement with the affected stakeholder(s). Signage would be installed for road closures or detours where required, to facilitate traffic movement.

To facilitate the use of the Cammeray Golf Course construction support sites (WHT10 and WFU8), as part of the early works and site establishment for the project, the Ernest Street/Merlin Street intersection would be modified with the addition of a north approach to allow construction vehicle access (refer to Figure 6-34).

The project would also necessitate the temporary alteration of cyclist and pedestrian facilities. Appropriate detour routes would be established, utilising existing cycle routes and paths where feasible.

The proposed access points to and from the construction support sites are described in Section 6.7.2 and Section 6.7.3 and shown in figures for each construction support site.

Where feasible, construction access is proposed to be to and from major arterial roads. No heavy vehicle road access to Yurulbin Point construction support site (WHT4) is proposed during major construction, though there may be a requirement for some heavy vehicle movements during the early works and site establishment phase (refer to Section 6.3 for more information regarding early works and site establishment). Night time spoil haulage from Yurulbin Point would not be required; however, loading of the barges may be carried out at night within an acoustic barge shed. There would also be limited deliveries to site at night, via barge, to support the tunnelling works. Additional information about marine vessel movements is provided in Table 6-38 and Figure 6-38.

During the early works and site establishment phase (refer to Section 6.3 for more information), vehicle movements would be required along Ridge Street for access and egress to the Ridge Street north construction support site (WHT9). These movements would be for the duration of the early works and site establishment phase, until the Warringah Freeway site access and egress point can be used. Following completion of this phase of the project, construction site access along Ridge Street, as shown in Figure 6-9, would be restricted and only used in instances where the Warringah Freeway access was either blocked, not suitable, or during the demobilisation works where the access is removed. The use of the Ridge Street site access point would be managed in accordance with a traffic management plan to minimise impacts on nearby sensitive land uses, including schools and residences. Additional information about the management of construction traffic impacts is provided in Chapter 8 (Construction traffic and transport).

Over-size and over-mass vehicles would be required for the delivery and removal of large plant and equipment on discrete occasions. There would be a higher proportion of these movements during site establishment and site closure, as large plant and equipment (such as roadheaders) are moved to and from site respectively.

Worst case daily light vehicle and heavy vehicle numbers associated with spoil and waste removal, material deliveries and arrival and departure of construction works are summarised in Table 6-37.

Temporary lane closures on the Warringah Freeway

Construction of the Warringah Freeway Upgrade component of the project would be carried out in four main stages, including tie-in works with the Western Harbour Tunnel component of the project and the separate Beaches Link and Gore Hill Freeway Connection project (if approved). Each stage would have a series of different lane arrangements to enable the required construction activities. Additionally, there would be an enabling works stage prior to the main construction works commencing. Full and partial closures of the Warringah Freeway during construction would require careful traffic planning, management and control. The traffic and demand management measures to be implemented would be consistent with management measures that are currently employed to mitigate the impacts of regular closures to the Warringah Freeway and Bradfield Highway/Cahill Expressway as part of scheduled maintenance works for the Sydney Harbour Bridge and Sydney Harbour Tunnel. Further construction traffic planning would be carried out to address potential impacts on local and collector roads as a result of signposted detour routes (refer to Chapter 8 (Construction traffic and transport)).

Table 6-37 Peak construction vehicle movements and access

Site	Proposed access route	Daily heavy vehicle movements[1]	Daily light vehicle movements	Construction vehicle movements during AM peak hours (6am to 10am)		Construction vehicle movements during PM peak hours (3pm to 7pm)	
				Heavy vehicles	Light vehicles	Heavy vehicles	Light vehicles
Western Harbour Tunnel sites							
Rozelle Rail Yards (WHT1)	City West Link Road	165	305	42	134	43	137
Victoria Road (WHT2)	Victoria Road	420	230	111	62	111	128
White Bay (WHT3)	James Craig Road/Port Access Road	700	530	189	205	189	255
Yurulbin Point (WHT4)	Louisa Road	Nil	Nil	Nil	Nil	Nil	Nil
Sydney Harbour south cofferdam (WHT5)	No road access	Nil	Nil	Nil	Nil	Nil	Nil
Sydney Harbour north cofferdam (WHT6)	No road access	Nil	Nil	Nil	Nil	Nil	Nil
Berrys Bay (WHT7)	Balls Head Road	55	210	11	101	12	69

Site	Proposed access route	Daily heavy vehicle movements[1]	Daily light vehicle movements	Construction vehicle movements during AM peak hours (6am to 10am)		Construction vehicle movements during PM peak hours (3pm to 7pm)	
				Heavy vehicles	Light vehicles	Heavy vehicles	Light vehicles
Berry Street north (WHT8)	Berry Street off ramp and Warringah Freeway	30	130	10	20	6	18
Ridge Street north (WHT9)	Warringah Freeway	200	165	51	64	51	67
Cammeray Golf Course (WHT10)	Ernest Street, Warringah Freeway	485	480	128	198	130	212
Waltham Street (WHT11)	Waltham Street	66	180	18	86	18	86
Warringah Freeway Upgrade sites							
Blue Street (WFU1)	Blue Street	10	315	4	96	2	92
High Street south (WFU2)	Pacific Highway, High Street	15	80	6	17	2	13
High Street north (WFU3)	Pacific Highway, Alfred Street North	10	65	4	14	2	8

Site	Proposed access route	Daily heavy vehicle movements[1]	Daily light vehicle movements	Construction vehicle movements during AM peak hours (6am to 10am)		Construction vehicle movements during PM peak hours (3pm to 7pm)	
				Heavy vehicles	Light vehicles	Heavy vehicles	Light vehicles
Arthur Street east (WFU4)	Arthur Street	10	135	4	28	2	23
Berry Street east (WFU5)	Berry Street, Warringah Freeway	30	30	4	9	2	5
Ridge Street east (WFU6)	Ridge Street	20	70	4	17	2	9
Merlin Street (WFU7)	Merlin Street	Nil	150	Nil	40	Nil	35
Cammeray Golf Course (WFU8)	Ernest Street, Warringah Freeway	40	865	12	238	7	250
Rosalind Street east (WFU9)	Rosalind Street	15	205	4	46	2	47
ANZAC Park (construction access)	Ernest Street eastbound and Cammeray Avenue intersection	30	75	10	27	4	19

Note 1: Vehicle movements are each way (ie a heavy/light vehicle arriving at a site and leaving a site counts as two movements).

Construction workforce car parking

A portion of the project's labour force would be required to drive and park at construction support sites. The numbers of construction workers requiring parking would vary over the duration of the construction program.

Due to the generally constrained nature of construction support sites, only limited car parking for construction workers would be available on site. Some car parking areas would be provided at the following construction support sites:

- White Bay (WHT3)
- Berrys Bay (WHT7)
- Berry Street north (WHT8)
- Ridge Street north (WHT9)
- Cammeray Golf Course (WHT10/WFU8)
- Waltham Street (WHT11)
- Blue Street (WFU1)
- High Street south (WFU2)
- High Street north (WFU3)
- Arthur Street east (WFU4)
- Berry Street east (WFU5)
- Merlin Street Reserve (WFU7)
- Rosalind Street east (WFU9).

The number of car parking spaces at the construction support sites would be determined during construction planning. Shuttle bus transfers between construction support sites would also be provided, where required.

The construction workforce would be encouraged to use public transport (except where construction workers are required to travel to site with construction-related tools and equipment). The following public transport provisions are available near the project to provide access to construction support sites:

- Key bus corridors along Victoria Road, Pacific Highway, Warringah Freeway, Falcon Street, Miller Street and Military Road have multiple bus routes which travel along these road corridors, with bus stops near construction support sites
- The Inner West Light Rail line runs along the southern side of City West Link, with stops near the Rozelle Rail Yards
- The Northern and Western Line on the Sydney Trains suburban train network would provide access to some of the Warringah Freeway Upgrade construction support sites with the closest railway station at North Sydney.

Measures to manage any potential parking impacts during construction are discussed in Chapter 8 (Construction traffic and transport).

Property access

Construction of the Warringah Freeway Upgrade would result in some residents along Alfred Street North southbound temporarily losing vehicular access for short periods of time for discrete construction activities. Temporary disruptions to access to the residential property at 1 McIntosh Lane may also occur during construction of the new southbound bus lane bridge off Falcon Street. Residents may also need to be escorted through the works when accessing properties on foot, to

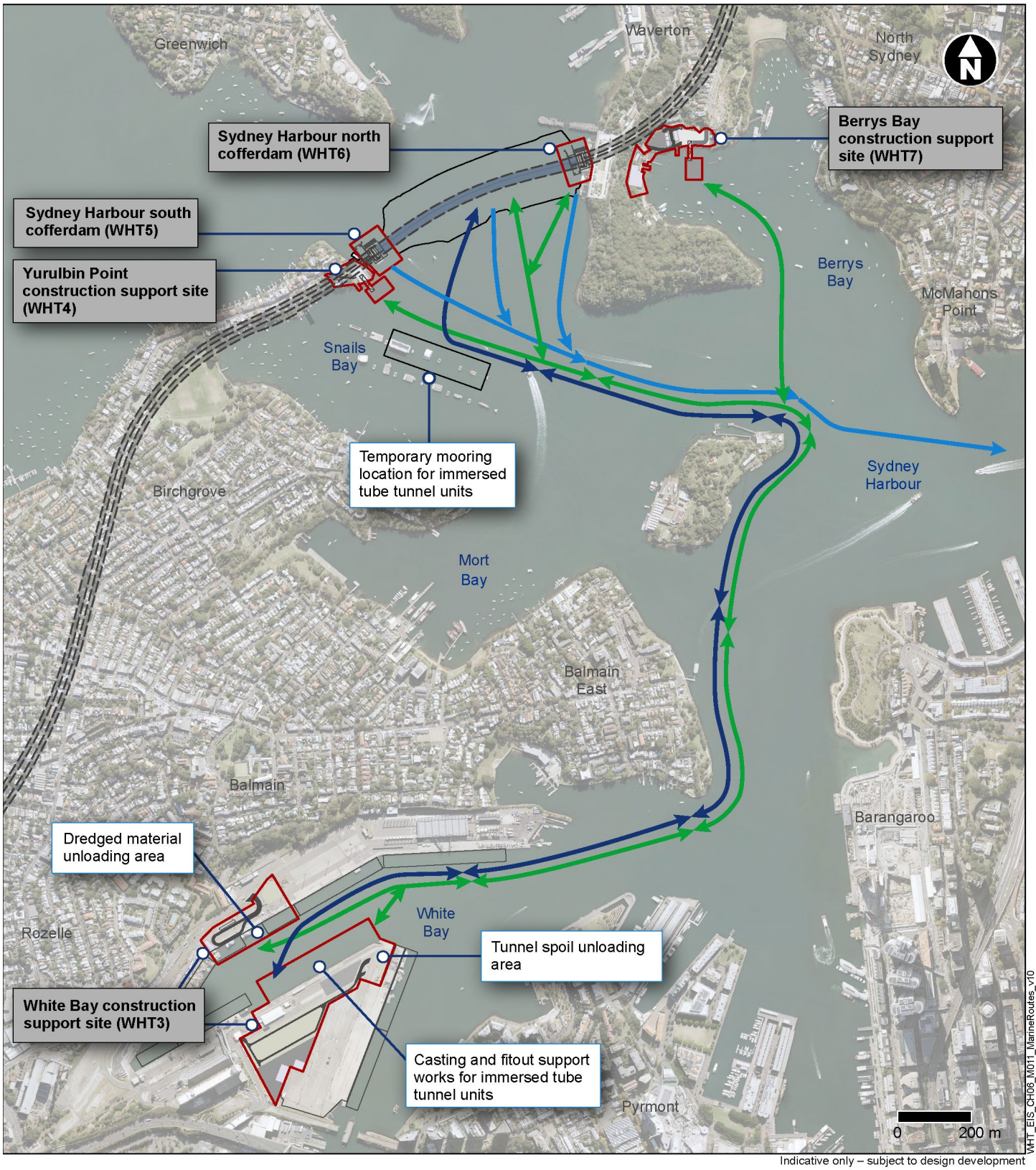
ensure safe passage. Specific engagement with affected properties during further design development would be required to determine appropriate mitigation measures.

Marine transport

Marine construction vessels would also be required during construction. Figure 6-38 shows the main routes which would be travelled across Sydney Harbour during construction. Table 6-38 details the indicative type and number of marine transport and construction vessels likely to be used during construction.

Table 6-38 Marine-based construction vessel movements

Site	Indicative vessel movements per day
White Bay (WHT3)	• Twenty-two small boat movements for transporting the construction workforce to and from harbourside and on-water sites. Shift changes requiring these movements would be carried out up to 24 hours per day, seven days per week • Fourteen barge movements for spoil removal during standard construction hours • Thirty-four barge movements for deliveries, to be carried out up to 24 hours per day, seven days per week.
Yurulbin Point (WHT4)	• Eight small boat movements for transporting the construction workforce. Shift changes requiring these movements would be carried out up to 24 hours per day, seven days per week • Four barge movements for spoil removal during standard construction hours • 12 barge movements for deliveries, to be carried out up to 24 hours per day, seven days per week.
Sydney Harbour north and Sydney Harbour south cofferdams (WHT5 and WHT6)	• Eight small boat movements for transporting the construction workforce. Shift changes requiring these movements would be carried out up to 24 hours per day, seven days per week • Two barge movements for cofferdam spoil and four barge movements for spoil dredged from the harbour crossing would be required per day to the designated offshore disposal site and may be required out outside of standard construction hours • Sixteen barge movements for deliveries, to be carried out up to 24 hours per day, seven days per week.
Berrys Bay (WHT7)	• Six small boat movements for transporting the construction workforce. Shift changes requiring these movements would be carried out up to 24 hours per day, seven days per week • Six barge movements for spoil removal during standard construction hours • Six barge movements for deliveries, to be carried out up to 24 hours per day, seven days per week.



Legend

- Driven tunnel
- Immersed tube tunnel
- Construction footprint
- Construction support site
- Immersed tube tunnel transportation route
- Marine construction traffic routes for dredging, tunnel spoil, cofferdams and permanent structures
- Route for offshore disposal

Figure 6-38 Marine transport and construction vessel routes in Sydney Harbour

6.8.3 Construction plant and equipment

The plant and equipment listed in Table 6-39 are likely to be used during construction of the project. The final list of plant and equipment required for each construction activity would depend on the final construction methodology developed by the construction contractor.

Table 6-39 Indicative construction plant and equipment

Plant and equipment	Early works	Site establishment	Construction of driven tunnels	Construction of the immersed tube tunnels	Construction of operational facilities	Tunnel fitout and finishing works	Surface road works	Testing, commissioning and demobilisation
Vacuum truck	X						X	
Grader, excavator, excavator with rock hammer	X	X	X	X	X		X	
Bulldozer	X						X	
Backhoe, bobcat, front end loader		X	X		X	X	X	X
Chainsaw[1]		X					X	
Grinder, mulcher[1]		X					X	X
Forklift		X	X			X		
Elevated work platform, scissor lift		X		X	X	X	X	X
Light tower[2]				X			X	
Mobile crane[2]	X	X	X	X	X	X	X	X
Light vehicle	X	X	X	X	X	X	X	X
Dump truck, concrete agitator	X	X	X	X	X	X	X	X
Truck	X	X	X		X	X	X	X
Linemarking truck		X					X	
Pavement laying machine							X	
Vibratory roller, compactor							X	
Power generator				X	X	X	X	X

Plant and equipment	Early works	Site establishment	Construction of driven tunnels	Construction of the immersed tube tunnels	Construction of operational facilities	Tunnel fitout and finishing works	Surface road works	Testing, commissioning and demobilisation
Compressor		X	X	X	X		X	
Jackhammer[1]				X			X	
Rock crusher[1]							X	
Concrete saw[1]	X						X	
Concrete pump, concrete vibrator		X	X	X	X	X	X	
Hand tools, welding equipment	X	X	X	X	X	X	X	X
Piling rig (bored)[1]		X	X		X		X	
Piling rig (impact)[1]				X			X	
Drilling machine (diesel)			X					
Pneumatic hammer/vibrator[1]			X			X		
Shotcrete rig			X				X	
Air track drilling rig[1]							X	
Roadheader			X					
Dust scrubber			X					
Ventilation fan		X	X					
Water cart							X	X
Road sweeper							X	X
Barge, small boat, tugboat			X	X				
Flat top work barge				X				
Mooring pontoon				X				
Dredging equipment				X				

Note 1: high noise generating equipment
Note 2: plant and equipment likely to generate a visual impact

6.8.4 Construction resources and waste management

Construction resource use

Construction would require various resources and materials. The main construction materials required would include:

- General fill and select fill for earthworks (sourced from within the project cutting and from tunnel spoil where the material is available and of suitable quality)
- Pavement materials, cement, concrete and steel
- Materials for lining drainage channels
- Aggregate used for concrete and asphalt
- Water
- Pre-cast concrete including pipes, culvert segments, bridge elements, retaining wall elements and roadside barriers
- Structural steel
- Plastics used for drainage, piping and conduits
- Pre-fabricated steel and road furniture units
- Wood for use in formwork and other temporary structures.

Construction material would generally be sourced from off-site suppliers. Where feasible, local sources of construction materials would be preferred to minimise haulage distances.

Indicative quantities of the main sources of materials required for construction are provided in Chapter 24 (Resource use and waste management).

Construction power requirements

Power supply would be required during the construction works at the majority of construction support sites. In particular, high voltage power would be required at the tunnel support sites. Prior to the connection of mains power supply to the tunnel support sites, roadheaders would be powered by diesel generators.

The power supply for each site would be sourced from outside the project area. The power supply requirements for construction support sites is described in Chapter 24 (Resource use and waste management). Potential supply source, supply route and power demand is described in Appendix D (Utilities management strategy).

Construction water requirements

Tunnelling works would require substantial volumes of water for excavation and would generate wastewater requiring treatment and disposal.

Construction water supply would also be required for tunnel connection construction and surface activities, including earthworks, concreting, building construction and dust suppression. Construction of the project would require about 837 kilolitres of potable water and 490 kilolitres of non-potable water per day. Additional information about construction water requirements is provided in Chapter 24 (Resource use and waste management).

Suitable connections for water discharge from wastewater treatment plants at construction support sites would be required at:

- Rozelle Rail Yards (WHT1) – to either Rozelle Bay or Whites Creek
- Victoria Road (WHT2) – to a drainage pit on Victoria Road
- Yurulbin Point (WHT4) – to a drainage pit within the construction support site

- Berrys Bay (WHT7) – to a drainage pit within the construction support site
- Cammeray Golf Course (WHT10) – to a drainage pit within the construction support site.

Further details are provided in Chapter 17 (Hydrodynamics and water quality).

Spoil and waste management

The project is estimated to generate about 2.1 million cubic metres of spoil, about 760,000 cubic metres of dredged material suitable for disposal at the designated offshore disposal site and about 140,000 cubic metres of material not suitable for offshore disposal. Spoil generation and dredged material from each construction support site is provided in Chapter 24 (Resource use and waste management).

Excess spoil that cannot be reused within the project would require offsite disposal. The final destination(s) for excess spoil from construction of the project would be confirmed prior to construction commencing.

The vast majority of the spoil generated by the project will be Virgin Excavated Natural Material (VENM) – typically consisting of crushed sandstone and shale. VENM is generally considered a desirable material for clean and stable fill in development sites and major earthworks projects across Greater Sydney. Recent examples include the use of crushed sandstone from Sydney Metro to construct runway pavements for the new Western Sydney Airport, and reuse of crushed sandstone from the WestConnex tunnels for numerous development projects.

An application for offshore disposal of suitable dredged material has been submitted to the Commonwealth Department of the Environment and Energy. It is proposed that suitable dredged material would be transported by barge and disposed of at a designated offshore disposal site (in accordance with legislative requirements). Dredged material unsuitable for offshore disposal would be loaded into adjacent hopper barges before being transported to White Bay, before being made spadable and then disposed of at a land-based licensed facility.

Other waste streams which would be generated during construction include:

- Demolition waste from existing structures and properties
- Contaminated soil and dredged material which may be encountered during construction
- General construction waste such as concrete, steel and timber formwork off-cuts
- Vegetation waste from clearing and grubbing
- Plant and vehicle maintenance waste such as oils and lubricants
- General office waste such as paper, cardboard, plastics and food waste
- Sewage waste.

Further details are provided in Chapter 24 (Resource use and waste management).

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