NSW GOVERNMENT | sydney METRO

West

Westmead to The Bays and Sydney CBD

Environmental Impact Statement

Concept and Stage 1

2020

Cover: Artist’s impression of Parramatta metro station.

Certification

Submission of Environmental Impact Statement

This Environmental Impact Statement has been prepared under Division 5.2 of the (NSW) *Environmental Planning and Assessment Act 1979* and in accordance with Part 3 of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000*.

Environmental Impact Statement prepared by:

Name	Katrina Smallwood
Qualifications	Bachelor of Applied Science
Address	Jacobs/Arcadis Level 7, 177 Pacific Highway, North Sydney NSW 2060
In respect of	Sydney Metro West Environmental Impact Statement – Concept and Stage 1
Applicant Name	Sydney Metro
Applicant Address	Level 43, 680 George Street, Sydney NSW 2000 PO Box K659, Haymarket NSW 1240
Proposed development	Sydney Metro West involves the construction and operation of a metro rail line, around 24 kilometres in length, between Westmead and the Sydney CBD. New metro stations would be developed at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock, The Bays and the Sydney CBD. Further details are provided in Chapter 6 (Concept description) and Chapter 9 (Stage 1 description).
Land to be developed	The Concept and Stage 1 would be carried out on land in the local government areas of Cumberland City, City of Parramatta, Strathfield, City of Canada Bay, Burwood, Inner West and City of Sydney. The track alignment would be mainly located underground in twin tunnels extending between Westmead and the Sydney CBD. New metro stations would be developed at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock, The Bays and the Sydney CBD. A stabling and maintenance facility would be developed Clyde, with services facilities at Rosehill (within the Clyde stabling and maintenance facility construction site), Silverwater and between Five Dock and The Bays.
Environmental Impact Statement	An Environmental Impact Statement is attached that assesses all matters specified in the Secretary's Environmental Assessment Requirements dated 11 December 2019, in accordance with Division 5.2 of the (NSW) *Environmental Planning and Assessment Act 1979* and other relevant legislation.
Declaration	I certify that I have prepared the contents of the Environmental Impact Statement in accordance with Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* and the Secretary's Environmental Assessment Requirements dated 11 December 2019, and that, to the best of my knowledge the information contained in the Environmental Impact Statement is not false or misleading.
Signature	
Name	Katrina Smallwood
Date	15 April 2020

Note: This document does not reflect the decision made by the NSW Government to not include Rydalmere as a station.

Executive summary

Executive summary

Overview

Sydney Metro is Australia's biggest public transport program. Services between Rouse Hill and Chatswood started in May 2019 on this new stand-alone metro railway system, which is revolutionising the way Sydney travels. Sydney Metro's program of work is shown in Figure E-1 and includes the Metro North West Line (which opened in May 2019), Sydney Metro City & Southwest (which is currently under construction and due to open in 2024), Sydney Metro West (this project) and Sydney Metro Greater West (which is currently in the final stages of planning).

Sydney is expanding and the NSW Government is working hard to deliver an integrated transport system that meets the needs of customers now and in the future. The delivery of Sydney Metro West is critical to keeping Sydney moving, and would:

- Provide a direct, fast, and frequent connection between Greater Parramatta and the Sydney CBD, linking communities along the way that have previously not been serviced by rail
- Relieve the congested T1 Western Line, T9 Northern Line (previously T1 Northern Line) and T2 Inner West and Leppington Line
- Double the existing rail capacity between the Sydney and Parramatta CBDs
- Significantly boost economic opportunities for Greater Parramatta
- Support new residential and employment zones along the Greater Parramatta to Sydney CBD corridor, including at Sydney Olympic Park and The Bays – providing improved transport for the additional 420,000 new residents and 300,000 new workers forecast to be located within the corridor over the next 20 years
- Allow customers fast and easy transfers with the T1 Western Line at Westmead, the T9 Northern Line at North Strathfield, and the suburban rail network and Sydney Metro in the Sydney CBD
- Allow for transfers with the future Parramatta Light Rail (Stage 1) at Westmead and Parramatta, as well as the planned future Parramatta Light Rail (Stage 2) at Sydney Olympic Park
- Create an anticipated 10,000 direct and 70,000 indirect jobs during construction (based on Sydney Metro analysis).

The planning approvals and environmental impact assessment for Sydney Metro West will be broken down into a number of stages recognising the size of the project. This includes:

- Sydney Metro West at a Concept level
- Stage 1 – All major civil construction works between Westmead and The Bays including station excavation and tunnelling
- Stage 2 – All stations, depots and rail systems between Westmead and The Bays.
- Stage 3 – All major civil construction works including station excavation, tunnels, stations, depots and rail systems between The Bays and the Sydney CBD Station, and operation of the line.

Whilst the content of these stages may be varied, this Environmental Impact Statement covers the Concept and Stage 1 comprising all major civil construction works between Westmead and The Bays including station excavation and tunnelling.

Key features of the Concept

Sydney Metro West (the Concept) would involve the construction and operation of a metro rail line, around 24 kilometres long, between Westmead and Sydney CBD (refer to Figure E-2).

The key components are expected to include:

- About 24 kilometres of twin tunnels between Westmead and the Sydney CBD
- New metro stations at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock, The Bays and Sydney CBD. The location of the Sydney CBD station will be determined following further investigations and community and stakeholder engagement. Optional stations at Rydalmere and Pyrmont are also under investigation

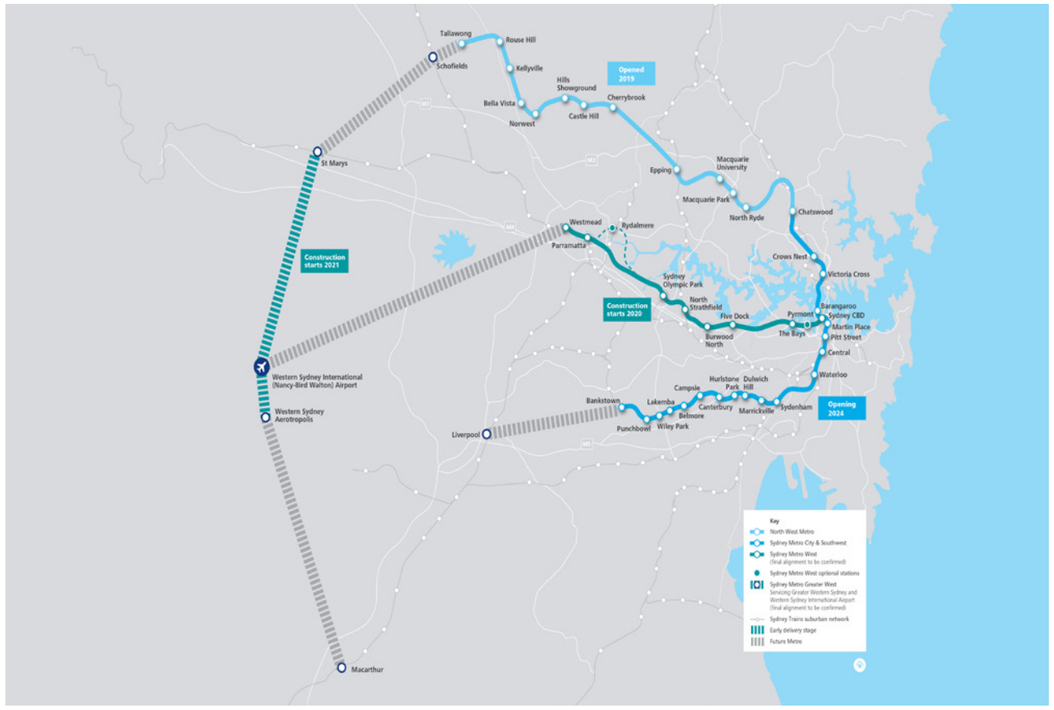

Figure E-1: The Sydney Metro network

- A turn-up-and-go metro service operating early morning to late at night, between Westmead and the Sydney CBD
- Pedestrian links and connections to other modes of transport (such as the existing suburban rail network and other parts of the metro network) and surrounding land uses
- Modifications to existing suburban stations and associated rail infrastructure (such as overhead wiring, signalling, access tracks/paths and rail corridor fencing) at Westmead and North Strathfield
- Services within each of the metro stations, including mechanical and fresh air ventilation equipment and electrical power substations to supply power for operation
- A stabling and maintenance facility at Clyde, including associated aboveground and belowground tracks to connect to the mainline tunnels
- Services facilities at Rosehill (within the Clyde stabling and maintenance facility construction site), Silverwater and between Five Dock and The Bays for fresh air ventilation and emergency evacuation
- Alterations to pedestrian and traffic arrangements, and cycling and public transport (e.g. bus) infrastructure around the metro stations
- Subdivision of station sites to support integrated station and precinct development and ancillary facilities
- Ancillary facilities to support construction.

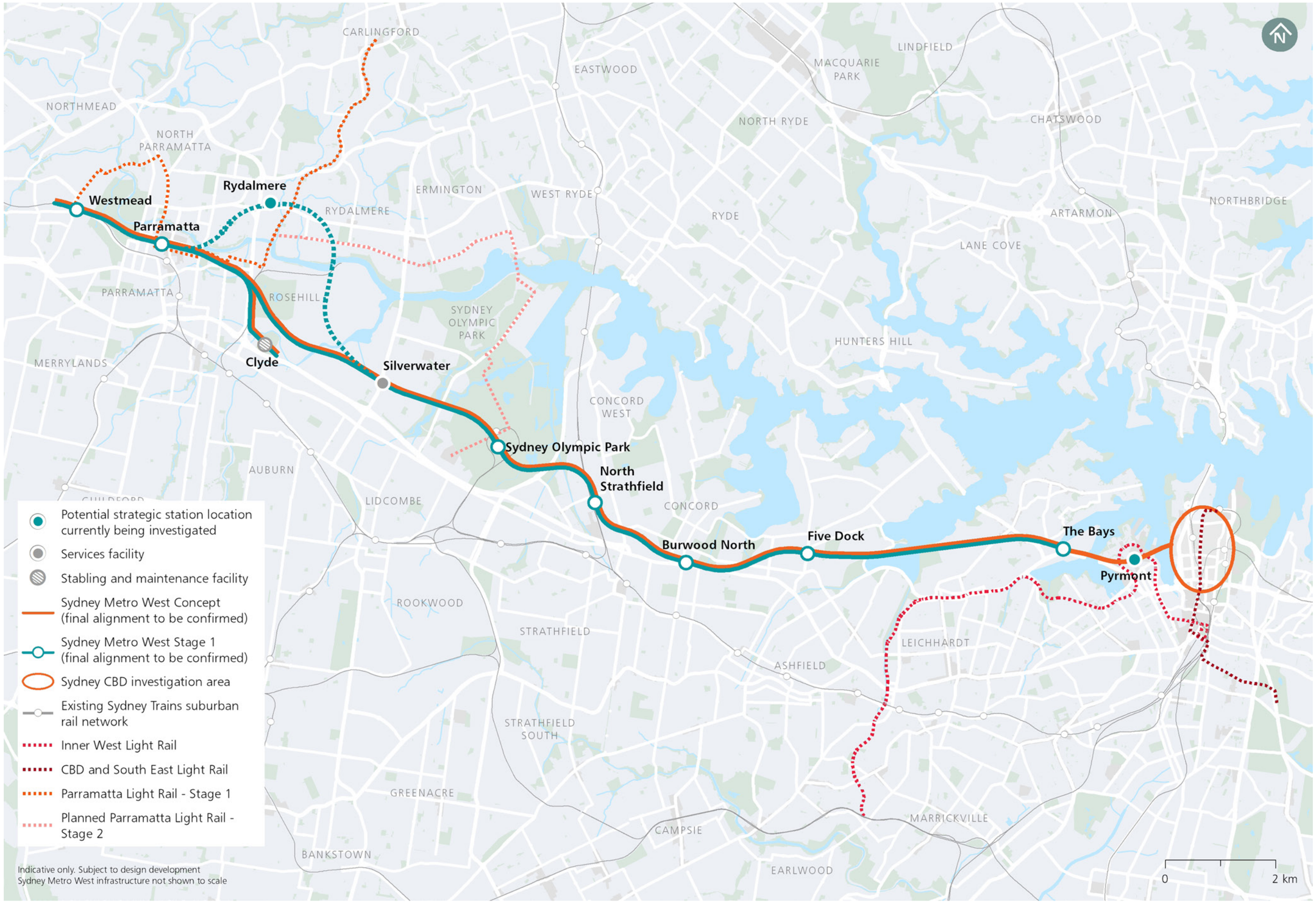

Figure E-2: Overview of the Concept

Key features of Stage 1

Stage 1 would involve major civil construction work between Westmead and The Bays, including:

- Enabling works
- Tunnel excavation including tunnel support activities
- Station excavation for new metro stations at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock and The Bays
- Shaft excavation for services facilities at Rosehill (within the Clyde stabling and maintenance facility construction site), Silverwater and for a facility between Five Dock and The Bays
- Civil works for the stabling and maintenance facility at Clyde including earthworks and structures for crossings at A'Becketts Creek and Duck Creek
- A concrete segment facility for use during construction located at the Clyde stabling and maintenance facility construction site
- Excavation of a tunnel dive structure and associated tunnels at Rosehill to support a connection between the Clyde stabling and maintenance facility and the mainline metro tunnels.

Construction program and major civil construction works

A number of construction sites would be needed. These include locations for tunnel equipment and support, stations, surface track and ancillary facilities.

Enabling works (preliminary construction works required to facilitate the start of substantial construction) would likely begin before major construction works. The total period for Stage 1 construction works would be around five years. An indicative construction program is shown in Figure E-3. The actual program and commencement of works at each construction site is subject to the final delivery strategy being confirmed.

Need for and benefits of Sydney Metro West

Key challenges

Sydney is Australia's financial and economic capital, housing half of the country's globally competitive service sector jobs. The Greater Parramatta to Sydney CBD corridor is one of the city-shaping transport corridors nominated in the Greater Sydney Region Plan (Greater Sydney Commission, 2018a). The corridor is of national economic significance and contains nearly 620,000 high productivity jobs, which is around 20 per cent of the jobs in Greater Sydney, and generates eight per cent of the nation's Gross Domestic Product per year.

Recognising the importance of the corridor, several land use planning and development initiatives have commenced in Westmead, Parramatta, Sydney Olympic Park, The Bays and the Sydney CBD. These initiatives are expected to account for more than 60 per cent of forecast population growth and more than 80 per cent of forecast jobs growth in the corridor by 2036

Sydney's growing population will continue to increase demand on the existing transport network. Despite planned upgrades and additional services which will provide some short term relief, the T1 Western Line is expected to reach capacity in 2024 and the T9 Northern Line is expected to reach capacity in 2027. Reliability impacts in the Sydney CBD cause network-wide impacts, reducing network capacity and increasing crowding on trains and platforms.

Benefits of Sydney Metro West

Sydney Metro West would effectively double rail capacity from Parramatta to the Sydney CBD with the delivery of a new high capacity rail connection. At ultimate capacity, Sydney Metro West would be able to move more than 40,000 people an hour in each direction and would complement the suburban and intercity services between Parramatta and the Sydney CBD. Sydney Metro would result in numerous transport benefits, including:

- Reducing crowding on trains and on station platforms at key existing stations on the suburban rail network
- Substantially improving accessibility via the public transport network to key economic centres across the Greater Parramatta to Sydney CBD corridor
- Increasing the reach and use of Sydney's public transport network by providing new station locations at Burwood North, Five Dock and The Bays
- Improving travel times for customers
- Reducing travel time between the Parramatta and Sydney CBDs to a target of around 20 minutes
- Providing an alternative to the existing Sydney Trains suburban rail network thereby reducing the impacts of scheduled maintenance and major unavoidable incidents
- Providing the opportunity to optimise the bus network by reducing the number of buses on congested corridors such as Parramatta Road and Victoria Road and increasing bus services on other parts of the network
- Providing the opportunity for mode shift from car to public transport, which could result in road user travel time savings.

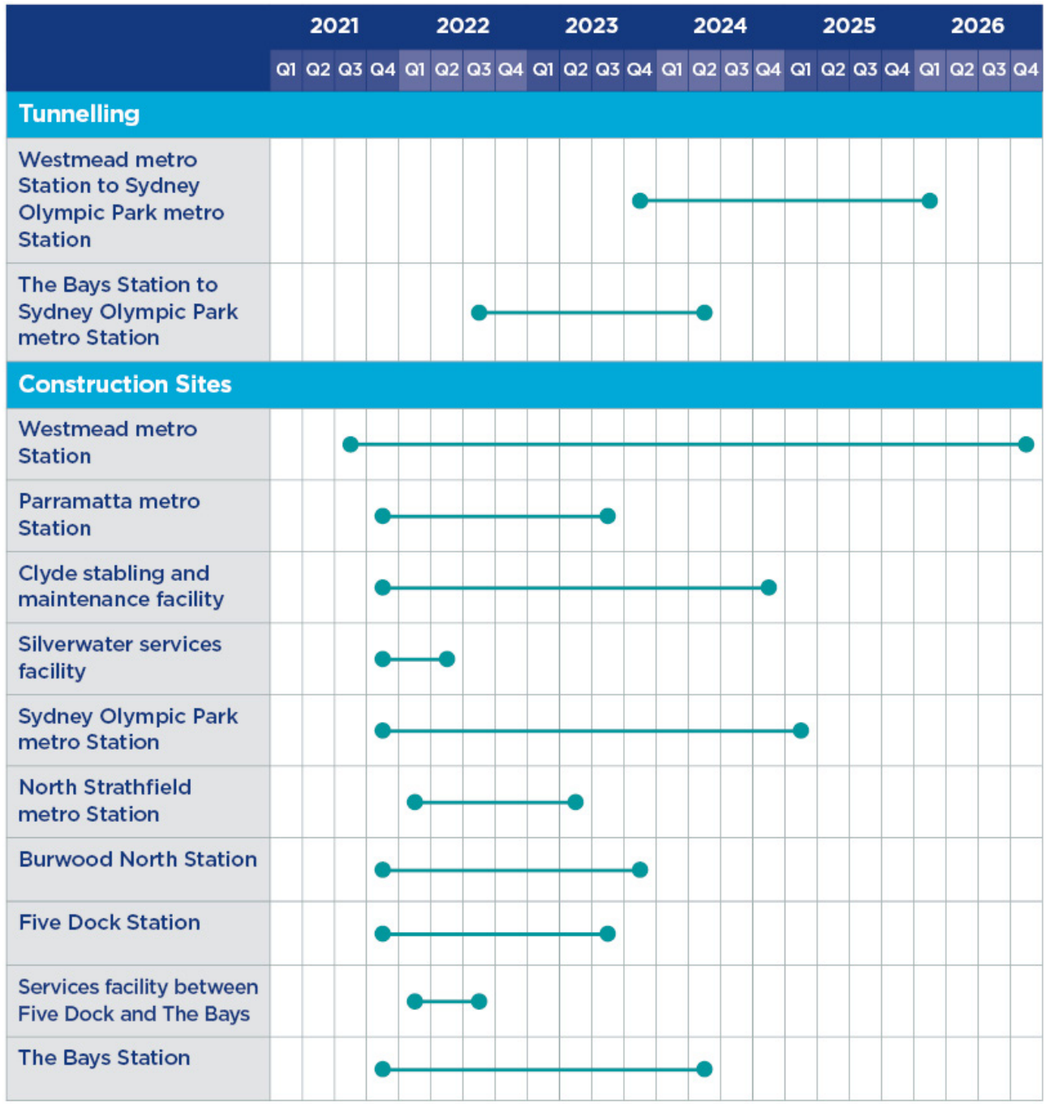

Figure E-3: Indicative construction program – Stage 1

Note: This program only shows major civil works (Stage 1) indicative duration and not the total works.

By improving the connections between key economic centres, Sydney Metro West would foster significant growth in jobs, including directly supporting the creation of new jobs within the corridor particularly at the key precincts of Westmead, Parramatta, Sydney Olympic Park and The Bays.

There is a strong link between public transport and land use change. Transport accessibility and amenity are critical to supporting employment, housing supply and urban renewal opportunities and ultimately to support Sydney's economic and population growth. Transport accessibility and amenity issues include crowding and capacity constraints within the Greater Parramatta to Sydney CBD corridor, and traffic congestion from high levels of car use. These issues are limiting the achievement of planned growth because these areas are less attractive to households and developers.

Sydney Metro West would provide city-shaping benefits including:

- Supporting planned growth and land use outcomes in the CBDs, planned precincts and urban renewal areas
- Supporting the implementation of 30-minute cities as outlined in the Greater Sydney Region Plan by providing turn-up-and-go services to key destinations
- Supporting the creation of jobs and housing opportunities in Western Sydney with improved liveability and better access to services and employment
- Promoting healthier and more sustainable travel behaviours through enhanced pedestrian environments, opportunities for incidental exercise and potential for reduced travel related stress.

Placemaking

The delivery of Sydney Metro West offers the opportunity to transform areas with new places, or to reinforce and enhance existing places. The approach to placemaking at each locality would be contextual, taking into consideration that metro stations would:

- Function as 'places' in their own right, creating focal points in the communities each station serves. The stations would attract a range of benefits and land uses, including reducing dependence on private vehicles, providing public places for gathering and human interaction supported by commercial and retail, as well as encouraging exercise by promoting walking and cycling to and from the stations
- Have a role in contributing to their surrounding environment or 'place' in which they are located by supporting planned growth and renewal, and acting as a catalyst for transit-oriented development within their catchments.

Further details regarding placemaking outcomes at each site will be assessed in subsequent assessment stages.

Sydney Metro West objectives

The Sydney Metro West network objectives are:

- Ensure transport services are meeting the needs of customers
- Deliver outcomes that align with and support key strategic land use and transport frameworks including the Smart Cities Plan, Greater Sydney Region Plan, Future Transport Strategy and the relevant District Plans
- Boost Sydney's international competitiveness, productivity and employment growth by supporting new and existing strategic centres
- Support future housing needs by increasing housing supply, choice and affordability
- Improve liveability and provide a catalyst for positive change by unlocking urban renewal opportunities, enhancing housing supply and supporting productivity of centres
- Improve access to and resilience of the transport network through integrated land use and transport planning, including integration of Sydney Metro West with other transport modes
- Ensure value for money and a sustainable and deliverable solution.

The Sydney Metro West Greater Parramatta to Sydney CBD corridor objectives are:

- Contribute towards the vision for a three cities metropolis established by the Greater Sydney Commission including the '30-minute city' concept
- Support additional housing supply and employment growth opportunities and support urban renewal initiatives within the Greater Parramatta to Sydney CBD corridor including key government precincts such as the Greater Parramatta and Olympic Peninsula and The Bays
- Achieve customer outcomes including relieving congestion on the busy T1 Western Line and T2 Inner West and Leppington Line, increased rail patronage and mode shift, reduced travel times between key destinations, providing new access to mass transit rail and relieving bus and road congestion in the western corridor.

Options considered

The Sydney Metro West development process has been driven by the identified strategic need to improve connectivity between Greater Parramatta and the Sydney CBD, and has included:

- Development of a solution to improve transport capacity and amenity between Parramatta and the Sydney CBD, and support population growth
- Consideration of alignment options and the type of service, including determining the optimal balance of travel times between the Parramatta and Sydney CBDs, and the number of stations to enable people to access metro services
- Analysis of options for station locations
- Analysis of options for a stabling and maintenance facility
- Analysis of options for the approach to tunnelling
- Investigations into safeguarding measures for potential future extensions of Sydney Metro West.

The option selection process has taken into account issues raised during consultation with key stakeholders, including government agencies and the community. Options were assessed against a range of criteria, including customer outcomes, constructability, operation, environmental impacts, accessibility, heritage and placemaking considerations, risk and cost effectiveness.

Stakeholder and community engagement

Stakeholder and community consultation for Sydney Metro West has played an integral part of the projects development and has informed scoping investigations for this Environmental Impact Statement, and will continue to do so through ongoing project development and construction.

Sydney Metro has developed a comprehensive community and stakeholder engagement program and has been proactive in engaging with local communities, key stakeholders, industry and government agencies throughout project development. A key objective of this engagement has been to encourage participation and obtain input for consideration in the development of Sydney Metro West and its future implementation.

Since the announcement of Sydney Metro West by the NSW Government in 2016, consultation has been undertaken with state government departments and agencies, local government, peak organisations, the community and industry. This has involved:

- A first round of community and industry consultation from June 2017 to September 2017 along a broad study area between Greater Parramatta and the Sydney CBD
- A stakeholder deliberative forum held on 30 August 2017, which was attended by 37 senior stakeholders from a range of state government departments and agencies, councils and some key local institutions
- A second round of community and industry consultation from March 2018 to May 2018 over a refined study area between Greater Parramatta and the Sydney CBD
- Community and stakeholder engagement after lodgement of the Scoping Report and during preparation of this Environmental Impact Statement between October 2019 and April 2020.

In addition to the consultation sessions undertaken with the community and industry, the following consultation activities have been undertaken:

- Letterbox drop to more than 220,000 residents and businesses
- Proactive media strategy, which resulted in broad coverage across Sydney metropolitan and local print, radio and television outlets
- Advertisements in local and multicultural newspapers
- Email alerts to registered community members and stakeholders
- Social media via the Sydney Metro Facebook page, which has a reach of almost 37,000 people
- Paper survey – via completing a form at a public information session
- Online survey – 'Have your say' on the Sydney Metro and Transport for NSW websites
- Two 'Project Overview' information booklets (published in June 2017, March 2018 and October 2019)
- Newsletter – 'Sydney Metro West – the city's next underground metro railway' (September 2018), delivered via letterbox drop and placed on the project website
- Newsletter – 'Sydney Metro West stations confirmed' (October 2019), delivered via letterbox drop and placed on the project website.

Ongoing communication channels have also been established for Sydney Metro West since the project announcement to provide for ongoing engagement with stakeholders and communities.

The Department of Planning, Industry and Environment will place this Environmental Impact Statement on public exhibition for a minimum of 28 days (as per Schedule 1 of the NSW *Environmental Planning and Assessment Act 1979*). During the exhibition period, government agencies, stakeholders and the community will be able to review the Environmental Impact Statement and will have an opportunity to make a written submission to the Department of Planning, Industry and Environment for consideration in its assessment of Sydney Metro West.

Environmental assessment

This Environmental Impact Statement has been prepared in accordance with the provisions of Part 5.1 of the *Environmental Planning and Assessment Act 1979*. In particular it addresses the requirements of the Secretary of the Department of Planning, Industry and Environment. It also includes consideration of the issues raised by the community and stakeholders during the development of the project.

Key environmental issues have been examined throughout the design and development process. Consultation has been carried out with affected stakeholders to identify key potential impacts at an early stage. Where possible, these would be avoided or appropriate mitigation measures have been developed. This has resulted in a number of design changes and refinements that have mitigated many of the potential significant impacts.

The main impacts identified in the environmental assessment are described in the following sections.

Concept environmental issues

As described above, the construction and operation of Sydney Metro West would result in numerous transport benefits, foster significant growth in jobs and support planned land use outcomes in the Parramatta and Sydney CBDs, planned precincts and urban renewal areas. Potential environmental impacts associated with the Concept have been broadly assessed by considering the existing environment of the Concept corridor.

Specific performance outcomes have been established so that potential environmental impacts associated with construction and operation of the Concept are avoided or minimised.

Potential key operational benefits and impacts of the Concept include:

- Positive traffic, transport and access benefits including increased capacity and reliability of the public transport network, improved travel times and comfort, reduced crowding, increased customer catchment, and improved connectivity and transfer opportunities for customers
- Changes to traffic arrangements, permanent or temporary loss of loading zones and parking spaces, altered pedestrian and cyclist arrangements
- Minimal ground-borne and structure-borne noise and vibration from train operations, the stabling and maintenance facility, ventilation facilities and other ancillary facilities
- Potential impacts on the heritage significance of listed heritage items and conservation areas due to the establishment of new infrastructure that detracts from the values of a heritage item and/or changes to the visual setting of a heritage item
- Support for planned growth and land use change in a number of precincts across the corridor, including Westmead, the Parramatta Road Corridor, Sydney Olympic Park and The Bays
- Permanent acquisition of property to enable the establishment and operation of Sydney Metro West infrastructure
- Changes to local visual and landscape character (both positive and negative) associated with the establishment of new stations, ancillary infrastructure, and the stabling and maintenance facility
- Increased business access to local and regional labour markets and improved customer access to businesses
- Support potential private development and investment within areas around new metro stations resulting in favourable business conditions
- Long-term positive social and community impacts including improved physical and mental health, amenity and placemaking benefits, increased access to jobs, universities and services, and improved air quality.

Performance outcomes would avoid, minimise or appropriately manage potential environmental impacts during construction of the Concept. Potential construction impacts would generally be temporary and would be offset by the significant transportation and other benefits that Sydney Metro West would provide over the medium to longer term and particularly for future generations. Potential key construction impacts would include:

- Potential temporary impacts to traffic performance on the road network surrounding construction sites due to changes to traffic arrangements, loss of loading zones and parking spaces, alteration of public and active transport arrangements, and temporary construction traffic
- Potential temporary ground-borne noise, airborne noise and vibration impacts on surrounding land uses and sensitive receivers due to temporary construction activities
- Potential direct impacts (from demolition and excavation works) and indirect impacts (from visual and vibration impacts) on non-Aboriginal heritage and potentially significant archaeological remains
- Potential direct impacts to known Aboriginal sites in Parramatta and potential impacts to previously unrecorded archaeological deposits with high archaeological significance
- Potential temporary disruption of utilities, services and transport assets
- Potential temporary impacts on landscape character and visual amenity for nearby sensitive receivers due to the presence of construction sites, acoustic sheds or other acoustic measures, removal of trees, construction vehicles, and potential temporary loss of open space
- Potential temporary impacts to local businesses associated with increased traffic congestion, utilities adjustments, and potential reduced visibility
- Potential temporary social and community impacts due to reduced local amenity, access and changes to local character
- Potential groundwater drawdown/lowering of the water table due to tunnelling, resulting in potential impacts on nearby groundwater users
- Ground disturbance potentially leading to soil erosion, exposure of acid sulfate soils and a reduction in surface water quality
- Potentially encountering contamination during excavation works associated with previous historic land uses.

Stage 1 environmental issues

Stage 1 would involve temporary construction activities associated with tunnelling, excavation and other major civil works between Westmead and The Bays. As a result, the potential temporary impacts associated with Stage 1 would be limited to the construction phase.

Where possible, Sydney Metro has avoided and minimised impacts as part of project development and design. Potential impacts would be adequately managed through the implementation of construction environmental management documentation and the specific performance outcomes and mitigation measures identified in this Environmental Impact Statement. This would include the use of the Sydney Metro Construction Environmental Management Framework, Construction Noise and Vibration Standard and Construction Traffic Management Framework which set out the overall approach to environmental management approach. These documents have been successfully implemented on previous Sydney Metro projects including Sydney Metro Northwest and City & Southwest.

Transport and traffic

Potential transport and traffic impacts of Stage 1 have been avoided and minimised, primarily by minimising the use of local roads, identifying the most efficient haul route to the arterial road network and minimising movements during existing network peak periods. In addition, the management of construction traffic would be in accordance with the Sydney Metro Construction Traffic Management Framework and site specific mitigation measures. This includes measures to manage pedestrian, cyclist and motorist safety around construction sites.

Stage 1 would require construction work to be carried out adjacent to areas with high volumes of traffic and pedestrians in busy urban areas. This would result in some potential temporary impacts to traffic performance on the surrounding road network due to the temporary addition of construction vehicles and temporary road closures. This potential temporary decrease in road network performance would result in delays at some intersections and increased queue lengths at some locations, particularly near the Westmead metro station, North Strathfield metro station and Five Dock Station construction sites.

Horwood Place in the Parramatta CBD would be closed for the duration of Stage 1 and alternative temporary access arrangements would be made for properties with rear access to Horwood Place. The demolition of the City Centre multi-level car park is identified in the Draft Parramatta CBD Public Car Parking Strategy (City of Parramatta, 2017). The City of Parramatta strategy identifies the potential measures to offset this loss of car parking. The Parramatta metro station construction site would require the demolition of this car park and some off-street parking spaces - a loss of 850 parking spaces.

Construction works would temporarily impact public transport including temporary relocation of bus stops and changes to bus routes. This could result in temporary minor delays and the need for commuters to walk further to reach their destinations.

Potential impacts on the active transport network are generally expected to be limited to the temporary closure of some footpaths near some construction sites. Alternative arrangements would be made, such as diversions onto the footpath on the opposite side of the road, to maintain pedestrian access in these areas. The closure of Batman Walk and Horwood Place would have minor impacts on pedestrians and cyclists travelling within the Parramatta CBD. Detours would be established and signposted in these areas.

Measures would be put in place to limit any potential temporary impacts on pedestrians and traffic during the large number of special events which occur within the Parramatta CBD area, Sydney Olympic Park and the Rosehill Gardens racecourse.

Noise and vibration

The management of construction noise and vibration would be in accordance with the Sydney Metro Construction Noise and Vibration Standard which provides standard mitigation measures and additional mitigation measures for certain noise and vibration impact levels. Site specific mitigation measures have also been identified to reduce noise and vibration impacts, including acoustic sheds (or other acoustic measures), the use of alternative construction methods and programming works around more sensitive periods.

Consistent with most major infrastructure projects in urban areas, where receivers are close to construction sites (such as at Westmead, Clyde, North Strathfield, Burwood North and Five Dock) the noise impacts during some of the works are expected to temporarily be 'high', particularly when noise intensive equipment such as rockbreakers are in use close to receivers. The worst-case impacts are generally predicted to occur in the early stages of the works, such as during enabling works, piling and initial excavation, which require noise intensive equipment to be used prior to the construction of acoustic sheds (or other acoustic measures). Enabling works such as roadworks and power supply works could occur during daytime, evening or night-time hours. Other early stage works including piling and initial excavation would generally occur during daytime hours.

Noise intensive works (such as excavations) within the construction sites during the night-time would generally only be completed inside acoustic sheds (or once other acoustic measures have been established) however, 'moderate' worst-case impacts are expected at some receivers.

The main potential sources of construction ground-borne noise and vibration are associated with the use of tunnel boring machines, roadheaders and rockbreakers during tunnelling and station shaft excavation. The worst-case predicted ground-borne noise impacts are generally compliant with the management levels or result in only 'minor' impacts for most receivers. 'Moderate' or 'high' impacts are, however, predicted for the Westmead metro station, Parramatta metro station, Clyde stabling and maintenance facility, North Strathfield metro station, Burwood North Station and Five Dock Station construction sites, either due to the tunnel being shallow at this location or sensitive receivers being near the station shaft excavation works. Alternative construction methods such as the use of blasting may be adopted in some locations to reduce these impacts.

There is potential for temporary exceedances of vibration cosmetic damage screening criteria at Parramatta, Clyde, Silverwater, Burwood North, Five Dock and The Bays, due to vibration sensitive structures being adjacent to the boundary of these sites. Further investigation would be carried out to determine appropriate vibration levels for these structures. Exceedances of the human comfort vibration criteria are also predicted at the nearest receivers to all construction sites, meaning occupants of affected buildings may be able to perceive the impacts at times when vibration intensive equipment is in use nearby.

There would also be minor construction and operational traffic noise impacts to receivers near the Westmead metro station construction site particularly along Grand Avenue and Alexandra Avenue.

Non-Aboriginal heritage

Potential non-Aboriginal heritage impacts of Stage 1 have been avoided and minimised where possible. For example, locally listed heritage items within the Parramatta metro station construction site would be retained and protected. In addition to archival recordings, management and mitigation measures have been identified to minimise direct and indirect impacts to heritage items. Where direct impacts are unavoidable such as at White Bay Power Station, this would include opportunities for salvage for the retention, conservation and reuse of original and significant heritage fabric. Further archaeological investigations would be undertaken as required in accordance with Heritage Council guidelines.

Stage 1 has potential to have direct and indirect impacts on three heritage items of State significance; Roxy Theatre, State Abattoirs and White Bay Power Station. Both the State Abattoir and White Bay Power Station would experience moderate direct impacts to the item as well as moderate indirect impacts on views and vistas associated with the introduction of construction elements near these items. There would be no direct impacts on Roxy Theatre and four other local heritage items however there would be moderate indirect impacts to views and vistas.

Potential temporary impacts due to construction vibration would be limited, with potential minor impacts identified for State Abattoirs, the White Bay Power Station, two local heritage items at Parramatta, one local heritage item at Clyde and one local heritage item at The Bays.

The Parramatta metro station construction site has low to moderate potential to contain State significant archaeological remains associated with the earliest phases of European settlement including convict huts, yards and gardens. The site also has low to moderate potential to contain archaeological resources relating to early colonial residences and yards, and the convict drain. These resources, should they be present, would likely be of local to State significance, depending on the intactness of remains. The Bays Station construction site is identified as having non-Aboriginal archaeological potential of local significance. Ground disturbance or excavation at these sites could impact on archaeological resources.

Aboriginal heritage

Development of Sydney Metro West has largely avoided direct impacts to known Aboriginal sites, and minimised the potential interface with areas with high Aboriginal archaeological potential. At sites with higher Aboriginal archaeological potential, test excavation would be carried out. If Aboriginal archaeological remains are identified during Stage 1, archaeological results would be used for Aboriginal heritage interpretation in future stages in consultation with registered Aboriginal parties.

Aboriginal archaeological sensitivity has been identified at the Parramatta metro station, Clyde stabling and maintenance facility, and The Bays Station construction sites. Of these, the Parramatta metro station site includes one registered Aboriginal site (AHIMS ID 45-6-3582) as well as the Parramatta Sand Body, which has demonstrated archaeological potential.

Archaeological sensitivity at the Clyde stabling and maintenance facility, and The Bays Station construction sites is subject to confirmation by archaeological test excavation and/or identification of intact soil profiles during non-Aboriginal (historical) archaeological investigation.

For the remaining construction sites, due to the landscape context and largely modified nature of the construction sites and surrounding areas, the likelihood of intact artefact bearing archaeological deposits is low. There is low potential for impact to Aboriginal objects, and any Aboriginal objects that might be located within the impact area are likely to be within a disturbed context and would therefore be of low archaeological significance.

Property and land use

Sydney Metro makes every effort to avoid the need to acquire private property. For example, the sites at North Strathfield and The Bays are wholly located on existing NSW Government owned land. Where existing government land is not available, site selection generally sought to minimise acquisition of residential land.

All property acquisitions would be managed in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and the land acquisition reforms implemented by the NSW Government. Sydney Metro has appointed Personal Managers to offer residents and small businesses assistance and support throughout the acquisition process.

During Stage 1, the main property impact would be the acquisition for construction sites proposed for station excavation, service facilities, the stabling and maintenance facility and ancillary facilities or services. Where possible, these construction sites would be located where permanent operational infrastructure would also be required, to avoid the need for temporary property impacts and minimise residual land holdings at the completion of construction.

It would also be necessary to acquire stratum for the tunnels below the surface of properties under the *Transport Administration Act 1988*. In most cases, subsurface acquisition does not affect the continued existing or intended future uses of property at the surface.

Landscape character and visual amenity

Measures would be implemented to reduce potential landscape character and visual amenity impacts. This would include retaining and protecting trees where possible, and offsetting trees removed to ensure no net loss of tree numbers.

Landscape and visual impacts would be experienced during construction near construction sites. Temporary visible elements would be introduced including acoustic sheds or other acoustic measures, machinery and equipment, site hoardings, partially complete structures, and other construction works. The introduction of these elements would affect landscapes and views including those which are considered to have high sensitivity due to the value of the landscape or urban place to the community.

The Abattoir Heritage Precinct gardens in Sydney Olympic Park, a regionally sensitive landscape, could be impacted through the removal of the southern portion of the palm grove and surrounding carriage loop gardens. This impact could be lessened with the reinstatement of the gardens with appropriate similar species and plantings in keeping with the provisions of the Conservation Management Plan. This would result in high level of visual impact. Sydney Metro is investigating the feasibility of design and construction options to avoid direct impacts to this heritage item.

Where vegetation removal is required for construction sites, there would be a reduction in the quality of landscape character and potential visual impacts from the introduction of construction sites near sensitive receivers.

At other construction sites, such as The Bays Station and Clyde stabling and maintenance facility, the works would be viewed within the context of a highly developed and dynamic urban environment, where construction and associated works are frequent occurrences.

Business impacts

Construction of Stage 1 would result in broad economic benefits by way of job generation. Locally, many businesses would benefit from increased demand from construction workers requiring food and beverage services and other goods. Construction of Stage 1 is anticipated to create 10,000 direct and 70,000 indirect jobs.

Direct impacts to business would occur where they are located within properties to be acquired. This would be managed in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991.* Sydney Metro has appointed Personal Managers to offer small businesses assistance and support throughout the acquisition process.

Measures would be also be implemented to support businesses potentially temporarily indirectly impacted during Stage 1 construction. Potential temporary indirect business impacts could include temporary constraints or restrictions on servicing and delivery/access, amenity issues such as increased traffic congestion, noise, vibration and dust, changes to customer access and parking.

Social impacts

Potential temporary social impacts associated with Stage 1 would generally be managed through appropriate mitigation of other aspects such as noise, traffic, visual and air quality. Sydney Metro would also develop a community benefit plan to guide the development of community benefit initiatives (by Principal Contractors).

The area around the Stage 1 construction sites includes a wide range of regional and local social infrastructure, with open spaces, community centres, recreation facilities, childcare centres, medical centres, nursing homes and creative and cultural facilities. The ability of certain community facilities to function, or the community's enjoyment of them, may be reduced where they are located close to construction sites.

There would be temporary changes to community character, such as changes to streetscape, access, businesses, increased numbers of workers and visitors in the area due to construction activity. Stage 1 would also potentially result in changes to sense of place and potential loss of community connections to the surrounding area due to temporary impacts of construction, potential impacts to heritage items, changes to the local business environment, changes to streetscape and urban fabric.

Groundwater and ground movement

To limit potential groundwater inflows and groundwater drawdown, the metro tunnels would be tanked (designed to prevent the inflow of groundwater, typically using concrete lining and waterproofing membrane). Similarly, the cross passages and some of the station caverns would be tanked. As a result, limited change is expected to groundwater levels.

Excavations at Stage 1 construction sites would act as local groundwater sinks, causing the surrounding groundwater to flow towards the excavations and leading to groundwater drawdown. While groundwater drawdown could affect two groundwater users (one near Westmead and one near Burwood North), potential impacts are expected to be minimal and groundwater supply is not expected to be affected. There could be some impacts to groundwater dependent ecosystems due to drawdown, although the affected plant communities are not likely to be entirely dependent on groundwater. At some locations (Westmead, Clyde, North Strathfield) groundwater drawdown could affect baseflows in nearby creeks.

Stage 1 would result in the potential migration of contaminated groundwater towards, and into, station excavations. This would pose a potential exposure risk to site users and workers and adjacent site users. This would also potentially reduce the beneficial use of the aquifer.

The majority of the Stage 1 alignment has been assessed as having a negligible ground movement risk, with superficial damage to buildings unlikely. Small areas at station sites and dive sites may require future building strain and structural assessment to address settlement related risks.

Soils and surface water quality

Given the relatively small areas of surface disturbance anticipated during construction, soil erosion would be adequately managed in accordance with proven standard mitigation measures.

Standard construction management measures would be implemented to manage the potential risk to downstream water quality from station excavation and tunnelling construction activities. Construction activities can impact on watercourses through disturbing and mobilising soil or other materials, which could result in discharges of substances to watercourses which could affect the water quality and ecosystem health. Surface construction activities would be generally be carried out in highly modified and urban environments and would not be located within or near waterways with the exception the Clyde stabling and maintenance facility construction site and The Bays Station construction site. The partial realignment and crossing of Duck Creek and A'Becketts Creek has the potential to result in a temporary change in in creek flows and velocities. The earthworks could also expose soils or sediments resulting in soil erosion and movement of soils into receiving waterways.

Water volumes generated during Stage 1 would vary based on construction activities both above and below the ground surface, the amount of groundwater inflow into the tunnels and the length of tunnels that have been excavated.

Considering the prevailing drought conditions in Sydney and across NSW, Sydney Metro is further investigating options to minimise potable water use and maximise wastewater reuse. This includes investigating opportunities for the reuse of water both on-site and off-site, and reduce reliance on potable water supply.

Contamination

The potential risks associated with encountering existing contamination would be appropriately managed by well-established mitigation processes and measures. All construction sites have a moderate to high potential for contamination. Contaminants that could be encountered during excavation and other ground disturbing activities include those associated with leaks and spills from fuel storage, processing of heavy end hydrocarbons, land reclamation and the use of uncontrolled fill materials and current and former industrial uses. Known and potential contamination was an important consideration during construction site selection. The location of the stabling and maintenance facility at Clyde, while having moderate risks associated with localised contamination, avoided impacting areas with widespread contamination (in the general Camellia/ Rosehill locality). This potentially reduces challenges in relation to substantial contamination remediation, which could pose risks to worker health and safety and nearby ecosystems.

Hydrology and flooding

Potential flooding impacts are expected to be minor to negligible at the majority of Stage 1 construction sites.

The drainage catchments across the Stage 1 area are highly urbanised, with large impervious surfaces created by roads, footpaths and buildings. These impervious surfaces are interspersed with pervious surfaces in parks and other unsealed surfaces (such as vacant land and landscaped areas). Due to the highly urbanised drainage catchments surrounding the Stage 1 area, flooding behaviour is expected to be largely controlled by the capacity of stormwater drainage systems and roadways that form overland flow paths.

Stage 1 construction activities and infrastructure have the potential to impact existing flooding behaviour through disruption of existing conditions (such as drainage systems and/or overland flow paths). In addition, flooding events during construction could impact areas within and near the Stage 1 construction sites, including the potential inundation of construction sites.

Key areas of potential flooding risk include the Parramatta metro station, Clyde stabling and maintenance facility and The Bays Station construction sites. At Clyde stabling and maintenance facility there would be a minor increase in peak flooding levels, an increase in the extent of floods and an increase in flood hazard during flooding events although these are all considered to be within acceptable levels. Increases in flow velocity and scour potential may result where Stage 1 alters flood flow patterns and significantly divert or concentrate flood flows although this would be managed using standard measures.

Further investigation and modelling would be carried out during detailed design so that the function of the floodplain is not materially affected by construction of Stage 1. Appropriate arrangements would also be in place to manage any flood events should they occur during either construction or operation.

Biodiversity

The Stage 1 construction footprint is mainly in built up areas and has substantially avoided direct biodiversity impacts. The limited amount of native vegetation to be disturbed is of poor to moderate quality and threatened species habitats are limited. Residual biodiversity impacts, primarily at the Clyde stabling and maintenance facility construction site would be offset in accordance with the requirements of the *Biodiversity Conservation Act 2016* and relevant guidelines.

Stage 1 would involve the direct removal of 0.18 hectares of native vegetation including 0.15 hectares of Mangrove Forests at the Clyde stabling and maintenance facility construction site and 0.03 hectares of Grey Box-Forest Red Gum grassy woodland at the Westmead metro station construction site. No threatened flora species would be directly impacted.

No threatened fauna species are likely to be significantly impacted by Stage 1. One threatened fauna species, the Southern Myotis (listed as vulnerable under the *Biodiversity Conservation Act 2016*) is considered likely to occur based on the presence of suitable foraging habitat. Other threatened fauna species may use vegetation, including both native and exotic planted trees and shrubs, that are within the Stage 1 construction footprint, however it is unlikely that Stage 1 would detrimentally affect these species.

The Stage 1 construction footprint is located within a highly disturbed landscape where most habitats have been cleared. The habitats that do remain are fragmented and isolated, however impacts to the vegetated riparian zones of Duck Creek and A'Becketts Creek may limit the movement of threatened species in that area.

To mitigate potential impacts to biodiversity associated with Stage 1, biodiversity credit obligations were calculated using the Biodiversity Assessment Method Calculator. A total of six credits would be required associated with impacts to the Mangrove Forest (PCT 920) and Southern Myotis (*Myotis macropus)*. The NSW Department of Primary Industries Policy and Guidelines for Fish Habitat Conservation and Management (NSW Department of Primary Industries, 2013) are applicable and the 0.15 hectares of impacted Mangrove Forest would be offset at a 10:1 ratio due to impacts on a mapped Coastal Wetland area.

Sustainability and climate change

The Sydney Metro West Sustainability Plan will set out the sustainability policy and objectives and identify key activities so that sustainability considerations are embedded across the project life cycle.

Six principles have been developed to govern environmental and socio-economic outcomes and performance for Sydney Metro West based around demonstrating leadership, tackling climate change, managing resources efficiently, driving supply chain best practice, valuing community and customers and respecting the environment. Targets and initiatives have been developed to support these sustainability principles.

Cumulative impacts

Given the potential overlap of construction with a number of large infrastructure projects particularly in Parramatta, The Bays and Sydney CBD, the key potential cumulative impact is expected to be experienced at these locations. Cumulative impacts would be highly dynamic and time/activity specific, so are difficult to define in any detail at this stage of the assessment process. Sydney Metro would work closely with the proponents of other nearby projects and stakeholders such as the Sydney Coordination Office to manage and coordinate the interface with other major projects under construction at the same time.

Other issues

A number of other issues were assessed including climate change and greenhouse gas, air quality, hazards, and waste management and resource use. No issues of major risk or consequence were identified. Notwithstanding this, management and mitigation measures have been identified to minimise any potential impacts.

Justification and conclusion

Sydney Metro West would provide a fast, reliable and frequent connection between Greater Parramatta and the Sydney CBD and would:

- Relieve the congested T1 Western Line, T9 Northern Line and T2 Inner West and Leppington Line
- Double the existing rail capacity between the Parramatta and Sydney CBDs
- Significantly boost economic opportunities for Greater Parramatta
- Support new residential and employment zones along the Greater Parramatta to Sydney CBD corridor, including at Sydney Olympic Park and The Bays – providing improved transport for the additional 420,000 new residents and 300,000 new workers forecast to be located within the corridor over the next 20 years
- Allow customers fast and easy transfers with the T1 Western Line at Westmead, T9 Northern Line at North Strathfield and the suburban rail network and Sydney Metro in the Sydney CBD
- Allow for transfers with the future Parramatta Light Rail (Stage 1) at Westmead and Parramatta, as well as the planned future Parramatta Light Rail (Stage 2) at Sydney Olympic Park
- Create an anticipated 10,000 direct and 70,000 indirect jobs during construction.

Sydney Metro West would provide city-shaping benefits as the significant increase in transport connectivity, capacity and amenity in the Greater Parramatta to Sydney CBD corridor, would boost the economic productivity of Sydney and unlock planned land use outcomes in the CBDs, planned precincts and urban renewal areas.

Sydney Metro West has been justified in relation to its strategic transport need and its anticipated benefits, taking into account the objectives of the *Environmental Planning and Assessment Act 1979* and matters of ecologically sustainable development. It best meets the network and corridor objectives when compared to all other alternatives considered.

Key environmental issues have been examined throughout the design development process. Consultation has been carried out with affected stakeholders to identify key potential impacts at an early stage. This has resulted in a number of design changes that have avoided or mitigated many of the potential significant impacts. Provided the measures and commitments specified in the Environmental Impact Statement are applied and effectively implemented during the design, construction and operational phases, the identified environmental impacts are considered to be acceptable and manageable.

Next steps

Sydney Metro is seeking approval from the Minister for Planning and Public Spaces for the Sydney Metro West Concept and construction of Stage 1. Subsequent steps in the process include:

- Exhibition of the Environmental Impact Statement for a minimum of 28 days and invitation for the community and stakeholders to make submissions
- Consideration of submissions. Submissions received by the Secretary of the Department of Planning, Industry and Environment would be provided to Sydney Metro who may then be required to prepare and submit:
  - A submissions report, responding to issues raised in the submissions
  - A preferred infrastructure report and/or an amendment report, outlining outlining any proposed changes to the Concept or Stage 1 to minimise its environmental impacts or to deal with any other issues raised
- Determination of the Environmental Impact Statement by the Minister for Planning and Public Spaces including, if approved, any Conditions of Approval.

Consultation with the community and stakeholders would continue throughout the detailed design and construction phases.

Any person wishing to make a submission should use the online form if possible. To find the online form go to the web-page for the proposal via www.planningportal.nsw.gov.au/major-projects/projects/on-exhibition.

Your submission must reach the Department of Planning, Industry and Environment by close of business on 26 June 2020. Before making your submission, please read the Privacy Statement at www.planning.nsw.gov.au/privacy or for a copy, telephone the number below. The Department of Planning, Industry and Environment will publish your submission in accordance with the Privacy Statement.

If you cannot lodge online, you can write to the address below. If you want the Department of Planning, Industry and Environment to delete your personal information before publication, please make this clear at the top of your letter. You need to include:

- Your name and address (at the top of the letter only)
- The name of the application and the application number (SSI-10038)
- A statement on whether you support or object to the proposal
- The reasons why you support or object to the proposal
- A declaration of any reportable political donations made in the previous two years. To find out what is reportable, and for a disclosure form, go to https://www.planning.nsw.gov.au/donations or phone 1300 305 695 for a copy.

Address:

Department of Planning, Industry and Environment
Locked Bag 5022
Parramatta NSW 2124

Your submission should be marked Attention: Director, Transport Assessments.

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1 Introduction

1 Introduction

This chapter provides an overview of the Sydney Metro West Concept and Stage 1, including the strategic context and key features, and the structure of the Environmental Impact Statement.

1.1 Overview

Sydney Metro is Australia's biggest public transport program. Services between Rouse Hill and Chatswood started in May 2019 on this new stand-alone metro railway system, which is revolutionising the way Sydney travels.

Sydney Metro's program of work is shown in Figure 1-1 and includes:

- The Metro North West Line – Opened in May 2019 with driverless trains running every four minutes in the peak in each direction between Tallawong Station in Rouse Hill and Chatswood
- Sydney Metro City & Southwest – A new 30-kilometre metro line extending the new metro network from the end of the Metro North West Line at Chatswood, under Sydney Harbour, through the Sydney CBD and south west to Bankstown. It is due to open in 2024 with an ultimate capacity to run a metro train every two minutes each way under the centre of Sydney
- Sydney Metro West (this project) – A new 24-kilometre metro line that would connect Greater Parramatta with the Sydney CBD. Confirmed stations include Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock, The Bays and Sydney CBD. The location of the Sydney CBD station will be determined following further investigations and community and stakeholder engagement. This infrastructure investment would double the rail capacity of the Parramatta to Sydney CBD corridor with a travel time target between the two centres of about 20 minutes
- Sydney Metro Greater West – A new metro rail line that would connect the city's greater west with Western Sydney International (Nancy-Bird Walton) Airport and Western Sydney Aerotropolis, which is working towards opening at the same time as the airport.

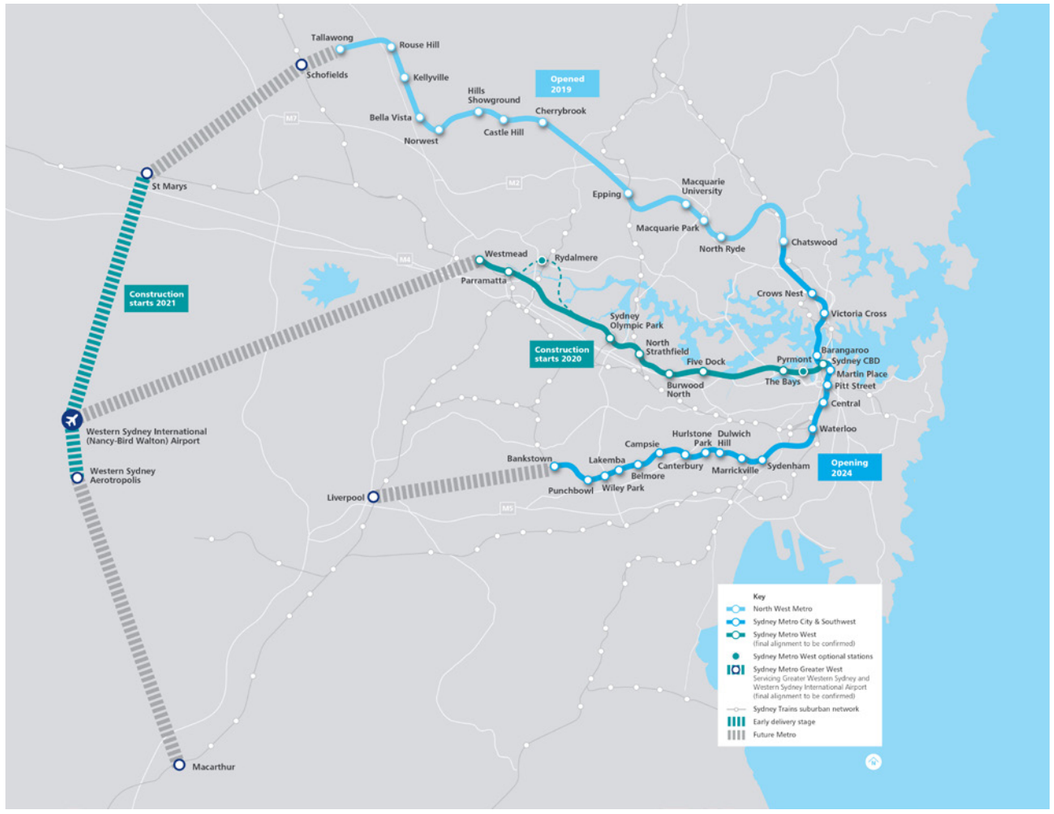


Figure 1-1: Sydney Metro network

Sydney is expanding and the NSW Government is working hard to deliver an integrated transport system that meets the needs of customers now and in the future. The delivery of Sydney Metro West is critical to keeping Sydney moving and is identified in a number of key strategic planning documents including the Greater Sydney Region Plan: A Metropolis of Three Cities – connecting people (Greater Sydney Commission, 2018a), Building Momentum: State Infrastructure Strategy 2018-2038 (Infrastructure NSW, 2018) and Future Transport Strategy 2056 (Transport for NSW, 2018).

Sydney Metro West would:

- Provide a direct, fast, reliable and frequent connection between Greater Parramatta and the Sydney CBD, linking communities along the way that have previously not been serviced by rail
- Relieve the congested T1 Western Line, T9 Northern Line (previously T1 Northern Line) and T2 Inner West and Leppington Line
- Double the existing rail capacity between the Parramatta and Sydney CBDs
- Significantly boost economic opportunities for Greater Parramatta
- Support new residential and employment zones along the Greater Parramatta to Sydney CBD corridor, including at Sydney Olympic Park and The Bays – providing improved transport for the additional 420,000 new residents and 300,000 new workers forecast to be located within the corridor over the next 20 years

- Allow customers fast and easy transfers with the T1 Western Line at Westmead, T9 Northern Line at North Strathfield, and the Sydney Trains suburban rail network and Sydney Metro in the Sydney CBD
- Allow for transfers with the future Parramatta Light Rail (Stage 1) at Westmead and Parramatta, as well as the planned Parramatta Light Rail (Stage 2) at Sydney Olympic Park
- Create an anticipated 10,000 direct and 70,000 indirect jobs during construction (based on Sydney Metro analysis).

1.1.1 Staged planning approval

The planning approvals and environmental impact assessment for Sydney Metro West will be broken down into a number of stages recognising the size of the project. This includes:

- Sydney Metro West at a Concept level
- Stage 1 – All major civil construction works between Westmead and The Bays including station excavation and tunnelling
- Stage 2 – All stations, depots and rail systems between Westmead and The Bays.
- Stage 3 – All major civil construction works including station excavation, tunnels, stations, depots and rail systems between The Bays and the Sydney CBD Station, and operation of the line.

Whilst the content of these stages may be varied, this Environmental Impact Statement covers the Concept and Stage 1 comprising all major civil construction works between Westmead and The Bays including station excavation and tunnelling.

At this point in development of Sydney Metro West, the design of the major civil elements (station excavations, tunnels and the formation of the stabling and maintenance facility) between Westmead and The Bays is well progressed. However, further work is required on the station location and tunnel alignment through the complex Sydney CBD.

Seeking planning approval for Stage 1 between Westmead and The Bays would allow:

- Additional time to consult with the stakeholders on the end-state design of stations including urban design, transport integration and placemaking outcomes
- Earlier commencement of critical construction activities which would allow Sydney Metro West as a whole to be delivered quicker and more efficiently, facilitating earlier realisation of the benefits of Sydney Metro West
- Each planning approval stage to be focussed on the critical issues associated with the particular works and the particular locations
- Additional time to solve certain design elements including the station location and tunnel alignment through the complex Sydney CBD environment.

The Sydney Metro West Concept is described in Section 1.3.2 and Chapter 6 (Concept description). Stage 1 is described in Section 1.3.3 and Chapter 9 (Stage 1 description). Sydney Metro West is subject to assessment by the Department of Planning, Industry and Environment and approval by the Minister for Planning and Public Spaces under Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

1.2 Background to Sydney Metro West

1.2.1 History

Sydney Metro and Transport for NSW are implementing a three-tiered rail network for Sydney, comprising:

- Tier 1: Sydney Metro – 'turn-up-and-go' services and single-deck metro trains
- Tier 2: Suburban – timetabled services with double-deck trains
- Tier 3: Intercity – timetabled services with on-board amenities for long distance trips.

This network delineation was first proposed in Sydney's Rail Future (Transport for NSW, 2012) and has been the basis for the development of the Sydney Metro network.

Congestion on the T1 Western Line is one of the most pressing challenges for the Sydney Trains suburban rail network. Demand for the T1 Western Line already exceeds capacity at peak times.

The need to upgrade capacity between Parramatta and the Sydney CBD was reinforced in February 2016 when Infrastructure Australia identified connectivity between the two centres as a national infrastructure priority.

In November 2016, the NSW Government announced Sydney Metro West as the State's next major public transport project, with a direct connection between Greater Parramatta and the Sydney CBD, and stations at Sydney Olympic Park and The Bays.

In March 2018, the NSW Government expanded the scope of Sydney Metro West to include a station at Westmead and a station to provide for customers to transfer to and from the T9 Northern Line. The NSW Government also announced that options for intermediate stations at Camellia/Rydalmere, Burwood North/Kings Bay/Five Dock, and Pyrmont were being considered.

1.2.2 Strategic context

Sydney is a global city and will experience significant population and employment growth in the coming decades. Investment in public transport will play an important role supporting this growth, ensuring Sydney's future liveability and global competitiveness.

The Greater Sydney Region Plan: A Metropolis of Three Cities (Greater Sydney Commission, 2018a) establishes a strategic vision that by 2056, Sydney will transform into a metropolis of three cities where people will live within 30 minutes of their jobs, education, health facilities and services. Sydney Metro West would be the mass transit link to connect the Central River City (Greater Parramatta) and the Eastern Harbour City (Sydney CBD) and support this transformation. Sydney Metro West would provide a fast, reliable and frequent connection between Greater Parramatta and the Sydney CBD to:

- Relieve the congested T1 Western Line, T9 Northern Line and T2 Inner West and Leppington Line
- Provide travel-time savings for customers in Western Sydney and along the corridor
- Reduce station crowding at some stations
- Provide rail transport to areas where this is currently not available
- Support the delivery of the '30-minute city' as identified in Future Transport Strategy 2056
- Reinforce Greater Parramatta as the Central River City
- Improve connectivity to major attractions, key precincts and public spaces located along the corridor, including Sydney Olympic Park and The Bays
- Support urban renewal and increased housing supply
- Increase accessibility across Sydney and provide customers with a new world-class metro service.

The Sydney Metro West corridor is characterised by the following key centres:

- Westmead – one of the largest health, education, research and training precincts in Australia
- Parramatta – where the number of jobs is expected to increase to more than 137,000 by 2036 (Greater Sydney Commission, 2018a)
- Sydney Olympic Park – a mixed used and lifestyle precinct where 34,000 jobs and more than 23,000 residents will be located by 2030 (Sydney Olympic Park Authority, 2018)
- The Bays – where the NSW Government is planning world-class destinations, including business hubs through urban renewal
- The Sydney CBD – Australia's largest business district.

Sydney Metro West is part of a broader metro network plan for Sydney which includes the Metro North West Line (opened in May 2019), Sydney Metro City & Southwest (due to open in 2024), and Sydney Metro Greater West anticipated to open when the new airport opens.

1.2.3 Sydney Metro

Customer experience

Delivering improved outcomes for customers and the transport network are critical to achieving Sydney Metro's vision for a 'world-class metro for Sydney'.

Sydney Metro places the customer at the centre of the design with the customer experience incorporating all aspects of a journey from door-to-door. Sydney Metro aims to make it easy for all customers, regardless of trip purpose, to choose public transport.

The Sydney Metro project development process includes consideration of the best outcomes for customers, transport integration, and city-shaping and land use benefits. This includes the design of the trains, stations and their relationship with the precincts within which they are located.

Sydney Metro features

Sydney Metro is designed to make the customer journey to and from the metro station as seamless as possible by integrating walking, cycling, light rail, bus, ferries, taxi, on demand vehicle, ride share and kiss and ride infrastructure.

Key features of Sydney Metro in delivering customer experience include:

- No timetable – customers can just turn up and go
- Opal ticketing – fares are the same as the rest of Sydney
- Customer service assistants at every station and moving through the network during the day and night
- Australian-first platform screen doors improving customer safety and allowing trains to get in and out of stations much faster. These doors run the full length of all metro platforms and open at the same time as the train doors
- Continuous mobile phone coverage throughout the metro network
- Operational performance requirements that include 98 per cent on time running and clean platforms and trains
- Multi-purpose areas for prams, luggage and bicycles
- Wheelchair spaces, separate priority seating and emergency intercoms inside trains
- Safety benefits including security cameras on trains and the ability for customers to see inside the train from one end to the other
- Video help points at platforms, connecting directly with train controllers – an Australian first
- Level access between the platform and train and three double doors per side per carriage for faster loading and unloading
- Heating and air-conditioning on all metro trains
- On-board real time travel information and live electronic route maps.

1.3 Overview of Sydney Metro West

1.3.1 Location

Sydney Metro West would be located largely underground in twin tunnels. Indicative locations of the proposed alignment, stations and the main elements of operational ancillary infrastructure are shown in Figure 1-2.

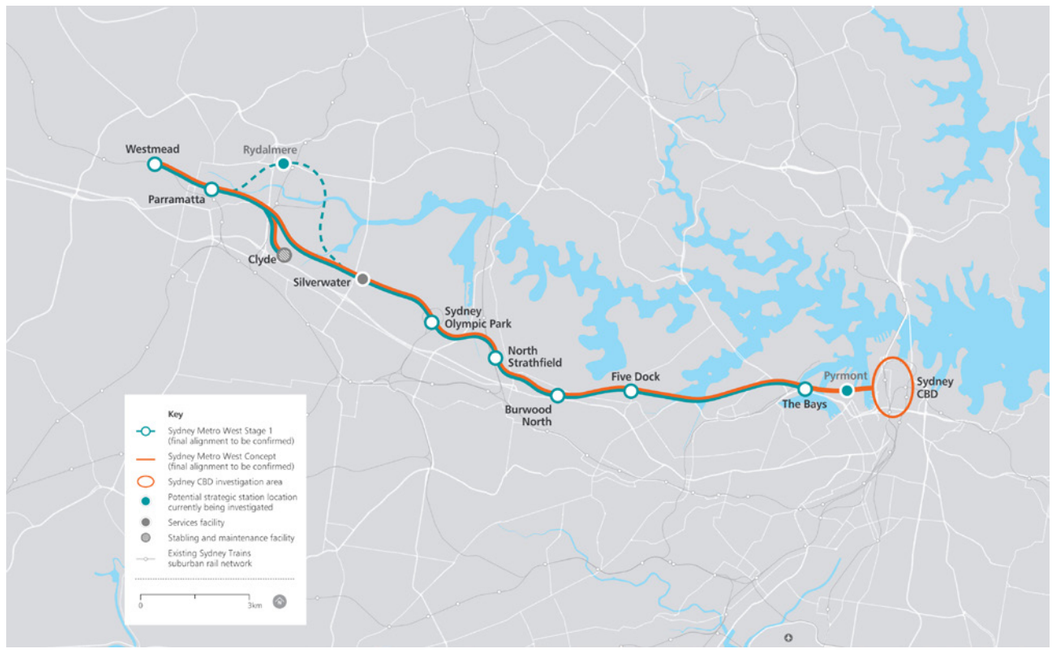


Figure 1-2: Sydney Metro West

1.3.2 The Concept

Sydney Metro West (the Concept) would involve the construction and operation of a metro rail line around 24 kilometres long between Westmead and Sydney CBD. The key components are expected to include:

- About 24 kilometres of twin tunnels between Westmead and the Sydney CBD
- New metro stations at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock, The Bays and Sydney CBD. The location of the Sydney CBD station will be determined following further investigations and community and stakeholder engagement. Optional stations at Rydalmere and Pyrmont are also under investigation
- A turn-up-and-go metro service operating early morning to late at night, between Westmead and the Sydney CBD
- Pedestrian links and connections to other modes of transport (such as the existing Sydney Trains suburban rail network and other parts of the metro network) and surrounding land uses
- Modifications to existing Sydney Trains suburban stations and associated rail infrastructure (such as overhead wiring, signalling, access tracks/paths and rail corridor fencing) at Westmead and North Strathfield
- Services within each of the metro stations, including mechanical and fresh air ventilation equipment and electrical power substations to supply power for operation
- A stabling and maintenance facility at Clyde, including associated aboveground and belowground tracks to connect to the mainline tunnels and other operational ancillary infrastructure
- Services facilities at Rosehill (within the Clyde stabling and maintenance facility construction site), Silverwater and between Five Dock and The Bays for fresh air ventilation and emergency evacuation
- Alterations to pedestrian and traffic arrangements, cycling and public transport (e.g. bus) infrastructure around the metro stations
- Subdivision of station sites to support integrated station and precinct development and ancillary facilities
- Ancillary facilities to support construction.

The Concept is further described in Chapter 6 (Concept description).

Components of Sydney Metro West are subject to ongoing design development and outcomes of stakeholder and community engagement.

1.3.3 Stage 1

Stage 1 would involve major civil construction work between Westmead and The Bays, including:

- Enabling works such as demolition, utility supply to construction sites, utility adjustments and modifications to the existing transport network
- Tunnel excavation including tunnel support activities
- Station excavation for new metro stations at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock and The Bays
- Shaft excavation for services facilities at Rosehill (within the Clyde stabling and maintenance facility construction site), at a location between the Five Dock Station and The Bays Station construction sites (to be determined), and at Silverwater
- Civil work for the stabling and maintenance facility at Clyde including earthworks and structures for crossings at A'Becketts Creek and Duck Creek
- A concrete segment facility for use during construction located at the Clyde stabling and maintenance facility construction site
- Excavation of a tunnel dive structure and associated tunnels at Rosehill to support a connection between the Clyde stabling and maintenance facility and the mainline metro tunnels.

Stage 1 is further described in Chapter 9 (Stage 1 description).

1.4 Purpose and structure of the Environmental Impact Statement

The purpose of this Environmental Impact Statement is to support Sydney Metro's application for approval as State significant infrastructure to the Minister for Planning and Public Spaces under section 5.15 of the EP&A Act. It addresses the environmental assessment requirements of the Secretary of the Department of Planning, Industry and Environment (the Secretary's Environmental Assessment Requirements), dated 11 December 2019 (refer to Appendix A).

This Environmental Impact Statement is presented in two volumes. Volume 1 contains the main Environmental Impact Statement (this report) and the initial appendices. Volume 2 provides the technical papers that form the technical basis of the information in Volume 1. The structure and content of this report are outlined in Table 1-1.

Table 1-1: Structure and content of this report

Chapter	Description
Part A: Introduction and context	
Chapter 1 Introduction (this chapter)	Outlines the key elements of Sydney Metro West and the purpose of this report.
Chapter 2 Strategic need and justification	Provides an outline of the need and justification for Sydney Metro West.
Chapter 3 Sydney Metro West development and alternatives	Provides an overview of the development process and the strategic transport alternatives and options considered for Sydney Metro West.
Chapter 4 Planning and assessment process	Provides an outline of the statutory approvals framework, including applicable legislation and planning policies.
Chapter 5 Stakeholder and community engagement	Outlines stakeholder and community engagement carried out to date, including during the preparation of this Environmental Impact Statement.
Part B: Sydney Metro West Concept	
Chapter 6 Concept description	Identifies the physical infrastructure, built form and operation of Sydney Metro West.
Chapter 7 Placemaking	Provides an overview of Sydney Metro's approach to placemaking and provides the design objectives for Sydney Metro West. Outlines the integration with local strategic plans, place and design principles for stations and ancillary facilities and the future design process.
Chapter 8 Concept environmental assessment	Provides a description of the existing environment of the study area, and an assessment of the potential direct and indirect impacts that may result during construction and operation of Sydney Metro West at a concept level.
Part C: Sydney Metro West Stage 1	
Chapter 9 Stage 1 description	Provides a description of Stage 1 including likely construction techniques and identifies the location and function of the main construction sites.
Chapters 10-26 Stage 1 environmental assessment	Provides an assessment of the potential direct and indirect impacts that may result during Stage 1.
Part D: Synthesis, risk analysis and conclusion	
Chapter 27 Synthesis of the Environmental Impact Statement	Provides a technical summary of the Environmental Impact Statement for the Concept and Stage 1.
Chapter 28 Environmental risk analysis	Provides an environmental risk analysis for the Concept and Stage 1 taking into account the potential impacts and mitigation measures identified in Chapters 9 to 26.
Chapter 29 Project justification and conclusion	Provides a conclusion to the report including justification for the Concept and Stage 1 and whether the Concept and Stage 1 has achieved the objectives of Sydney Metro West and has met the objects of the EP&A Act.

2 Strategic need and justification

2 Strategic need and justification

This chapter outlines the strategic need and justification for the Sydney Metro West Concept with regards to its critical State significance, taking into account the transport and land use challenges that Sydney faces now and into the future. It also provides an outline of consistency within the NSW strategic planning and transport policy framework.

2.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to strategic need and justification, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 2-1.

Table 2-1: Secretary's Environmental Assessment Requirements – Strategic need and justification

Reference	Secretary's Environmental Assessment Requirements	Where addressed
2. Environmental Impact Statement		
2.1	The EIS must include, but not necessarily be limited to, the following: f. a summary of the strategic need with regard to its critical State significance and relevant NSW Government policies;	Sections 2.5 and 2.6
	g. a statement of the strategic objective(s), including: how the Concept will integrate with the broader transport network (existing and proposed);	Section 2.7 Section 2.4 and 2.6

2.2 Background

The Greater Sydney Region Plan: A Metropolis of Three Cities (Greater Sydney Commission, 2018a) sets the 40-year vision to 2056 and 20-year implementation plan for Greater Sydney to become a global metropolis of three unique and connected cities, the Western Parkland City, Central River City and Eastern Harbour City, as shown in Figure 2-1.

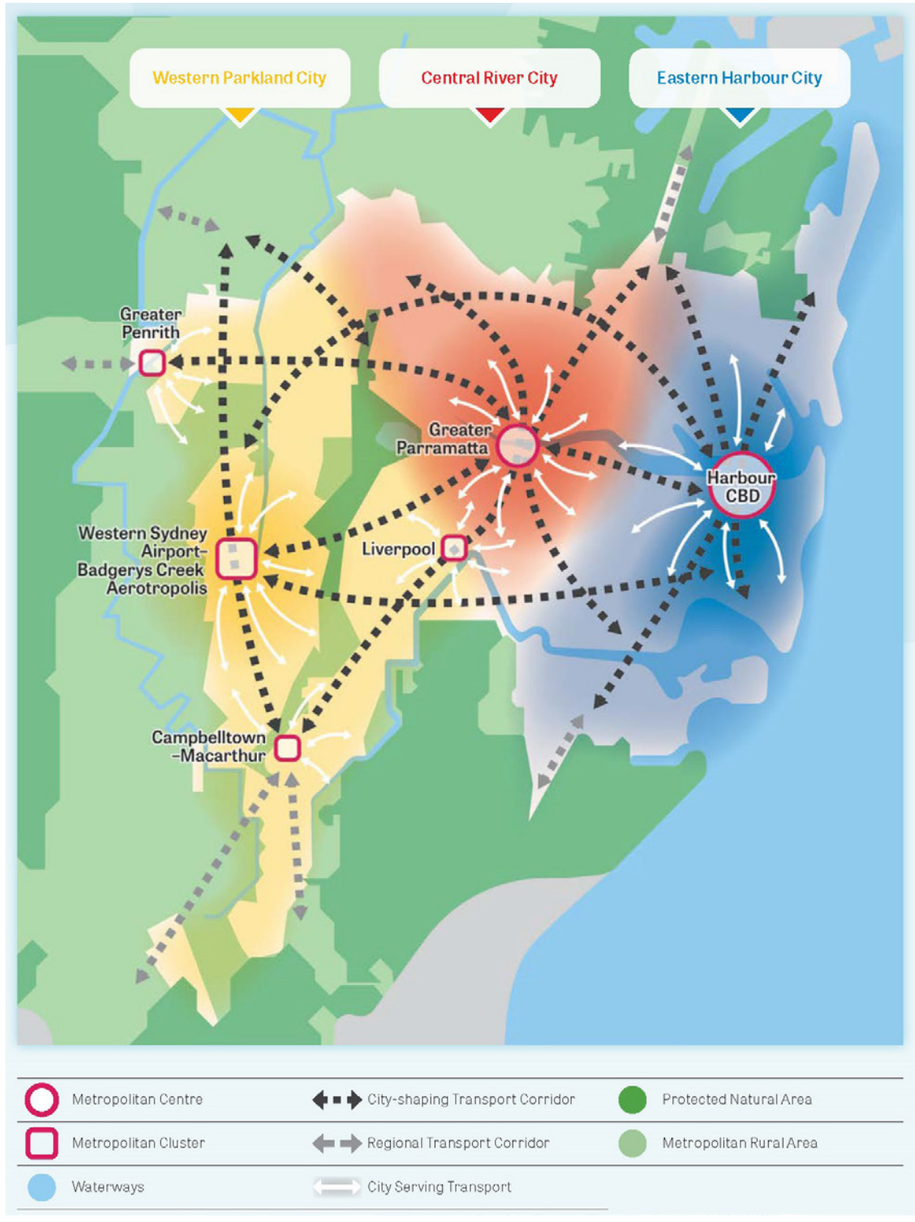


Figure 2-1: A Metropolis of Three Cities (Greater Sydney Commission, 2018a)

By integrating land use, transport and infrastructure across the three cities, people in Sydney will have access within 30 minutes to jobs, schools, hospitals and services.

The plan identifies the following areas of growth over the next 20 years:

- Greater Sydney's population is forecast to increase from 4.7 million to 6.4 million by 2036 and to eight million by 2056
- A target of 725,000 new homes in Greater Sydney; including 207,500 in the Central River City, and 157,500 in the Eastern Harbour City
- An additional 817,000 jobs are required to meet the needs of a changing economy and workforce
- Daily trips will increase to 22 million within Greater Sydney, and people's homes, jobs, schools, healthcare and other services will need to be connected to an efficient transport network.

To enable and support this growth, Sydney's mass transit network must be enhanced to better connect economic centres, and to connect people to jobs, as well as to schools, services and attractions.

2.3 Sydney's challenges

2.3.1 Population and economic growth

Sydney is Australia's financial and economic capital, housing half of the country's globally competitive service sector jobs. Greater Sydney is forecast to grow significantly from a population of 4.7 million to 6.4 million by 2036 (an additional 1.7 million) and 8 million by 2056 (an additional 3.2 million). This expected growth will require places for an additional 817,000 jobs and an additional 725,000 homes by 2036 (Greater Sydney Commission, 2018a).

The Greater Parramatta to Sydney CBD corridor is one of the city-shaping transport corridors nominated in the Greater Sydney Region Plan (Greater Sydney Commission, 2018a). It runs from the heart of Parramatta to the Sydney CBD (refer to Figure 2-1) and includes one of Australia's largest health, education and research precincts in Westmead, the rapidly growing central CBD at Parramatta, the lifestyle precinct at Sydney Olympic Park, the planned innovation and technology hub at The Bays and the global centre that is the Sydney CBD.

Analysis by Sydney Metro shows that the corridor is of national economic significance. It already contains nearly 620,000 high productivity jobs, which is around 20 per cent of the jobs in Greater Sydney, and generates eight per cent of the nation's Gross Domestic Product per year. The corridor has some of the most productive centres in Greater Sydney, with the Sydney CBD generating $96 billion of Gross Domestic Product per year.

Recognising the importance of the corridor, a number of land use planning and development initiatives have commenced. These include:

- State led strategic planning at precincts where the Department of Planning, Industry and Environment would lead strategic planning work to inform future rezoning proposals. Relevant precincts include Westmead and Greater Parramatta to Olympic Park
- Collaborative planning where the Department of Planning, Industry and Environment would play a coordination role to facilitate partnerships across the Department, the local council and other state agencies. Identified precincts include North Westmead, South Westmead, Camellia, Burwood/Strathfield/Homebush, Bays West and Pyrmont
- The Greater Parramatta Growth Area as defined by the Department of Planning, Industry and Environment and the Greater Parramatta to Olympic Park Peninsula Infrastructure Compact being managed by the Greater Sydney Commission
- Significant urban renewal areas in the Parramatta Road Corridor Urban Transformation Strategy area.

These areas are shown on Figure 2-2. Westmead, Parramatta, Sydney Olympic Park, The Bays and the Sydney CBD account for more than 60 per cent of planned population growth and more than 80 per cent of planned jobs growth in the corridor by 2036.

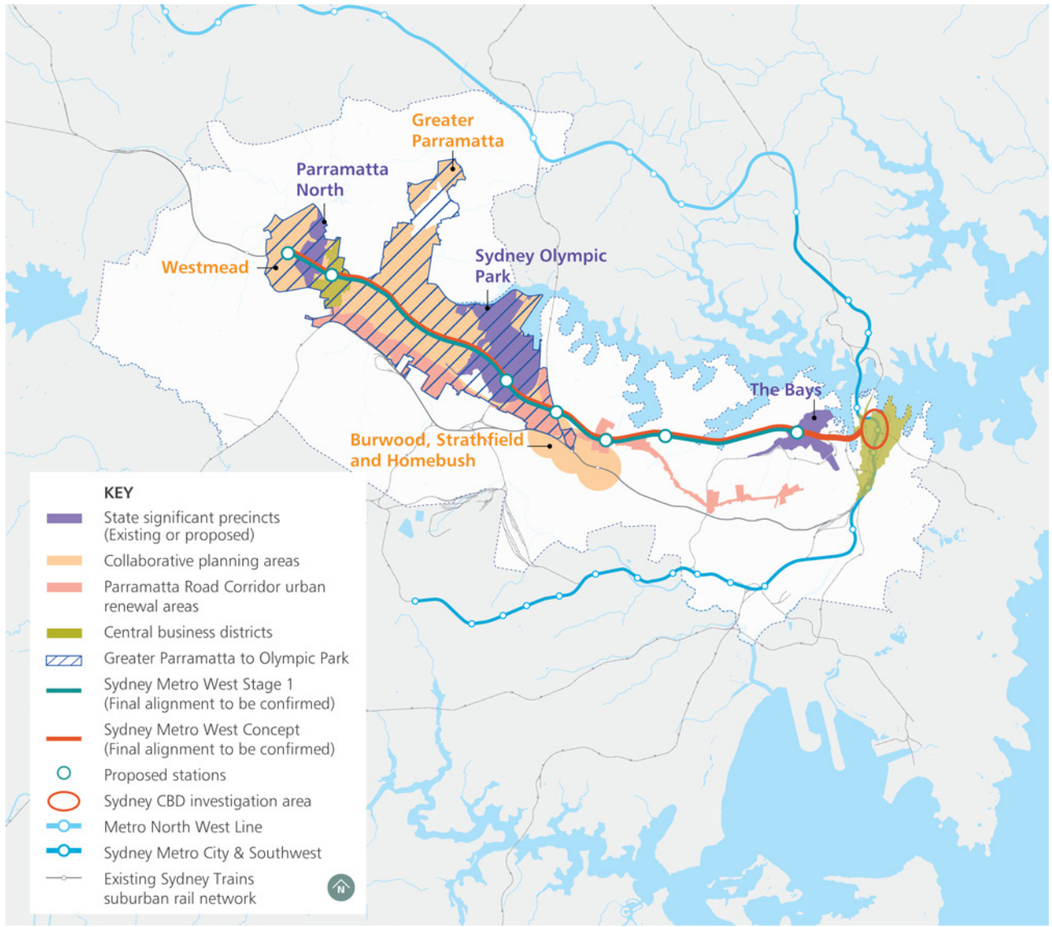


Figure 2-2: Planned growth areas in the Greater Parramatta to Sydney CBD corridor

2.3.2 Transport capacity, accessibility and reliability

Sydney Trains suburban rail network is the backbone of the city's public transport system, which connects the city's skilled workforce with high value employment land located in Sydney's established and growing economic corridors. Data from Transport for NSW shows that over the past five years there has been about a 29 per cent increase in demand across Sydney's rail network. Sydney Trains data shows that Sydney's rail network now carries 420 million customers per year, up from 326 million customer trips five years ago. This is an increase of more than 90 million journeys.

Sydney's growing population will continue to increase demand on the existing transport network. By 2056, NSW transport networks will need to accommodate 28 million trips per day (Transport for NSW, 2018).

Key challenges include increasing capacity on the network to ease congestion and support growing demand, as well as providing rail services to areas that have not previously been serviced. Analysis undertaken by Sydney Metro showed that in 2017, the T1 Western Line moved around 19,100 people each morning in the one-hour AM peak (8am-9am). Around 43,700 people in the one-hour AM peak travelled from Parramatta to the Sydney CBD on all lines (T1 Western Line, T9 Northern Line, T2 Inner West and Leppington Line, and intercity services), which collectively operated at about 85 per cent total capacity.

The reliability and capacity of the Sydney Trains suburban rail network, particularly in the Greater Parramatta to Sydney CBD Corridor, is currently constrained by a number of factors, which include:

- The large number of lines which converge in the western rail corridor between Greater Parramatta and the Sydney CBD, including the T1 Western Line, T9 Northern Line and T2 Inner West and Leppington Line. This limits the capacity to increase rail services between Parramatta and the Sydney CBD
- Train timetables that require trains with different service patterns to share the same track, which can result in slower trains delaying all services (including fast and express trains) and requires customer journey trade-offs or further investment in the track network
- Crowded trains with two doors, double decks and 3 + 2 seating arrangements, which are slow to load and unload, resulting in long 'dwell times' (the time a train needs to stop in a station for customers to board and alight). Longer dwell times challenges on-time running of services, and leads to fewer services operating in a given time period
- Crowded CBD stations that rely on stairs instead of escalators as the principal means of accessing platforms and concourse levels
- Sharing of rail infrastructure with freight services, which impacts suburban rail services.

Additionally, access to public transport is limited at key precincts in Sydney which are forecast to have significant employment and housing growth, including:

- Sydney Olympic Park which is currently serviced by the T7 Olympic Park Line. Customers on the T7 Olympic Park Line are required to transfer at Lidcombe to travel to or from the Parramatta or Sydney CBDs
- The Bays, which is set to undergo urban transformation and become a major employment hub and destination. There is no rail connection to White Bay, and capacity constraints on Victoria Road and the Anzac Bridge limit the opportunity to increase bus services. A mass transit solution is required to accommodate growth at The Bays.

Greater Sydney has significantly higher car mode shares than other international cities which leads to increased traffic congestion. This increases travel times for commuters and businesses, reduces reliability and safety and increases noise and pollution for pedestrians and cyclists.

Consequences of forecast customer growth

The existing rail network is congested, with customers on most rail lines often experiencing significant crowding on trains and station platforms during the morning and evening peaks.

Short-term relief in demand would be realised as a result of the new Sydney Metro North West Line (opened in 2019) and Sydney Metro City & Southwest (due to open in 2024).

Despite planned upgrades and the provision of more services, modelling carried out by Sydney Metro shows that the T1 Western Line is forecast to reach capacity in 2024 and the T9 Northern Line is expected to reach capacity in 2027, as shown by Figure 2-3 and Figure 2-4 respectively.

Figure 2-3: Forecast peak patronage in the western rail corridor – T1 Western Line (one-hour AM peak, suburban services only, 2017 to 2051)

Figure 2-4: Forecast peak patronage in the western rail corridor – T9 Northern Line (one-hour AM peak, 2017 to 2051)

Train and station crowding reduces service reliability, which results in fewer services operating in a given time period and in turn leads to further crowding. Reliability impacts in the Sydney CBD cause network-wide impacts, reducing network capacity and increasing crowding on trains and platforms.

2.4 Key benefits of Sydney Metro West

2.4.1 Transport benefits

Increased transport network capacity

Sydney Metro West would more than double rail capacity from Parramatta to the Sydney CBD with the delivery of a new high capacity rail connection. At ultimate capacity, Sydney Metro West would be able to move more than 40,000 people an hour in each direction and would complement the suburban and intercity services between Parramatta and the Sydney CBD.

Reduced train crowding

By providing additional rail services, Sydney Metro West would significantly reduce train crowding on the T1 Western Line and the T9 Northern Line. This would help improve the reliability of Sydney Trains services and improve customer comfort.

Train crowding relief would occur on parts of the T1 Western Line and T9 Northern Line due to direct interchange with Sydney Metro West; as well as the T2 Inner West and Leppington Line services. This also means more efficient Sydney Trains services in the west, outer west and regional areas like the Blue Mountains due to resulting improved capacity on the T1 Western Line. Based on modelling carried out by Sydney Metro, the expected passenger volumes compared to the capacity of the lines, with and without Sydney Metro West at key locations along each line, is shown by Figure 2-5 and Figure 2-6 respectively.

Figure 2-5: T1 Western Line passenger volume compared to capacity – 2036

Figure 2-6: T9 Northern Line passenger volume compared to capacity – 2036

Reduced station crowding

The introduction of new rail services and infrastructure, including new stations in the Parramatta and Sydney CBDs, would reduce congestion and help alleviate platform and station crowding. Reduced platform and station crowding would shorten the time spent by customers in heavily crowded platform conditions and improve network performance by reducing station dwell times (and therefore improve travel times).

Sydney Metro West would help to reduce crowding at:

- The busiest CBD stations
- Strathfield Station
- The existing Parramatta Station due to the delivery of a new metro station in Parramatta and interchange at Westmead.

Crowding at existing stations, such as Epping and Burwood, would also be reduced.

Figure 2-7 and Figure 2-8 show forecast changes to passenger movements (i.e. the redistribution of passengers due to differing trip choices), and therefore the potential changes to station crowding at existing stations with and without the Sydney Metro West in the years of 2036 and 2056. Reduced crowding is also expected at Central, Town Hall and Wynyard Stations. The extent of reduced crowding would be confirmed once the optimum location of the Sydney CBD Station is determined. Westmead and North Strathfield stations would become key interchanges as part of Sydney Metro West and would be designed to accommodate an increase in customers.

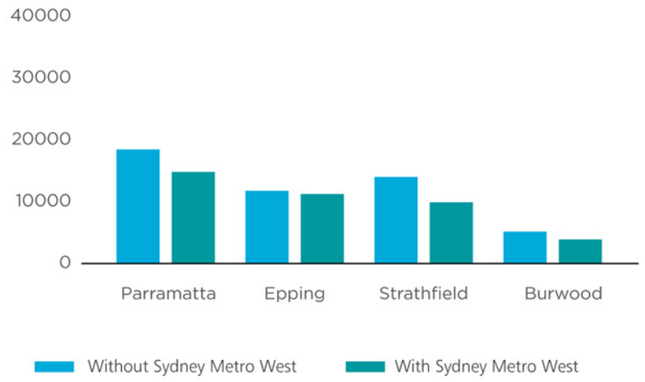


Figure 2-7: Forecast passenger movements (2036 AM peak) at key stations with and without Sydney Metro West

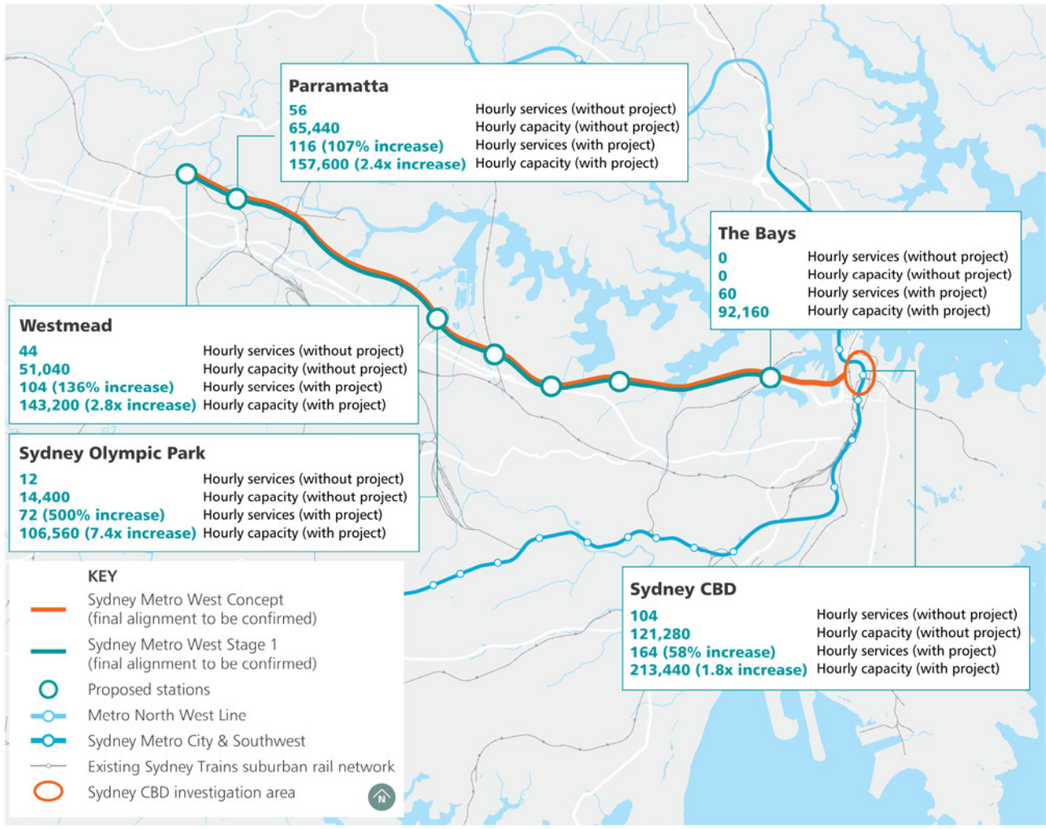
Figure 2-8: Forecast passenger movements (2056 AM peak) at key stations with and without Sydney Metro West

Increased accessibility to key centres

Sydney Metro West would substantially improve the public transport network accessibility to key economic centres across the Greater Parramatta to Sydney CBD corridor. It would:

- Increase accessibility to the future key centre at The Bays, which is not currently serviced by the existing suburban rail network
- Increase rail services and overall rail capacity to Westmead, Parramatta, Sydney Olympic Park and the Sydney CBD.

A summary of additional train services and capacity to key economic centres across the corridor based on modelling by Sydney Metro is shown on Figure 2-9. This provides a comparison of existing services and capacity, compared to ultimate capacity of Sydney Metro West.



Note: The Sydney CBD data does not include train services and capacity provided as part of Sydney Metro City & Southwest

Figure 2-9: Increased network capacity and accessibility to key economic centres (ultimate capacity, one-hour AM peak)

Increased public transport network reach and use

Sydney Metro West would increase the reach (the catchments from which customers access the public transport network) and use of Sydney's public transport network by:

- Providing new stations at localities not serviced by the existing Sydney Trains suburban rail network, including Burwood North, Five Dock and The Bays
- Increasing the number of customers who are able to access the Parramatta and Sydney CBDs by rail
- Providing a more direct connection to Sydney Olympic Park. Customers on the T7 Olympic Park Line are currently required to transfer at Lidcombe to travel to or from the Parramatta or Sydney CBDs
- Providing additional interchange capability at Westmead, North Strathfield and in the Sydney CBD.

Improved travel times

Sydney Metro West would create a significant opportunity to improve travel times by providing:

- More direct routes between areas with existing rail services
- Access to rail services in areas that currently do not have train stations
- Reduced crowding on trains and at some stations, leading to improved service reliability
- A high-frequency service, with customers able to 'turn-up-and-go' and no longer rely on timetables.

The largest travel-time savings would be experienced in areas where:

- New stations are provided in areas currently not serviced by the existing suburban rail network, such as Burwood North, Five Dock and The Bays
- More direct routes are provided, such as trips from Parramatta to the Sydney CBD and to and from Sydney Olympic Park
- Customers could more efficiently transfer between services at new stations – including at Westmead and North Strathfield.

Sydney Metro West would also improve connections between key employment centres, enabling journeys between centres such as Parramatta to Chatswood and Sydney Olympic Park to North Sydney to take 30 minutes or less. Based on an interchange between Sydney Metro West and Sydney Metro City & Southwest in the Sydney CBD, there would also be improved travel times between Greater Parramatta and other parts of Sydney including the North Shore and the Northern Suburbs.

Table 2-2 illustrates the forecast travel time savings on key routes based on modelling undertaken by Sydney Metro. Sydney Metro West would also result in travel time savings to the Sydney CBD. The details of these travel time savings would be confirmed once the location of the Sydney CBD Station is determined, however indicative travel time savings have been included in Table 2-2.

Travel times to the Sydney CBD with Sydney Metro West are approximated and would be confirmed once the location of the Sydney CBD Station is determined.

Sydney Metro West would attract some customers from further west of the Sydney Metro West corridor (that is, west of Westmead), who would use Sydney Metro West for part of their journey by interchanging at Westmead instead of using the suburban rail service the whole way to reach their destinations. For trips originating from Penrith to the Sydney CBD, it is expected that Sydney Metro West would attract around 41 per cent of these customers due to the net travel time saving, even when including interchange time.

Table 2-2: Travel-time savings between key locations (2036)

Locations	With/without Sydney Metro West	Approximate travel time	Approximate travel time saving
In the corridor			
Parramatta to Sydney CBD	Without project	31 minutes	About 10 minutes
	With project	Target of about 20 minutes	
Sydney Olympic Park to Parramatta	Without project	23 minutes	19 minutes
	With project	4 minutes	
Sydney Olympic Park to Sydney CBD	Without project	38 minutes	More than 20 minutes
	With project	Less than 15 minutes	
Burwood North to Parramatta	Without project	24 minutes	15 minutes
	With project	9 minutes	
Five Dock to Sydney CBD	Without project	45 minutes	More than 35 minutes
	With project	Less than 10 minutes	
The Bays to Sydney CBD	Without project	25 minutes	More than 20 minutes
	With project	Less than 5 minutes	
Connecting Western Sydney			
Blacktown to Sydney Olympic Park	Without project	34 minutes	14 minutes
	With project	20 minutes	
Parramatta to Rhodes	Without project	29 minutes	10 minutes
	With project	19 minutes	
Parramatta to Epping	Without project	30 minutes	9 minutes
	With project	21 minutes	
Parramatta to Macquarie Park	Without project	49 minutes	10 minutes
	With project	39 minutes	

Notes:
- No project case travel times derived using existing timetables and Google Maps and assuming an 8am Wednesday departure
- Fastest travel routes using public transport have been assumed
- Station to Station assumes no entry/exit time
- Includes in-vehicle time and accounts for interchange and dwell time
- Based on Sydney Metro City & Southwest being open
- Travel time savings for trips to the Sydney CBD are indicative as no station location has been selected.

Improved resilience to incidents on the network

Shutdowns on the suburban rail network during unplanned and planned events (including periodic maintenance) impact on customer service provision and access to key destinations.

Sydney Metro West would provide an additional, high-capacity public transport link in the corridor between Greater Parramatta and Sydney CBD, which would be separated from the Sydney Trains suburban rail network. This would provide an alternative route for customers during these planned and unplanned events. Sydney Metro West would also enable additional connectivity with interchange opportunities to the wider rail and public transport network, which would reduce the impact on customers during major incidents and increase the resilience of the network.

Opportunity to optimise the bus network

The additional mass transit accessibility and amenity provided by Sydney Metro West would provide the opportunity to optimise the bus network. This could include additional 'feeder services' (services which generally connect customers to rail stations) to Sydney Metro West stations and re-deployment of existing parallel bus services that would duplicate parts of the Sydney Metro West alignment. This would maintain the level of bus services across the network while providing the opportunity to:

- Reduce the number of buses on congested corridors such as Parramatta Road and Victoria Road
- Increase bus services on other parts of the network with lower levels of mass transit accessibility and amenity
- Improve bus travel times to major destinations along the Sydney Metro West corridor.

Road user and community benefits

By encouraging people to use the metro network, Sydney Metro West would provide the opportunity for mode shift from car to public transport. This could result in road user travel time savings by reducing the numbers of vehicles on the road network. Analysis undertaken by Sydney Metro shows that total network wide car trips would be reduced by about 83,000 weekday trips by 2036 and about 110,000 weekday trips by 2056. The potential reduction in private vehicle car use could create benefits in the form of:

- Car use travel time savings and improved reliability for remaining car users who do not shift modes
- Reduction in environmental impacts to communities such as air pollution, greenhouse gas, noise and water pollution.

2.4.2 Productivity benefits

By improving the connections between key economic centres, Sydney Metro West would foster significant growth in jobs. Sydney Metro West would directly support the creation of new jobs within the corridor, particularly at key precincts including Westmead, Parramatta, Sydney Olympic Park and The Bays.

Sydney Metro West would also support:

- Enhanced international competitiveness through increased accessibility to world-class precincts which would be expected to attract international visitors, jobs and investment
- A move to productive jobs by attracting knowledge-based industries that would want to take advantage of the corridor's premier location and presence of knowledge industries in key areas
- Connectivity benefits by enabling an increase in the effective employment density of the corridor and a reduction in travel time between businesses in the corridor. This would effectively bring businesses closer together, supporting increased knowledge transfer, collaboration and innovation.

2.4.3 City-shaping benefits

There is an intrinsic link between public transport and land use change. Access to public transport makes those locations more attractive to live or work. Transport accessibility and amenity (including comfort and convenience for customers) are critical to supporting employment, housing supply and urban renewal opportunities and ultimately to support Sydney's economic and population growth.

Sydney Metro West would provide a significant increase in transport connectivity, capacity and amenity in the Greater Parramatta to Sydney CBD corridor, which would boost the economic productivity of Sydney and facilitate planned land use outcomes in the CBDs, planned precincts and urban renewal areas.

The key city-shaping benefits of Sydney Metro West are detailed below.

Supporting planned growth

New and improved public transport access offers opportunities for transit-oriented development, encourages urban renewal, and allows more efficient use of land within station catchments.

Sydney Metro West would facilitate the growth in jobs, homes and residents that is currently planned for the Greater Parramatta to Sydney CBD corridor. This planned growth in the corridor may not otherwise be achieved without Sydney Metro West as current transport accessibility and amenity would potentially restrict planned growth from being realised by businesses, workers and residents. Growth may otherwise occur in other parts of Sydney without the necessary transport solution.

Based on analysis by Sydney Metro of the population, housing and employment forecasts by Greater Sydney Commission, 2018, Sydney Metro West is forecast to facilitate between 2016 and 2036:

- An additional 169,000 jobs within walking catchments of proposed metro stations. Of these new jobs, about 47 per cent would not otherwise be achieved without Sydney Metro West
- An additional 46,000 homes within walking catchments of proposed metro stations, of which about 43 per cent would not be achieved without Sydney Metro West
- A population increase of 106,000 new residents within walking catchment of proposed metro stations, of which about 44 per cent would not be achieved without Sydney Metro West.

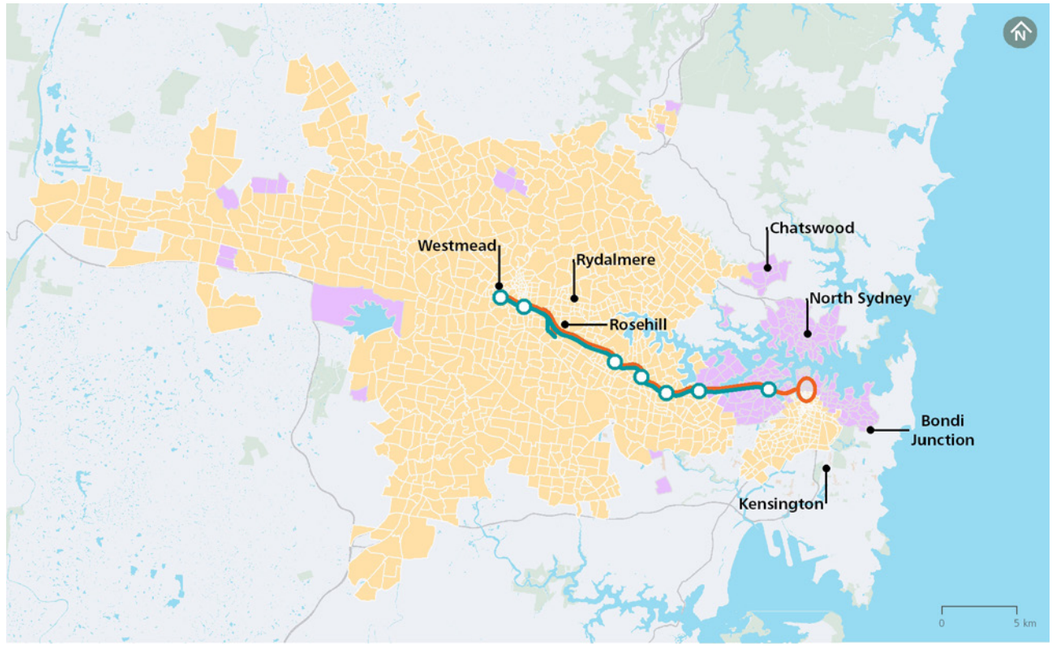
Expanding the 30-minute cities

Sydney Metro West would help implement the vision for 30-minute cities as outlined in the Greater Sydney Region Plan (refer to Section 2.5.2), by providing customers an easy connection to key destinations including cities, health and education precincts, diverse employment centres and residential areas. The catchment of Sydney Metro West would be expanded by interchanges with the suburban rail, light rail and bus networks, allowing a greater number of people to reach key destinations within 30 minutes.

The reach of Sydney Metro West would also be expanded by:

- Bus network optimisation, which would increase the frequency and directness of feeder services to new metro stations
- Integration with the future Parramatta Light Rail Stage 1. Light rail would be complementary to Sydney Metro West by serving local demand across Greater Parramatta and improving the quality of feeder services
- Provision of a new rail interchange at North Strathfield would enable T9 Northern Line customers to more directly access locations to the east or west via Sydney Metro West
- Linking into key active transport (walking and cycling) networks along the corridor.

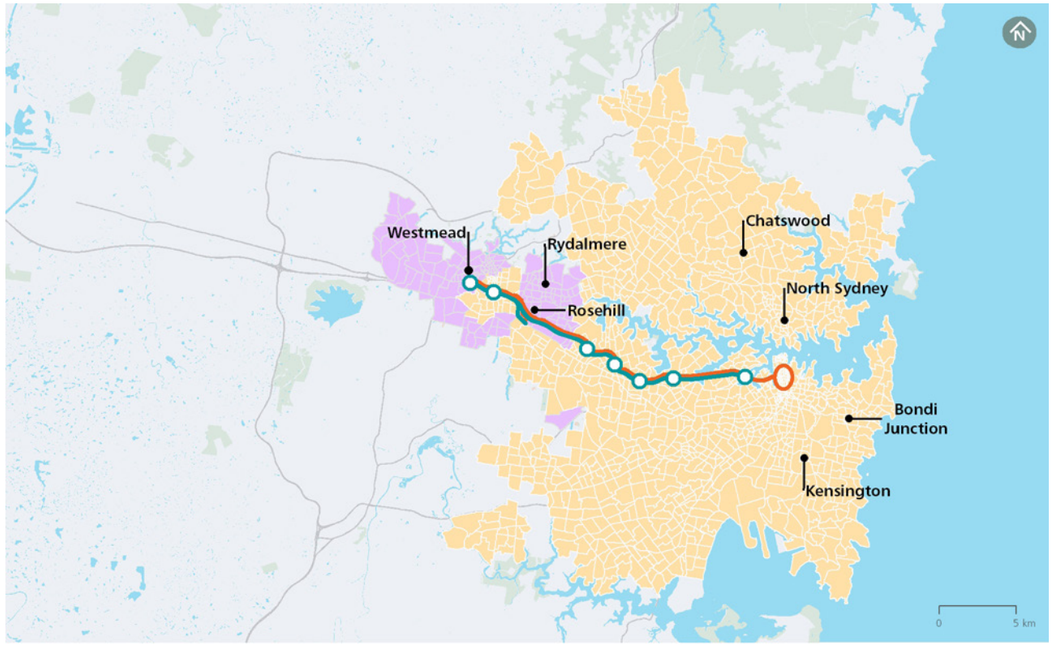
It is forecast that by 2036 Sydney Metro West would facilitate an additional 595,000 jobs and 405,000 people to be within 30-minutes of the Parramatta CBD, and an additional 135,000 jobs and 250,000 people within 30-minutes of the Sydney CBD by public transport. Figure 2-10 and Figure 2-11 provides a comparison of the locations accessible to the Parramatta CBD and Sydney CBD within 30 minutes by public transport with and without Sydney Metro West.



Locations accessible within 30 minutes of Parramatta CBD by public transport (in-vehicle time)

Sydney Metro West Concept (final alignment to be confirmed)
Sydney Metro West Stage 1 (final alignment to be confirmed)
30-minute city: without Sydney Metro West
Expanded 30-minute city: with Sydney Metro West
Sydney CBD investigation area

Figure 2-10: '30-minute city' for Parramatta CBD with and without the Sydney Metro West



Locations accessible within 30 minutes of Sydney CBD by public transport (in-vehicle time)

Sydney Metro West Concept (final alignment to be confirmed)
Sydney Metro West Stage 1 (final alignment to be confirmed)
30-minute city: without Sydney Metro West
Expanded 30-minute city: with Sydney Metro West
Sydney CBD investigation area

Figure 2-11: '30-minute city' for Sydney CBD with and without the Sydney Metro West

Increased all day accessibility

By connecting customers to a diverse range of destinations (such as health and education precincts, diverse employment centres and residential areas) and providing a turn-up-and-go service, Sydney Metro West would enable a wide range of trip purposes, which lends itself to higher all day usage.

Reduced public infrastructure provision and household energy consumption

Sydney Metro West would help to support urban renewal along the corridor. Development within the corridor would provide the opportunity for new homes that use less electricity, gas and water compared to existing larger homes, reducing the cost of living for these households and greenhouse gas emissions.

Housing supply and affordability

Housing affordability is a key issue in Sydney mainly due to strong demand for new homes, limited future housing supply and a relative lack of housing diversity (and associated diversity in housing prices). Sydney Metro West would support planned improvements in land use and a broader range of housing opportunities, which can offer improved and more affordable housing with better access to services and employment, and improved liveability.

Social equity

Sydney Metro West would support the creation of jobs and housing opportunities in Western Sydney, allowing people to live near their place of work. The improved west to east connections would also increase employment options for people in Western Sydney and increase access to services such as educational institutions.

Sustainability, health and amenity benefits

With planned changes to land use, improved accessibility via Sydney Metro West, and by facilitating the development of new homes and jobs, the number of people who live, work in and visit the Greater Parramatta to Sydney CBD corridor is expected to grow. Sydney Metro West would promote more sustainable travel behaviours and enhanced liveability for these people through:

- Opportunities for incidental exercise, with customers able to walk and cycle to and from the stations
- Amenity and placemaking benefits from enhanced pedestrian environments around stations and pedestrian and cycle links
- Opportunities for urban renewal and integrated station and precinct development along the corridor, resulting in better access to jobs and services and improved social cohesion
- Potential to reduce travel related stress for people by offering metro as a travel choice and decreasing the time spent in congested conditions.

2.5 Consistency with strategic planning and policy

Sydney Metro West is consistent with key NSW and Australian Government planning strategies, as outlined in this section.

2.5.1 Building Momentum: NSW State Infrastructure Strategy 2018-2038

The NSW State Infrastructure Strategy (Infrastructure NSW, 2018) sets out independent advice on NSW's infrastructure needs and priorities over the next 20 years across all sectors including transport.

Sydney Metro West supports several of the Strategy's key recommendations including to:

- Support the development of a three-city metropolis for Greater Sydney by investing in transport infrastructure that provides high-frequency and high-volume access to, and connectivity between, each of the three cities, while enhancing local amenity
- Invest in transport infrastructure that is integrated with land use to create opportunities for agglomeration and enhance productivity, liveability and accessibility, in support of the policy goal of a '30-minute city'.

2.5.2 Greater Sydney Region Plan: A Metropolis of Three Cities

Sydney Metro West is identified in the Greater Sydney Region Plan (Greater Sydney Commission 2018a) as being able to significantly enhance intercity links between the Central River City of Greater Parramatta and the Eastern Harbour City of the Sydney CBD. Sydney Metro West is also identified as a catalyst for realising the vision of the Greater Parramatta and the Olympic Peninsula region, which will be a place for new business, housing choice, education, research, entertainment and tourism.

Sydney Metro West would support key directions outlined in the Greater Sydney Region Plan by:

- Providing infrastructure to support the three cities, including the '30-minute city' concept where people will have access to jobs, schools, hospitals and services within 30 minutes
- Connecting the Eastern Economic Corridor with the Greater Parramatta to Olympic Peninsula Economic Corridor
- Facilitating greater housing supply.

The contribution of Sydney Metro West to achieving the directions and objectives of the Greater Sydney Region Plan is outlined in Table 2-3.

Table 2-3: Consistency of Sydney Metro West with the objectives of the Greater Sydney Region Plan

Direction	Corresponding objectives of the plan	Sydney Metro West contributions to achieving the plan's direction and objectives
A city supported by infrastructure	Objective 1: Infrastructure supports the three cities	Sydney Metro West would provide rail infrastructure connecting the Central River City with the Eastern Harbour City, as well as various key precincts located along this corridor.
	Objective 2: Infrastructure aligns with forecast growth – growth infrastructure compact	Sydney Metro West would provide infrastructure which has been designed to align with a number of future growth areas which include the Greater Parramatta to Sydney CBD corridor and The Bays.
	Objective 3: Infrastructure adapts to meet future needs	Sydney Metro West has been designed to meet the future needs of Sydney, providing for a substantial growth in capacity between the Eastern Harbour City and the Central River City. This connection would align with the future growth of key places along the corridor, including at The Bays and Sydney Olympic Park. Sydney Metro West would also use industry leading technology.
	Objective 4: Infrastructure use is optimised	Sydney Metro West would provide additional infrastructure to provide relief to the currently congested T1 Western Line, while providing new connections between communities along the corridor. This would enable both the existing suburban rail network to be optimised, as well as the growing Sydney Metro network.
Working together to grow a Greater Sydney	Objective 5: Benefits of growth realised by collaboration of governments, community and business	The development of Sydney Metro West has involved consultation and collaboration between Sydney Metro, relevant stakeholders and communities. Further discussion regarding the consultation for Sydney Metro West is provided at Chapter 5 (Stakeholder and community engagement).
A city for people	Objective 6: Services and infrastructure meet communities' changing needs	Sydney Metro West would deliver a new mass transit service for Greater Sydney, providing additional connectivity within and between the Central and Eastern Cities. Sydney Metro West would also provide improved connectivity for those along the T1 Western Line west of Westmead through the interchange at Westmead Station and reduced travel times.
	Objective 7: Communities are healthy, resilient and socially connected	Sydney Metro West would directly connect various existing and future communities of Greater Sydney. Meaningful engagement will continue with local communities to enable Sydney Metro West to build on the communities' strengths and networks. Public transport delivers multiple benefits to communities, principally through the provision of new community focal points around stations which further social cohesion. By delivering world class public transport along the corridor, Sydney Metro West would enable the delivery of health benefits to communities – encouraging people to use public and active transport (walking and cycling).
A city of great places	Objective 12: Great places that bring people together	Sydney Metro West has been designed to improve the accessibility and connectivity of existing places, whilst also providing for the creation of future great places around metro stations.
	Objective 13: Environmental heritage is identified, conserved and enhanced	Sydney Metro West has been designed to minimise and mitigate heritage impacts wherever possible. Detailed assessment of the heritage impacts of Sydney Metro West is provided at Chapter 12 (Non-Aboriginal heritage - Stage 1) and Chapter 13 (Aboriginal heritage - Stage 1).

Direction	Corresponding objectives of the plan	Sydney Metro West contributions to achieving the plan's direction and objectives
A well connected city	Objective 14: A Metropolis of Three Cities – integrated land use and transport creates walkable and 30-minute cities	Sydney Metro West has been designed to ensure that future transport has been integrated with existing and future land use, and would facilitate the creation of walkable centres. The connectivity provided by Sydney Metro West would allow for an increase in the accessibility of various centres, directly contributing to the achievement of the 30-minute city vision.
	Objective 15: The Eastern, Greater Parramatta to Olympic Peninsula and Western Economic Corridors are better connected and more competitive	Sydney Metro West would provide a new, high capacity link between the Eastern Economic Corridor and Greater Parramatta to Olympic Peninsula Economic Corridor, allowing for the connectivity of various centres along this route. Sydney Metro West would also safeguard a future extension west of Westmead, which could connect to the Western Economic Corridor.
Jobs and skills for the city	Objective 18: Harbour CBD is stronger and more competitive	Sydney Metro West would directly improve the strength and competitiveness of the Harbour CBD by improving accessibility into and within the Eastern Harbour City. By providing a direct link between the Central River City, new growth areas and the Eastern Harbour City, Sydney Metro West would also expand the area of accessibility and influence of the Eastern Harbour CBD, enabling future growth.
	Objective 19: Greater Parramatta is stronger and better connected	Sydney Metro West would provide new connections to, from and within Greater Parramatta. Connections to the broader public transport network within Greater Parramatta would include an interchange with the T1 Western Line at Westmead and to the Parramatta Light Rail Stage 1 at Westmead and Parramatta. These connections, alongside the benefits of providing new metro stations with a direct connection to Greater Parramatta, would work to substantially improve connectivity of the area.

2.5.3 Central City District Plan

The Central City District Plan (Greater Sydney Commission, 2018b) is the 20-year plan for the implementation of the vision detailed in the Greater Sydney Region Plan. Sydney's Central River City includes Greater Parramatta as its metropolitan centre, acknowledging its function in providing world-class health, education and research institutions as well as finance, business services and administration.

Priorities for the Central River City include growing a stronger and more competitive Greater Parramatta, and a better connected and competitive Greater Parramatta and the Olympic Peninsula Economic Corridor. The plan also seeks to deliver 30-minute cities through integrated land use and transport planning.

Sydney Metro West is identified as being able to support these priorities through enhancing transport connections to and within Greater Parramatta and the Olympic Peninsula, providing the opportunity for new housing and office floor space, and improving access to jobs.

2.5.4 Eastern City District Plan

The Eastern City District Plan (Greater Sydney Commission, 2018c) is the 20-year plan to implement the vision established in the Greater Sydney Region Plan. The Eastern City District includes the Sydney CBD as its metropolitan centre, acknowledging its role as Australia's established global gateway and financial capital.

Priorities of the plan which are aligned to Sydney Metro West include planning for a city supported by infrastructure, growing a stronger internationally-competitive Sydney CBD, and delivering integrated land use and transport planning and a 30-minute city.

2.5.5 Greater Parramatta and the Olympic Peninsula Vision

Greater Parramatta and the Olympic Peninsula Vision (Greater Sydney Commission, 2016) details the strategic direction for Sydney's 'true centre'.

Sydney Metro West aligns with the directions to encourage investment in economic anchors of Parramatta-Westmead and Olympic Park, support 30-minute cities within these locations and beyond, and support high quality public spaces to enhance liveability.

The vision is further developed in the Greater Sydney Region Plan (refer to Section 2.5.2), in which Sydney Metro West is also described as a catalyst for realising the vision of the Greater Parramatta to Olympic Peninsula region. Sydney Metro West provides strong support for this vision through the delivery of stations in Westmead, Parramatta and Sydney Olympic Park.

2.5.6 Smart Cities

The Smart Cities Plan (Australian Government, 2016) sets out the Australian Government's vision for cities, and a plan for maximising their potential. It includes three pillars: smart investment, smart policy and smart technology.

Central to a smart investment approach is prioritising projects that meet broader economic and city objectives such as accessibility, jobs, affordable housing and healthy environments. Sydney Metro West is consistent with this approach with its support for 30-minutes cities and improved connections to key destinations including health and education precincts, diverse employment centres and residential precincts.

As part of the Sydney Metro network, Sydney Metro West also embraces new transport technology with new-generation trains that would deliver fast, safe and reliable journeys for customers with high performance standards and good customer amenities.

2.6 Consistency with NSW strategic transport infrastructure policy

2.6.1 Future Transport 2056 strategy

The Future Transport 2056 strategy (Transport for NSW, 2018) is the NSW Government's 40-year strategy to support growth and the NSW economy, focusing on customer needs and the technological, economic and social changes ahead. Future Transport's investment priorities for Greater Sydney will be guided by the vision of a metropolis of three cities.

The three cities vision will require a sustained and staged investment program to develop a connected mass transit network across the city. These investments will provide improved public transport, congestion management and urban renewal outcomes, enabling capacity on existing road and rail corridors and supporting renewal and walkability by drawing traffic away from centres.

The strategy sets a vision for the future city-shaping transport network (shown on Figure 2-12) including major transport corridors which provide high speed and volume links between centres and shape locational decisions of residents and businesses.

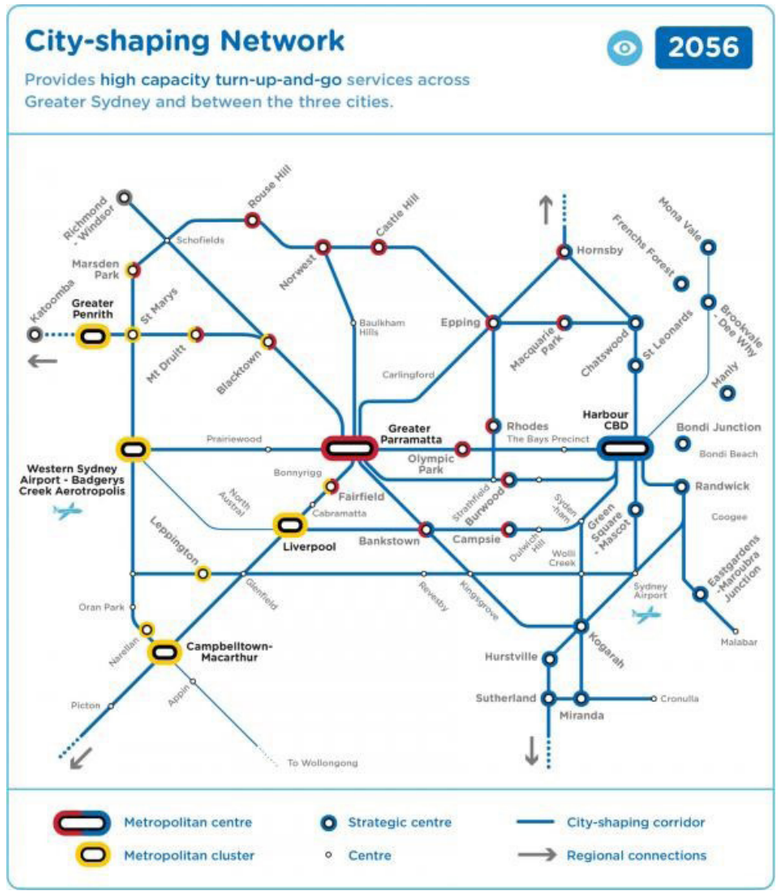


Figure 2-12: City-shaping Network 2056 – Future Transport 2056 strategy (Transport for NSW, 2018)

The corridor between Greater Parramatta and the Sydney CBD, connected via Sydney Olympic Park and The Bays is identified as a city-shaping corridor. Sydney Metro West would help fulfil the vision of this corridor.

Sydney Metro West would also accommodate for future city-shaping corridors identified in the strategy and would safeguard for possible future extensions.

The Future Transport 2056 strategy identifies Sydney Metro West as a committed project connecting the Central River City to the Eastern Harbour City.

2.6.2 Sydney City Centre Access Strategy

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

Several key transport challenges for the Sydney CBD are discussed in the Strategy, including public transport capacity (in particular the T1 Western Line) and meeting future demand for access to the city centre. Sydney Metro West is a key initiative which would be able to address this demand for services to the Sydney CBD.

The Sydney City Centre Access 2018 update provides an overview of the key transport initiatives that have been implemented since the 2013 strategy was released, and what still needs to be done to support the changing city.

2.7 Objectives for Sydney Metro West

Sydney Metro West's objectives are separated into network and corridor objectives. The network objectives represent the outcomes to be achieved by Sydney Metro West in its full configuration, including potential extensions. The corridor objectives include the specific plans and needs of the geographic area between Greater Parramatta and Sydney CBD.

2.7.1 Sydney Metro West network objectives

The Sydney Metro West network objectives are:

- Ensure transport services are meeting the needs of customers
- Deliver outcomes that align with and support key strategic land use and transport frameworks including the Smart Cities Plan, Greater Sydney Region Plan, Future Transport Strategy and the relevant District Plans
- Boost Sydney's international competitiveness, productivity and employment growth by supporting new and existing strategic centres
- Support future housing needs by increasing housing supply, choice and affordability
- Improve liveability and provide a catalyst for positive change by enabling urban renewal opportunities, enhancing housing supply and supporting productivity of centres
- Improve access to and resilience of the transport network through integrated land use and transport planning, including integration of Sydney Metro West with other transport modes
- Ensure value for money and a sustainable and deliverable solution.

2.7.2 Sydney Metro West Greater Parramatta to Sydney CBD corridor objectives

The Sydney Metro West Greater Parramatta to Sydney CBD corridor objectives are:

- Contribute towards the vision for a three cities metropolis established by the Greater Sydney Commission including the '30-minute city' concept
- Support additional housing supply and employment growth opportunities and support urban renewal initiatives within the Greater Parramatta to Sydney CBD corridor including key government precincts such as the Greater Parramatta and Olympic Peninsula and The Bays
- Achieve customer outcomes including relieving congestion on the busy T1 Western Line and T2 Inner West and Leppington Line, increased rail patronage and mode shift, reduced travel times between key destinations, providing new access to mass transit rail and relieving bus and road congestion in the western corridor.

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3 Sydney Metro West development and alternatives

3 Sydney Metro West development and alternatives

This chapter describes the evaluation process undertaken to determine the preferred option for the Sydney Metro West Concept. It includes an overview of the strategic alternatives, alignment options, station options, and technical design and construction options.

3.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to alternatives and options and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 3-1.

Table 3-1: Secretary's Environmental Assessment Requirements – Alternatives and options

Reference	Secretary's Environmental Assessment Requirements	Where addressed
2. Environmental Impact Statement		
2.1	The EIS must include but not necessarily be limited to, the following: g. a statement of the strategic objective(s), including: • how the Concept will integrate with the broader transport network (existing and proposed); • an analysis of any feasible alternatives; • a description of feasible options within the Concept (including station numbers and locations); and • a description of how alternatives to and options within the Concept were analysed and optimised to inform the selection of the preferred alternative/option. The description must contain sufficient detail to enable an understanding of why the preferred alternative to and options(s) within the Concept were selected;	The strategic objectives and how the Concept would integrate with the broader transport network is addressed in Chapter 2 (Strategic need and justification). The remainder is addressed in sections 3.3 to 3.8.

3.2 Overview of the Sydney Metro West development process

The Sydney Metro West development process has been driven by the identified strategic need to improve connectivity between Greater Parramatta and the Sydney CBD, and has included:

- Consideration of alignment options and the type of service, including determining the optimal balance of travel time between the Parramatta and Sydney CBDs and the number of stations to enable people to access metro services
- Analysis of options for station locations
- Analysis of options for a stabling and maintenance facility
- Analysis of options for the approach to tunnelling.

Development has been carried out in consultation with stakeholders and the community. This is further detailed in Chapter 5 (Stakeholder and community engagement).

3.3 Strategic alternatives

As part of the development process for Sydney Metro West, a range of potential strategic alternatives to Sydney Metro West have been considered. These alternatives are presented below and are based on the future transport infrastructure network documented in Future Transport Strategy 2056 (Transport for NSW, 2018). Future Transport Strategy 2056 identifies a range of committed transport initiatives, as well as future transport investment initiatives that will be subject to further investigation in the short, medium and long term.

The strategic alternatives relevant to Sydney Metro West and the Parramatta CBD to Sydney CBD corridor include:

- Do nothing
- Improvements that can be achieved through implementing regulatory, governance and better-use reforms
- Improvements to other parts of the transport network, including road, bus, light rail and ferry
- Improvements to other parts of the Sydney Trains network.

3.31 Do nothing

Demand on much of Sydney's rail network is nearing capacity during the morning and evening peak periods. To ensure continued growth in productivity, cater for forecast employment and population growth, and sustain the city's liveability, Sydney's transport capacity will need to substantially increase.

If the additional mass transit capacity offered by Sydney Metro West does not proceed, it is expected that:

- The T1 Western Line, T9 Northern Line and T2 Inner West and Leppington Line will continue to operate at or near capacity at peak times, with very limited capacity for new growth in the corridor
- The road network in the corridor will continue to operate at capacity in peak times, creating congested roads and increased travel times for motorists and bus customers
- The lack of transport connectivity at key precincts such as Sydney Olympic Park and The Bays will not be adequately addressed
- The long term public transport capacity requirements for the projected population and employment growth between Parramatta and Sydney CBD would not be met
- Growth would more likely be accommodated on Sydney's urban fringe in areas with more limited access to public transport, which would contribute to ongoing urban sprawl and congestion. Alternatively, growth may occur in an unplanned manner within existing communities, potentially impacting local character and amenity
- There would be reduced potential for development of areas and new housing stock
- There would be reduced productivity and international competitiveness due to congestion and reduced clustering of businesses in economic centres within the Greater Parramatta to Sydney CBD corridor.

3.32 Regulatory, governance and better-use reforms

The NSW Government has considered a range of regulatory, governance and better-use reforms to improve transport and land use outcomes, to cater to growing transport demand and meet Sydney's growing population needs. These reforms include continued implementation of rail network improvements such as automated signalling and increased frequency of rail services as part of the More Trains, More Services program, more efficient use of roads, more frequent bus and ferry service and bus priority initiatives. Reviews of transport legislation to allow for more flexible services and integrated transport and land use planning have also been investigated.

Other commitments set out in Future Transport Strategy 2056 include:

- Public transport passenger service improvements
- Investment in digital technology, such as the Intelligent Congestion Management Program
- Investments to ease congestion by optimising the network and better use existing infrastructure, such as via the Bus Priority Infrastructure Program, the Pinch Point Program, smart motorways and clearways
- Transport access program to improve access to train stations and ferry wharves.

While these reforms are vital to meeting the NSW Government's policy objectives and are already being implemented, additional investment in transport infrastructure is needed so that Sydney's transport network meets future demand.

3.33 Transport mode alternatives

Further investment in road, bus and light rail as a strategic alternative to Sydney Metro West has been considered including new motorways, suburban rail connections, bus rapid transit services, and increased ferry services.

Buses and light rail are complementary to mass transit modes, bringing customers to and dispersing them from the major transport hubs served by the Sydney Trains suburban rail network and metro rail services. Buses can also potentially provide a flexible response to local demand pressures and light rail can offer medium capacity solutions for major transport corridors, replacing lower capacity bus services. However, these modes would not provide sufficient mass transit capacity to address Sydney's transport bottlenecks in the Greater Parramatta to Sydney CBD corridor.

Ferry services tend to be slower and less reliable than rail services. Ferry travel times between Parramatta and the Sydney CBD are also impacted by speed restrictions on the Parramatta River, and natural low tides between Rydalmere and Parramatta reduces service reliability.

The NSW Government is currently investing in projects to improve transport and land use outcomes in the Greater Parramatta to Sydney CBD corridor. These include the future Parramatta Light Rail (Stage 1) and planned Parramatta Light Rail (Stage 2), the Parramatta Road Corridor Urban Transformation Strategy and road projects such as WestConnex.

The current and planned light rail network would largely serve local demand focused on the Parramatta and Sydney CBDs and provide feeder services to mass transit spines (currently the Sydney Trains network), rather than providing connectivity across the entire corridor.

While current committed and future initiatives are important to service key precincts within the corridor, these projects on their own cannot wholly support the large hourly commuter movements required in and out of the Parramatta and Sydney CBDs which requires a mass transit system such as that provided by metro rail.

3.34 Rail network alternatives

The NSW Government is currently investing in improvements to the Sydney Trains suburban rail network, through the More Trains, More Services Program which includes extra rail services, new trains on the suburban network and upgraded rail infrastructure.

As part of the program, in late 2017, an extra four express services were provided between Parramatta and Sydney CBD in both the morning and afternoon peaks, increasing the service to 20 trains per hour.

While the More Trains, More Services Program is important to accommodate customer growth and continually increase demand across the existing Sydney Trains suburban rail network, an additional solution is required to meet demand for rail services between the Parramatta and Sydney CBDs in the long term. So that joint objectives are achieved, the More Trains, More Services program would need to be integrated with Sydney Metro West.

Additionally, these improvements to the existing Sydney Trains suburban rail network are unable to support opportunities related to housing growth and the development of new areas. Without the provision of new stations, these improvements will not provide services to new rail catchments and key precincts currently not serviced by rail, including The Bays and direct services to Sydney Olympic Park.

Other longer-term future transport initiatives identified for investigation in Future Transport Strategy 2056 include:

- Parramatta to Bankstown to Hurstville/Kogarah Mass Transit/Train Link
- Parramatta to Epping Mass Transit/Train Link
- Parramatta to Norwest Mass Transit/Train Link
- Macquarie Park to Hurstville Mass Transit/Train Link.

These future transport initiatives do not fundamentally service the Greater Parramatta to Sydney CBD corridor, and in many instances would be complementary to Sydney Metro West.

3.4 Travel time between Parramatta and the Sydney CBD

A guiding principle for Sydney Metro West is to offer a faster trip than would be possible on the existing T1 Western Line between Parramatta and the Sydney CBD. The fastest travel time between Parramatta and Wynyard Station on the existing Sydney Trains suburban rail network is 31 to 33 minutes. Travel time between the two cities is important to support both the '30-minute city' concept and to facilitate improved customer, transport and land use outcomes.

This principle has influenced further development of Sydney Metro West, including alignment and station options. Key considerations in determining an optimum travel time between Parramatta and the Sydney CBD are detailed below.

3.4.1 Importance of travel time

The Greater Sydney Region Plan: A Metropolis of Three Cities (Greater Sydney Commission, 2018a) provides direction to develop more accessible and walkable 30-minute cities. This means more people should have 30-minute public transport access to one of the three cities and to services in their nearest strategic centre seven days a week. Through integrated land use and transport planning, Sydney Metro West would support this vision and link houses, jobs, education, health and other services.

Customers travel for a range of reasons, including commuting, business-to-business and leisure trips. Meeting the travel time needs for all trip purposes is a key consideration for travel time between the two cities.

3.4.2 Influences on travel time

A range of factors influence travel time, including the number and location of stations, train type and station design. The challenge of balancing the optimal number and location of stations with travel times has a direct influence over the land use outcomes, economic benefits, expanded customer catchments and increased network connectivity.

The speed of the rolling stock and efficiency of the station and platform design also influence travel times. The speed of the rolling stock would provide a comfortable journey for customers as well as offering a good balance between comfort and travel time between the two cities. The number of doors and internal configuration of the rolling stock would be designed to provide customers with efficient boarding and alighting times, with train dwell times of around 30 seconds at each station.

3.4.3 Optimum travel time between the two cities

The optimum travel time between Parramatta and the Sydney CBD is about 20 minutes. A travel time of about 20 minutes delivers a range of combined benefits for customers within the Sydney Metro West corridor, as well as for Greater Sydney, including:

- Greatest balance of benefits for customers travelling for a range of reasons, including commuting, business-to-business and leisure trips
- Offers greater economic benefit through a balance of fast travel times, new stations within the corridor to create new rail catchments and improved transport connectivity
- Supports the '30-minute city' concept by offering customers a high-frequency, turn-up-and-go service
- Allows intermediate stations to be delivered along the alignment, to open up new rail catchments and expand connections across the transport network
- Expands the 30-minute catchment for the key anchor precincts of Sydney Metro West at Sydney Olympic Park, The Bays and Greater Parramatta
- Provides the highest volume of travel time benefits to the largest number of customers across Greater Sydney, when compared to a 15- or 25-minute trip.

3.5 Alignment alternatives

3.5.1 Strategic alignment and service alternatives

Four strategic alignment and service alternatives have been evaluated by Sydney Metro. A key consideration in decision making around alignment options was the balance between travel times and number of stations. Options investigated were:

- About four to five stations from Parramatta CBD to the Sydney CBD (inclusive) ('Metro Express'). This option would achieve a higher speed but service a small amount of stations. This option was found to be limited in its ability to service a large catchment due to a minimal number of stations
- About nine to 10 stations from Parramatta to the Sydney CBD (inclusive) ('Metro Rapid'), with anchor precincts at Parramatta, Sydney Olympic Park, The Bays and Sydney CBD. This option was found to achieve a balance between an efficient travel time between Greater Parramatta and Sydney CBD, and the ability to service a large catchment area and key precincts
- About 11 to 12 stations from Greater Parramatta to the Sydney CBD (inclusive) ('Metro Local South'). This option would service a large catchment due to a higher number of stations, yet result in a higher travel time between Greater Parramatta and the Sydney CBD. An 11 to 12 station option north of Parramatta River ('Metro Local North') was also investigated; however this alignment would be unable to service key precincts including Sydney Olympic Park.

This evaluation concluded that a service with about nine to 10 stations was the preferred option as it could achieve a balance between travel times and an optimal number of stations to service a large catchment. This preference was the basis for further development of the Concept, which involved considering station location options as well as other criteria, such as horizontal curves and vertical grades, geology, and the need to avoid underground structures such as major utilities and basements. Options investigated for station locations are detailed in Section 3.6.

3.6 Station location options

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

- Strategic station locations: Identified the key locations to be serviced at Parramatta, Sydney Olympic Park, The Bays and Sydney CBD
- Preliminary station locations: Identified that adding Westmead as a core station provided significant benefits
- Assessed and shortlisted station option pairs for Westmead and Parramatta and to connect to the T1 Western Line
- Assessed station location options between Parramatta and Sydney Olympic Park
- Assessed and shortlisted station options to connect to the T9 Northern Line
- Assessed and shortlisted station options between the T9 Northern Line and The Bays
- Shortlisted station locations: Involved detailed analysis of the short-listed station locations.

Further investigation is currently underway to identify an optimum station location within the Sydney CBD. An additional phase is also underway (strategic station options) to investigate the feasibility and affordability of stations at Rydalmere and Pyrmont. These strategic station options at Rydalmere and Pyrmont are currently being investigated and do not form part of the Concept at this stage.

Options to be investigated for metro stations were identified through:

- Engagement with community and stakeholders including local councils and industry
- A strategic station location process conducted by Sydney Metro
- Consultation with key government stakeholders including the Department of Planning, Industry and Environment, the Greater Sydney Commission, other sections of Transport for NSW and the Department of Premier and Cabinet.

Activities undertaken to support the station location options evaluation included:

- Feedback from community and industry engagement
- Land use and transport modelling
- Scoping design, technical feasibility and engineering studies
- Feedback from key stakeholder workshops and working groups.

3.6.1 Strategic station locations

Preliminary investigations identified that stations at Parramatta, Sydney Olympic Park, The Bays and Sydney CBD would provide connections to key centres along the corridor and were core to the Concept (referred to as 'core stations').

These station locations were announced in November 2016. An interchange with the T1 Western Line was also determined to be a key element of the Concept to provide relief to this service, which was expected to become overcrowded without intervention. The benefits and reasoning for each of the core stations is provided in Table 3-2.

Table 3-2: Core station evaluation

Core station	Evaluation
Parramatta	A new metro station at Parramatta would reinforce its role as the metropolitan centre of the Central River City with access to reliable, high capacity public transport. This would support connectivity to employment, in an area where the number of jobs is expected to double over the next 20 years to 137,000 (Greater Sydney Commission, 2018a), and connect Parramatta to key employment centres across Greater Sydney. Sydney Metro West would also enable more customers to travel to Greater Parramatta from the east during the AM peak – supporting the development of Sydney as a multi-centric city.
Sydney Olympic Park	A metro station would enable full realisation of the Sydney Olympic Park lifestyle super precinct as a centre of recreation, entertainment, knowledge intensive jobs and higher-density living. Mass transit would support the 34,000 jobs and more than 23,000 residents which are expected to be located in the area by 2030 (Sydney Olympic Park Authority, 2018), and significantly enhance public transport connectivity.
The Bays	The Bays is set to be Sydney's new world-class destination and employment hub where 95 hectares of land is being regenerated. Sydney Metro West would enable The Bays to be developed to its full potential, with a focus on improved international competitiveness and knowledge based jobs.
Sydney CBD	A metro station in the Sydney CBD would allow easy access to the existing public transport network, Metro North West Line (opened in 2019), and Sydney Metro City & Southwest (currently under construction). Sydney Metro West would provide a direct connection from the Sydney CBD to current and future employment centres such as Greater Parramatta, Sydney Olympic Park and The Bays. It would also improve accessibility to Sydney's cultural, recreational and tourism attractions. There is also potential to provide congestion relief to the existing Town Hall and Wynyard stations.

3.6.2 Preliminary station locations

This phase identified and assessed station location options including connections to the T1 Western Line, T9 Northern Line and Sydney CBD. It included:

- Considering feedback from the first round of community and industry engagement
- Additional land use and transport modelling
- Scoping design, technical feasibility and engineering studies
- Considering feedback from key stakeholder workshops and working groups.

Westmead as a core station location

Westmead is home to one of the largest health, education, research and training precincts in Australia, and a key provider of jobs for Greater Parramatta and the Western Sydney region. Westmead provides direct health services to almost 10 per cent of Australia's population (Deloitte and Westmead Alliance, 2016). The catchment extends across Western Sydney and NSW, and throughout Australia. By 2026, the Westmead precinct will have over 2.8 million outpatient visits and over 160,000 emergency department presentations every year (Greater Sydney Commission, 2018a).

Westmead is an engine for health innovation and a major contributor to the Australian Government's national innovation and science agenda. Westmead produces world-leading scientists and analysts, and is home to successful health research collaborations, including translational research that aims to 'translate' research into meaningful health outcomes.

The Westmead health and education precinct spans more than 75 hectares and comprises over 400,000 square metres of high-end health-related developments, including four major hospitals, three world-leading medical research institutes, and the largest research-intensive pathology service in NSW.

Servicing the precinct with metro would provide a significant opportunity to underpin the new vision for Westmead by offering improved accessibility to and from the precinct, and attracting global practices and businesses. Westmead was therefore added as a core station location.

Connecting with the T1 Western Line – Westmead and Parramatta paired assessment

A metro station interchanging with the T1 Western Line would offer significant relief to existing T1 services, could provide customers with faster travel times and expand the 30-minute catchment for Greater Parramatta. A connection along the T1 Western Line may facilitate land use change with residential and employment growth opportunities, and provide wider accessibility and journey time savings across Greater Sydney.

A total of seven station option combinations were investigated including one single station option. Table 3-3 provides a summary of the station combinations evaluated. Figure 3-1 shows the shortlisted options in Westmead and Parramatta.

Table 3-3: Westmead and Parramatta – preliminary station location options evaluation

Locality	Preliminary evaluation	Shortlisted
Westmead North and Parramatta Station	This option would provide a station in Westmead North and one at the existing Parramatta Station where it would interchange with the T1 Western Line, T5 Cumberland Line and the T2 Inner West and Leppington Line. This option would relieve the busy T1 Western Line at Parramatta, serving the greatest number of existing Sydney Trains rail customers and providing an interchange with the existing bus network. This option would enable a metro station at Westmead to be closer to the health precinct and support delivery of the Westmead health and education super precinct. It would also offer customers an opportunity to transfer to and from Parramatta Light Rail.	Yes
Westmead Station and Parramatta CBD	This option would provide an interchange with T1 Western Line services at the existing Westmead Station and a new metro station in the Parramatta CBD. A new metro station in the northern part of the commercial district of Parramatta, in the heart of the Parramatta CBD, would serve the greatest number of jobs and provide fast and efficient connections with the Sydney CBD. It would create a second gateway to Parramatta, reinforcing its status as the Central River City. A new transport node could be established around a new station, providing much needed relief to the existing Parramatta Station and bus layover areas. This option would offer the opportunity to create a high-quality interchange for customers at Westmead with the T1 Western Line and T5 Cumberland Line, T-way bus services and Parramatta Light Rail. A new metro station at the existing Westmead Station would improve accessibility to the Westmead health and education super precinct, while also supporting renewal of the Westmead South residential precinct.	Yes
Parramatta Station only	With only one metro station at Parramatta, this option would create pressure on the constrained Parramatta Station and would not serve the health and education precinct at Westmead.	No
Westmead Station and Parramatta Station	Duplicating connections to the T1 Western Line at both existing stations would dilute the opportunity to reinforce the Parramatta CBD or serve the health and education precinct at Westmead and relieve the T1 Western Line.	No
Westmead North and Parramatta CBD	Although this option would both reinforce the Parramatta CBD and serve the health and education precinct at Westmead, it would not provide a direct connection with the T1 Western Line and therefore would not provide relief to the existing Sydney Trains suburban rail network.	No
Westmead Station and South Parramatta	A South Parramatta station could support additional housing supply in southern Parramatta, however would be at a further distance to the core activity of the Parramatta CBD (relative to other options considered). As such, it would not support the development of the Parramatta CBD.	No
Westmead North and South Parramatta	This option would not provide a direct connection with the T1 Western Line and therefore would not provide relief to the existing Sydney Trains suburban rail network. This option would also not support the development of the Parramatta CBD.	No

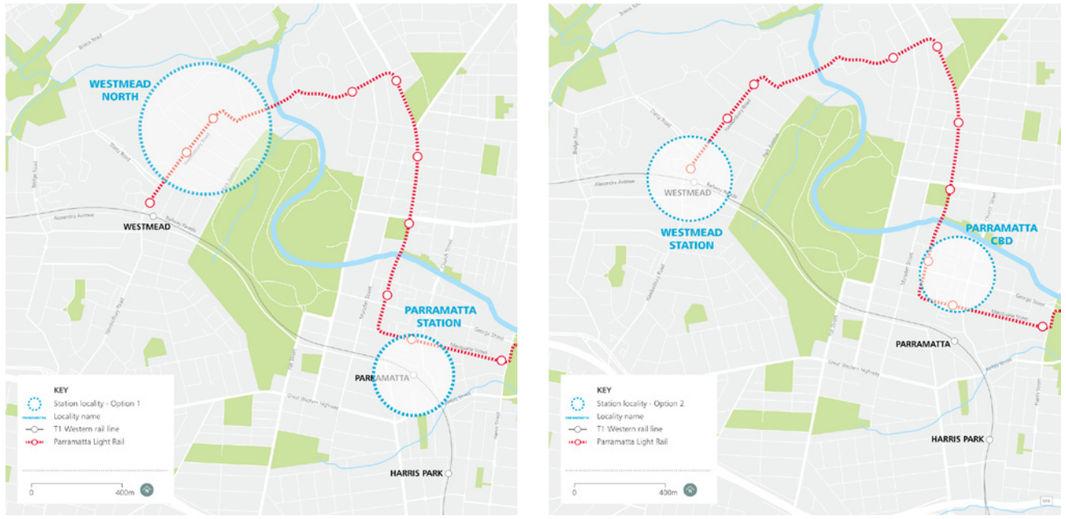

Figure 3-1: Shortlisted options to connect with the T1 Western Line and Greater Parramatta

Between Parramatta and Sydney Olympic Park – Greater Parramatta to the Olympic Peninsula area

Seven station locality options were investigated between Parramatta and Sydney Olympic Park. Table 3-4 outlines the station locality options which were evaluated.

Table 3-4: Greater Parramatta to the Olympic Peninsula – preliminary station location options evaluation

Locality	Preliminary evaluation	Shortlisted
Rydalmere	A metro station in Rydalmere could support urban renewal opportunities within the station catchment, including education, residential and mixed-use employment. Rydalmere could provide customer benefits to a growing catchment and transport integration with links to the Parramatta Light Rail and bus routes along Victoria Road delivering improved accessibility. A station in this locality may not align with the NSW Government's current strategic land use vision to retain essential urban services in this area (Greater Sydney Commission, 2016). Rydalmere is currently being assessed as a strategic station location (refer to Section 3.6.4).	Yes
Camelia	A new metro station could be located in the future Camellia Town Centre, offering an opportunity for an interchange with the future Parramatta Light Rail and supporting urban renewal. This option would present considerable constructability challenges in relation to contamination and flooding.	Yes
North Auburn	North Auburn would provide some support for mixed use development along Parramatta Road. However, this option would present significant constructability-related challenges associated with likely contamination and the existing road network, and the alignment would limit the ability to efficiently provide a station location in Parramatta.	No
Ermington	This option could support an increase in dwelling and population, although substantial uplift in this locality is not identified in strategic plans. This option would also result in a less efficient alignment between Sydney Olympic Park and Greater Parramatta, resulting in longer travel times for customers.	No
Silverwater	A station in this locality would not align with the Government's current strategic land use vision to retain essential urban services in this area (Greater Sydney Commission, 2016).	No

Locality	Preliminary evaluation	Shortlisted
Newington	While this option would create a new rail catchment area and support travel time savings, a station in this locality would not align with the current strategic land use vision for this area which seeks to retain the existing residential community without any significant increase in density, enabling the retention and protection of essential industrial and urban services land in adjoining Silverwater (Department of Planning and Environment, 2017a).	No
North Lidcombe	A station in this locality would not align with the Government's current strategic land use frameworks, which seek to retain existing urban services (Greater Sydney Commission, 2016). This option would have a highly constrained catchment due to transport and geographic barriers, and presents significant constructability-related challenges.	No

The evaluation identified that Camellia and Rydalmere could deliver significant benefits, particularly in relation to urban renewal, and were subject to further analysis. The Camellia and Rydalmere localities are shown on Figure 3-2.

While Camellia and Rydalmere were initially found to be the preferred locations from the options assessed in this area, it was determined that further analysis of this area was required due to:

- The strategic vision for land use in the area broadly between Parramatta and Sydney Olympic Park is to retain industrial or urban services functions
- Community and stakeholder consultation and feedback during round two of engagement in 2018, particularly in relation to Silverwater and Newington.

The area between Parramatta and Sydney Olympic Park was therefore progressed to the strategic station options phase to further investigate the opportunity for a station. Information on further and ongoing assessment of station location options in this area is detailed in Section 3.6.4.

Figure 3-2: Greater Parramatta Olympic Park station location options taken forward from initial investigations

Connection with the T9 Northern Line

Providing a metro station that interchanges with the T9 Northern Line would offer significant relief to existing services, provide customers with faster travel times and expand the 30-minute catchment for Greater Parramatta. The station would provide an attractive interchange option for customers and extend the catchment of Sydney Metro West to Sydney's north. A connection along the T9 Northern Line may facilitate land use change with residential and employment growth opportunities, and provide wider accessibility and journey time savings across Greater Sydney.

Along the T9 Northern Line, four stations were subject to a preliminary station assessment. Of these four stations, two were shortlisted for further evaluation. Table 3-5 provides a summary of the station options evaluated.

Table 3-5: Connection to the T9 Northern Line – preliminary station location options evaluated

Locality	Preliminary evaluation	Shortlisted
Rhodes	A station at Rhodes would align with the objective of Rhodes as a strategic centre and would support a minor uplift in job and population. However there is less opportunity for urban renewal at this location (compared to other station localities) due to the geographic constraints. Rhodes is located on a peninsula, making a connection at this location challenging from a constructability point of view (associated with existing basements and water crossings), and impacts to the alignment, and therefore travel time for customers.	No
Concord West	A Concord West station location would provide opportunities for integration with the local bus network and would support some residential and employment growth, however would have a relatively small walking catchment due to large open spaces nearby.	Yes
North Strathfield	A North Strathfield station location would support urban renewal within the Homebush precinct redevelopment area. The station would reach a significant walking catchment and offer a more efficient alignment (and therefore improved travel times for customers travelling between Parramatta and the Sydney CBD).	Yes
Strathfield	A station at Strathfield would provide limited residential and jobs growth as high density development already surrounds the station, and the locality is not identified as a key employment centre. The existing Strathfield Station is constrained in terms of capacity and this option would duplicate the existing T1 Western Line services between Parramatta and the Sydney CBD.	No

The evaluation identified Concord West and North Strathfield could deliver significant benefits and were subject to further analysis. The two shortlisted options are shown on Figure 3-3.

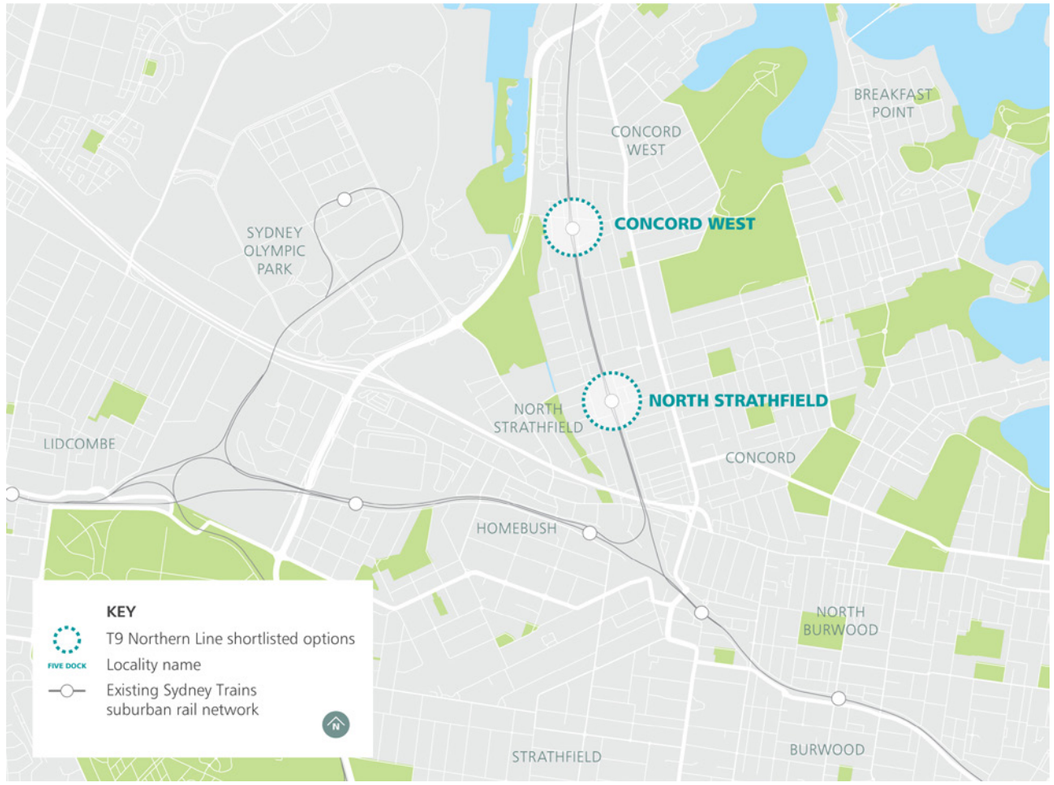

Figure 3-3: T9 Northern Line shortlisted options

Between the T9 Northern Line and The Bays

Currently, public transport accessibility between the T9 Northern Line and The Bays is largely limited to road-based transport. There are opportunities to provide customers with significant travel time improvements, connect more of the workforce to jobs within 30 minutes and integrate with the bus network.

Between the T9 Northern Line and The Bays, a total of 13 station options were assessed, three of which were taken forward to the next phase of evaluation. Table 3-6 provides a summary of the station combinations evaluated.

Table 3-6: T9 Northern Line to The Bays – preliminary station location options evaluated

Locality	Preliminary evaluation	Shortlisted
Concord	Concord is characterised by lower density residential land use with significant green space. There is limited employment activity within the locality and limited opportunity for residential and employment uplift. Heritage attributes and green space in the locality would also require careful consideration.	No
Mortlake	Mortlake is a peninsula constrained by the Parramatta River. There is limited employment activity within the locality. Recent medium density residential development and the presence of waterbodies and green space limit opportunities for employment and residential uplift in the locality. The location would present some constructability and deliverability challenges due to interaction with multiple water crossings, varied elevation (impacting station depth), and a potentially inefficient alignment.	No
Burwood North	The Burwood North locality is within the Parramatta Road Corridor Urban Transformation Strategy area and characterised by a mix of uses along Parramatta Road and along Burwood Road towards the Burwood strategic centre. A station at Burwood North could support employment growth and intensification of existing land uses in the surrounding catchment, with opportunities for residential growth. It would open a new rail catchment to provide customer benefits with a more frequent, reliable and fast mass transit service, and would provide an opportunity to integrate with the existing bus network. A station in this locality would offer a relatively efficient corridor alignment that supports efficient travel times between the Parramatta and Sydney CBDs.	Yes
Burwood	As the current level of Sydney Trains suburban rail service is high to Burwood, with the existing Burwood Station serviced by multiple lines, customers in the locality would receive relatively less improvement to service frequency, travel time and improved access compared to other station locations. As Burwood is located significantly south of The Bays and Olympic Park stations, the station location would result in an inefficient alignment and deliver longer travel times. In addition, intensive land use around the rail corridor would present constructability challenges including the potential to impact to existing rail services.	No
Kings Bay	Kings Bay is characterised by mixed land use on nearby Parramatta Road including residential, retail, light industrial and education. There is employment and mixed residential land use within the locality, with opportunity for employment uplift and planned renewal as part of the Parramatta Road Corridor Urban Transformation Strategy. The delivery of a metro station would provide customer benefits through a more frequent, reliable and fast service to an area that does not currently connect with mass transit, and presents a transport interchange opportunity with local bus services on Parramatta Road. A station in this locality would offer a corridor alignment that supports efficient travel times between the Parramatta and Sydney CBDs.	Yes
Five Dock	Five Dock is characterised by mixed land uses, including lower density residential and a local town centre on Great North Road. A metro station would provide customers with a more frequent, reliable and fast service to an area that is currently not serviced by mass transit. Five Dock is recognised as a location for bus interchange and active transport connectivity. A metro station in this locality could offer a relatively efficient corridor alignment that supports efficient travel times between the Parramatta and Sydney CBDs.	Yes
Ashfield	Ashfield would provide limited support for additional renewal and growth, as development is already occurring in the short and medium term. Ashfield is currently served by the T1 Western Line and other services at the existing Ashfield Station. This option would also result in an inefficient north-south alignment to connect to The Bays, which would increase travel times for customers.	No
Haberfield	Haberfield is characterised by lower density residential land use with limited employment activity within the locality and heritage attributes in the area. This locality would also have constructability and deliverability challenges due to interaction with the Rozelle Interchange (tunnel) and Hawthorne Canal. It would also have an inefficient alignment to The Bays, which would increase travel times.	No
Drummoyne	Drummoyne would offer limited residential and employment growth opportunities due to the geographic constraints of the peninsula. Drummoyne would present challenging constructability and deliverability due to interaction with multiple water crossings, the varied elevation in the locality that would impact station depth, and an inefficient alignment that would increase travel time between the two CBDs.	No
Lilyfield	Lilyfield is characterised by lower density residential land use, some green space and heritage which would limit the opportunity for urban renewal. The locality would present highly difficult constructability and deliverability due to interaction with the Rozelle Interchange and Hawthorne Canal. Initial investigations suggest this would require a very deep station, resulting in greatly increased access and interchange times for customers.	No

Locality	Preliminary evaluation	Shortlisted
Leichhardt North	Leichhardt North would present challenging constructability and deliverability due to interaction with the Rozelle Interchange and Hawthorne Canal. Initial investigations suggest that this would require a very deep station, resulting in greatly increased access and interchange times for customers.	No
Leichhardt	Leichhardt is characterised by lower density residential land use, limited employment activity within the existing locality, and limited scope for employment uplift due to the heritage value of the area. It is also currently served by light rail along its western boundary. The locality would present challenging constructability and deliverability due to interaction with the Rozelle Interchange and Hawthorne Canal.	No
Annandale North	Annandale North presents less opportunity to connect to employment activity, and growth in employment and population at this locality. Any station option would also require careful consideration of heritage conservation areas. This option would also result in an inefficient north-south alignment to connect to The Bays, which would increase travel times for customers.	No

The evaluation identified the station localities of Burwood North, Kings Bay and Five Dock could deliver significant benefits and were subject to further analysis. These options are shown on Figure 3-4.

Figure 3-4: Shortlisted station locations between T9 Northern Line and The Bays

Connecting into the Sydney CBD

The Sydney CBD is one of the most productive and well-connected areas in Australia. A connection to the Sydney CBD would:

- Connect customers to high value employment and support efficient business-to-business links
- Offer greater choice for customers and travel time savings to the Sydney CBD
- Enable new interchange opportunities with the existing suburban and intercity rail network and the future Sydney Metro network
- Provide relief to existing Sydney CBD stations.

Further investigation is currently underway to identify an optimum station location within the Sydney CBD. The location of a station with the Sydney CBD and an analysis of potential options would be presented as part of the assessment for a future stage.

Outcome of preliminary station locations assessment

The preliminary station locations assessment concluded:

- Westmead was included as a core station location
- The shortlisted pairs for station locations at Westmead and Parramatta and to connect to the T1 Western Line were Westmead North/Parramatta Station and Westmead Station/Parramatta CBD
- No obvious station location was identified for the area between Parramatta and Sydney Olympic Park. This area was therefore carried forward for further assessment as part of the strategic station options phase
- The shortlisted locations for the T9 Northern Line connection were Concord West and North Strathfield
- The shortlisted locations for the area between the T9 Northern Line and The Bays were Burwood North, Kings Bay and Five Dock
- The preferred location for the Sydney CBD connection requires further investigation to identify the optimum location.

3.6.3 Shortlisted station locations

Detailed assessment of shortlisted stations against the network objectives was carried out.

Input to these assessments included additional land use and transport modelling, detailed technical design and engineering assessments, urban design and placemaking assessments, customer testing, a second round of community and industry consultation, and multiple meetings and workshops with key stakeholders.

The performance of each of the shortlisted station options was assessed in detail against the Sydney Metro West objectives and scored as 'strong alignment' (green), 'some or neutral alignment' (orange) or 'no or negative alignment' (red). The results are summarised in Table 3-7 and a discussion of each assessment is provided below.

Table 3-7: Performance of shortlisted stations against Sydney Metro West objectives

Station location option	Evaluation criteria						
	Customer benefits	Strategic land use and transport alignment	Productivity & jobs	Housing supply	Urban renewal & place-making	Transport integration	Deliverability & value for money
Station locations in Westmead and Parramatta and T1 Western Line connection							
Westmead Station & Parramatta CBD	🟢	🟢	🟠	🟢	🟢	🟢	🟠
Westmead North & Parramatta Station	🟠	🟠	🟢	🟢	🟢	🟠	🔴
T9 Northern Line connection							
Concord West	🟠	🟠	🟠	🟠	🟠	🟢	🟢
North Strathfield	🟢	🟠	🟢	🟢	🟢	🟢	🟠
Between the T9 Northern Line and The Bays							
Burwood North	🟢	🟢	🟢	🟢	🟢	🟠	🟠
Five Dock	🟢	🟠	🟢	🟠	🟠	🟢	🟠
Kings Bay	🟢	🟠	🟠	🟠	🟢	🟠	🟠

Station locations in Westmead and Parramatta and connecting with the T1 Western Line

The assessment of the Westmead Station and Parramatta CBD pair identified that this option would:

- Support the vision for a metropolis of three cities (Greater Sydney Commission, 2018a) by reinforcing Parramatta with a multi-nodal transport offering
- Provide relief to the existing Parramatta Station
- Deliver strong place-based outcomes in Parramatta CBD by supporting the delivery of part of the Civic Link between the existing Parramatta Station and the cultural precinct along the Parramatta River
- Substantially relieve the T1 Western Line through the provision of a metro station interchanging with the existing Sydney Trains suburban rail services at Westmead
- Serve the health and education precinct to the north as well as the planned precinct to the south
- Offer a new multimodal transport interchange at Westmead, integrating with Parramatta Light Rail, T-way buses and Sydney Trains suburban rail services.

The assessment of the Westmead North and Parramatta Station pair identified that this option would:

- Result in increased pressure on the existing Parramatta Station and bus layover, requiring significant capacity increase
- Have major constructability challenges due to the presence of sensitive receivers surrounding the hospital precinct at Westmead North and the need for a substantial intervention to the existing Parramatta Station
- Offer benefits to customers who already experience an existing high level of service in the catchment of Parramatta Station, rather than extending the mass transit catchment to the north of the Parramatta CBD
- Potentially pose limitations on construction of future mass transit corridors in Parramatta indicated in the Future Transport Strategy 2056 (Parramatta to Epping, Parramatta to Kogarah).

Subsequently, Westmead Station and Parramatta CBD was identified as the preferred option to connect to the T1 Western Line and serve Greater Parramatta.

T9 Northern Line connection

The assessment identified that a metro station at North Strathfield would support and facilitate urban renewal within the Parramatta Road Corridor Urban Transformation Strategy Homebush Precinct and enable an efficient tunnel alignment into Sydney Olympic Park metro station.

Relative to the North Strathfield option, a metro station at Concord West would provide less support for growth in homes and jobs within a walkable catchment of the station. Additionally, a metro station at Concord West would result in a less efficient alignment to Sydney Olympic Park metro station and potentially increase overall travel times between Parramatta and the Sydney CBD.

As a result, North Strathfield was identified as the preferred station to connect to the T9 Northern Line.

Between the T9 Northern Line and The Bays

The assessment identified that:

- A metro station at Burwood North would create a multi-nodal, integrated transport offering along Burwood Road with two mass transit nodes supporting the Burwood strategic centre to the south and the Parramatta Road Corridor Urban Transformation Strategy area to the north. The station would offer customers significant travel time savings as well as improved connections with key bus corridors coming from the local peninsulas of Concord and Abbotsford as well as Burwood Road
- A metro station at Five Dock would open a new rail catchment and deliver significant travel time savings of more than 30 minutes for customers travelling to the Sydney CBD and about 30 minutes for customers travelling to the Parramatta CBD. Five Dock could provide an efficient bus to metro interchange and help relieve the bus network along Parramatta Road, Victoria Road, the Drummoyne peninsula and parts of the Inner West entering the Sydney CBD
- The Burwood North and Five Dock station location options present an opportunity to function as a pair of stations. The delivery of both stations would service a greater catchment over this length of the corridor
- Relative to the Burwood North and Five Dock options Kings Bay would support a smaller station catchment (as its catchment is limited by Canada Bay and surrounding green space), deliver a smaller increase in productivity and have less opportunity for integration with the wider transport network
- Kings Bay would not support additional intermediate locations, as its catchment would overlap significantly with both the Burwood North and Five Dock options, limiting the opportunity to service a larger catchment. The majority of the catchment serviced by a Kings Bay station would be able to be serviced with a combination of Burwood North and Five Dock metro stations.

Burwood North and Five Dock were identified as preferred the options for the area between the T9 Northern Line connection and The Bays.

Outcome of shortlisted station locations assessment

The assessment of shortlisted metro station locations identified the following preferred station options:

- Westmead Station and Parramatta CBD for the Greater Parramatta area and to connect to the T1 Western Line
- North Strathfield as the T9 Northern Line connection
- Burwood North and Five Dock for the area between the T9 Northern Line and The Bays.

Design refinement for preferred station locations

The preferred metro station locations are further described in Chapter 6 (Concept description). During the development of preferred station designs a range of factors would be considered, including:

- Orientation of station buildings and associated infrastructure to provide effective and efficient access for customers and integration with surrounding land uses
- Constructability
- Potential opportunities for future integrated station and precinct development above or adjacent to the station and how this is considered in design.

Refinements to the Stage 1 station configurations and construction footprints are detailed in Section 3.7.1, and further described in detail in Chapter 6 (Concept description).

3.6.4 Strategic station options

An additional phase is ongoing to determine optional station locations to be included as part of Sydney Metro West.

The strategic station options phase includes further evaluation of potential station locations between Parramatta and Sydney Olympic Park and at Pyrmont. Further investigation and analysis is required to determine the inclusion of additional station options as part of the Concept. This would include analysis of community and stakeholder feedback (refer to Appendix C (Stakeholder and community feedback) for a summary of feedback received), additional land use and transport modelling, technical considerations, and consideration of strategic planning at precincts under investigation.

Between Parramatta and Sydney Olympic Park

As identified during the preliminary station location assessment, further assessment of a potential station between Parramatta and Sydney Olympic Park was required.

This assessment involved collaboration with the Department of Planning, Industry and Environment to investigate the long term land use outcomes between Parramatta and Sydney Olympic Park, and considered feedback received during the community consultation period in April 2018.

A summary of the station locations options assessment for the area between Parramatta and Sydney Olympic Park is provided in Table 3-8.

Table 3-8: Performance of station options between Parramatta and Sydney Olympic Park against the network objectives

Station location option	Evaluation criteria						
	Customer benefits	Strategic land use and transport alignment	Productivity & jobs	Housing supply	Urban renewal & placemaking	Transport integration	Deliverability & value for money
Rydalmere	🟢	🟢	🟢	🟢	🟢	🟡	🟡
Camelia	🟢	🟡	🟡	🟡	🟡	🟡	🔴
Rosehill	🟢	🟡	🟡	🟢	🟡	🟡	🔴
Silverwater East	🟡	🟡	🟢	🔴	🔴	🟡	🟡
Silverwater West	🟡	🟡	🟢	🟡	🟡	🟡	🟡

The assessment shows that the preferred option for a station between Parramatta and Sydney Olympic Park is at Rydalmere. A station at Rydalmere would support the growth and development of a diverse and connected Parramatta CBD, and would provide significant opportunity for urban renewal, housing and employment growth while maintaining the existing essential urban services land use in the broader area.

While a Rydalmere station option would provide the benefits described, it would also result in a longer alignment, an associated greater cost and increased travel times for some metro customers. The feasibility and affordability of this option is currently being investigated as a strategic station option and does not form part of the Concept at this stage.

Pyrmont

Pyrmont had been identified as a strategic station option which has potential to strategically enhance Sydney Metro West.

A station at Pyrmont would serve the commercial, residential and entertainment precinct in the locality. It also has the potential to serve some of the catchment area for the existing Town Hall Station. A station at Pyrmont would also provide an opportunity to improve accessibility to existing employment and various attractions.

The station location and configuration of Pyrmont Station would seek to:

- Provide customers with access to the commercial and entertainment precinct, with key destinations including the International Convention Centre and Sydney Fish Markets, as well as a pedestrian connection along Pyrmont Bridge to the western side of the Sydney CBD
- Enable connections between the Sydney CBD, Pyrmont and The Bays to support the creation of an expanded and connected Sydney CBD
- Deliver a direct rail service to a catchment not currently serviced by mass transit, and an opportunity to create an interchange with Inner West Light Rail and bus services.

A metro station at Pyrmont would present some constraints and challenges in relation to:

- Barriers to pedestrian movement which may constrain the catchment of a metro station – including steep topography throughout the peninsula and around the waterfront; retaining walls and cuttings around the L1 Dulwich Hill light rail; major at-grade intersections at Fig Street and Bank Street entrances to the Western Distributor
- Minimising or avoiding impacts on heritage items in the area, including the Union Square conservation area, as well as relocation of major utilities
- Alignment diversion and speed restrictions between The Bays Station and Sydney CBD Station locations may impact travel times.

The feasibility and affordability of the Pyrmont Station option is currently being investigated as a strategic station option and does not form part of the Concept at this stage.

3.7 Technical design and construction alternatives

3.7.1 Stage 1 station construction sites

As part of the development of Stage 1, station locations and construction footprints have been subject to further refinement taking into account expected future operational requirements for the stations, as well as considering the key construction requirements for the tunnel and stations. The key factors that have influenced the construction footprint for each Stage 1 station are summarised in Table 3-9 and each construction footprint is described in detail in Chapter 9 (Stage 1 description). In all cases the station construction footprints have been reduced as much as practicable to minimise the need for land acquisition, minimise disruption to local communities and to minimise environmental impacts.

Table 3-9: Stage 1 station and construction footprint optimisation analysis

Stage 1 Station	Factors influencing station and construction footprint
Westmead	• Cut-and-cover type station construction • Minimisation of disruption to services on the T1 Western Line during construction • Construction site required to accommodate tunnel boring machine dive site and major spoil extraction and management activities • Minimisation of impacts to sensitive medical receivers to the north of the existing Westmead Station.
Parramatta	• Cut-and-cover type station construction • Construction arrangements to retain access for surrounding businesses • Minimisation of construction and operational impacts on nearby heritage items.
Olympic Park	• Cut-and-cover type station construction • Coordinated station orientation and operational access arrangements with Sydney Olympic Park Master Plan • Provision of connections with the planned Parramatta Light Rail Stage 2 • Minimisation of construction and operational impacts on nearby heritage items • Construction site required to accommodate tunnel boring machine extraction.
North Strathfield	• Cut-and-cover type station construction • Minimisation of disruption to the T9 Northern Line during construction • Coordinated access to the T9 Northern Line • Minimisation of land acquisition of established residential and commercial properties.
Burwood North	• Cut-and-cover type station construction • Minimisation of land acquisition of established residential properties • Minimisation of construction impacts on surrounding road network including Parramatta Road, Burwood Road and Loftus Street • Enabling of future operational access to the station from both sides of Parramatta Road.
Five Dock	• Binocular cavern type station construction • Minimisation of land acquisition of established residential properties.
The Bays	• Cut-and-cover type station construction • Construction site required to accommodate tunnel boring machine dive site and major spoil extraction and management activities • Coordination of construction works with other infrastructure projects – including WestConnex and Western Harbour Tunnel, especially in relation to construction site area, construction access traffic management • Minimisation of construction impacts on surrounding port users and the heritage listed White Bay Power Station.

3.7.2 Tunnel configuration alternatives

Sydney Metro West would provide a new metro rail line comprising two underground rail tracks to be operated in both directions. The rail line could either be housed within a twin or single tunnel configuration. A twin tunnel configuration involves housing each rail track in a separate tunnel, whereas a single tunnel configuration would accommodate both rail tracks within a larger, single bored tunnel.

The majority of the tunnel alignment of Sydney Metro West would be underground and would be constructed using tunnel boring machines which excavate a circular tunnel profile. There are three main options for tunnel configuration which have been assessed concentrating on circular tunnel profiles. These are shown on Figure 3-5 and are:

- Twin-tube (two, single-track tunnels)
- Single-tube side-by-side (single, side-by-side, twin-track tunnel)
- Single-tube vertically stacked (single, vertically-stacked, twin-track tunnel).

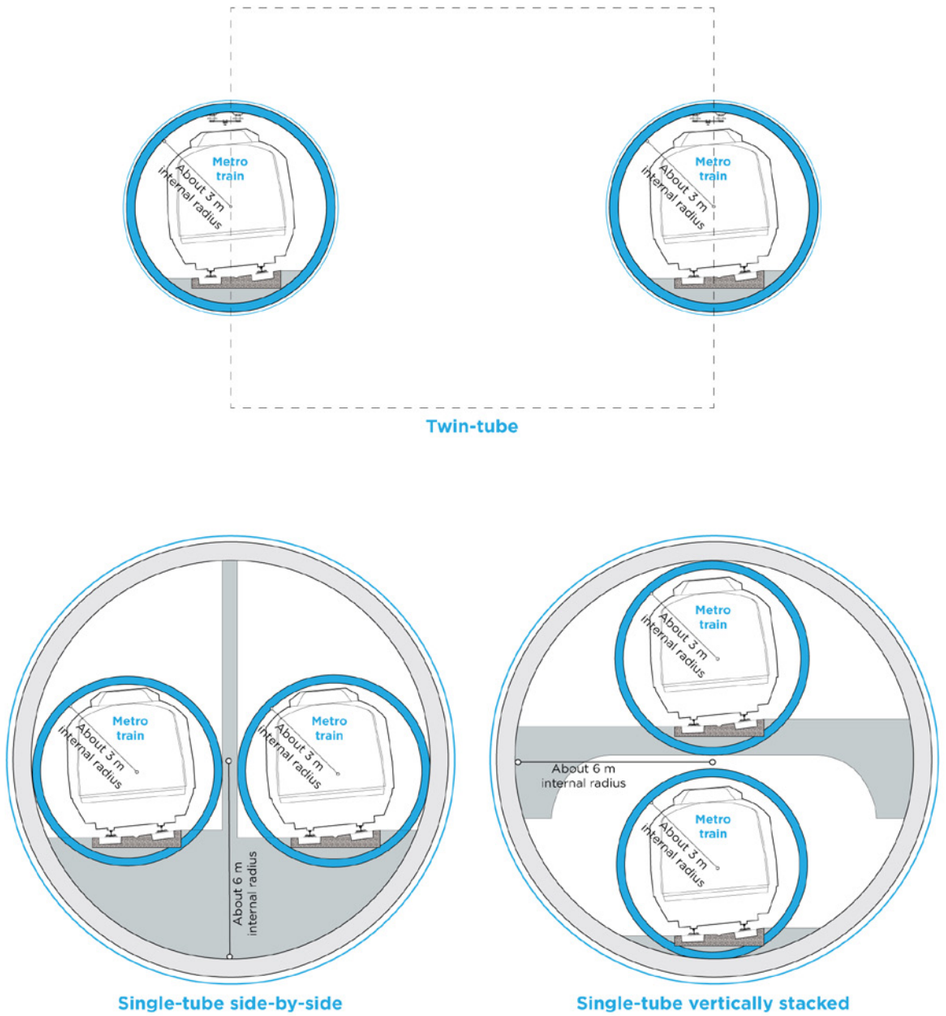

Figure 3-5: Tunnel configuration options

A qualitative assessment was undertaken for these options focussing on the following engineering requirements:

- Geotechnical risk and challenge, for example size and volume of tunnel excavation, and tunnel alignment profile and diameter
- Impact to the surrounding built environment and properties
- Availability of suitable size tunnel boring machines in the market
- Maintenance and operational considerations such as emergency and operation access within and between running tunnels
- Size of tunnel internal space provided for rolling stock, tunnel services, overhead electrification, and structural gauge requirement, in particular for necessary height provided from the tunnel invert to mean rail level
- Tunnel ventilation accommodation and implications
- Connecting the tunnels to the station excavations.

From the assessment, the twin-tube tunnel configuration is the preferred option due to the following benefits:

- More efficiently facilitates a full range of station typologies (binocular, island platform cavern and stacked platform cavern)
- Provides an effective fire and life safety strategy
- Minimises geotechnical and construction program risks
- Allows safer and easier access to undertake maintenance
- Generates less tunnel spoil and less impact to the surrounding built environment such as from construction vibration
- Allows greater alignment flexibility in heavily constrained underground environments.

3.7.3 Stabling and maintenance facility alternatives

A stabling and maintenance facility to support an efficient, safe and reliable metro network would be required for Sydney Metro West.

Initial assessment included consideration of a long list of location options for a stabling and maintenance facility. These included:

- Camellia/Rosehill
- Northmead
- Silverwater
- Rydalmere
- Clyde
- Options further west, including Girraween and Greystanes.

Following initial assessment, Northmead, Silverwater and Rydalmere were not taken forward for further investigation. These options would impact on the viability of the remaining land use and businesses in the localities. Additionally, sites in Northmead and Rydalmere have been identified for future development, which a stabling and maintenance facility may not support.

Options further west, including Girraween and Greystanes, were also not taken forward for further assessment. These sites would be located about five kilometres west of the terminus station at Westmead. This would result in inefficient operations and 'dead running' of rolling stock (where trains operate without carrying passengers, generally to and from a stabling facility).

Following initial assessment, the former Shell refinery site (now the Viva Energy property) in the Camellia/Rosehill area and Clyde were shortlisted as the potential locations for the stabling and maintenance facility. The Camellia/Rosehill location would have a relatively low impact on existing properties and land uses, however it would present challenges in relation to flooding and previous substantial contamination, which may pose constraints to construction methodology, program, cost, and worker health and safety.

The Clyde site would also require management of flooding and existing contamination, however these issues can be more easily managed when compared to the Camellia/Rosehill location. However, this location would potentially affect a larger number of existing properties and land uses, when compared to the Camellia/Rosehill location (consideration and assessment of the potential impacts to existing properties and land uses is provided in Chapter 14 (Property and land use – Stage 1), Chapter 16 (Business impacts – Stage 1) and Chapter 17 (Social impacts – Stage 1)). On balance, the Clyde site was found to be the least constrained of all options assessed (when considering construction, program, cost and worker health and safety) and would provide for the efficient operation of the line. Therefore, Clyde was identified as the preferred locality for the stabling and maintenance facility.

3.7.4 Tunnel construction alternatives

Principles influencing the selection of tunnel boring machine launch and retrieval sites include:

- Availability of land to support tunnel boring machine launch activities, with a preference for government-owned and underutilised land, in order to minimise the need for property acquisition
- Ability to optimise tunnelling distances and the number of tunnel boring machines required. Distances around 10 kilometres or less are generally more manageable, reduce the need for tunnel boring machine repairs and maintenance, and can provide a short transportation distance for segments, materials and workers from the support site to the tunnelling face
- Access to arterial roads from the site to enable efficient transportation of tunnel boring machines, segments, spoil and other materials, and minimise impact to local streets
- Ability to minimise impacts to sensitive receivers, the road network and residential areas
- Topography, proximity of adjacent infrastructure, and engineering requirements
- Co-location with future operational infrastructure to limit property acquisition requirements.

Taking into account these principles, preferred options were selected for tunnel boring machine launch and retrieval sites. Key options also considered how to optimise the tunnelling strategy, by focussing on locations at either end of the tunnels and locations around the middle of the tunnel alignment.

Tunnel boring machine launch and retrieval sites

The following were identified as either launch or retrieval sites:

- Westmead metro station construction site as it would be at the western end of Stage 1
- The Bays Station construction site as it would be at the eastern end of Stage 1
- Sydney Olympic Park metro station construction site as it would provide an optimised tunnelling strategy by providing a relatively even distance for tunnel boring machine drives to the east and west.

Analysis identified the following as the preferred tunnel boring machine launch and retrieval sites:

- The Bays Station construction site was identified as a preferred launch site, as it would provide sufficient land to support tunnel boring machine launch activities and would minimise impacts on sensitive receivers (there are no residential properties within the immediate vicinity). Road network impacts could also be minimised, with the opportunity for deliveries and spoil removal by barge
- The Sydney Olympic Park metro station construction site was identified as a preferred retrieval site, as it would provide sufficient land to support tunnel boring machine retrieval activities due to its open cut-and cover construction method and surrounding wide modern streets. The site would minimise impacts on residential properties relative to other nearby site options and would have direct access to the arterial road network and the M4 Motorway
- Westmead metro station construction site would be the other preferred launch site, providing sufficient land to support tunnel boring machine launch activities and convenient access to the arterial road network and the M4 Motorway.

Sydney Metro would investigate options for managing the tunnel boring machines at the end of the line in the Sydney CBD once the location of the Sydney CBD Station is determined.

Concrete segment facility

A concrete segment facility would be required to support the tunnel construction works.

The Clyde stabling and maintenance facility was selected as the preferred location for the concrete segment facility as it provides sufficient land, is located in an existing industrial zone and has significant distances to sensitive residential receivers, thereby minimising environmental amenity impacts associated with the facility.

3.7.5 Services facilities

Fresh air tunnel ventilation for Sydney Metro West would generally be provided at the proposed stations. However, additional facilities would be required where there are longer distances between stations. Based on the current design two services facilities are required between Parramatta and Sydney Olympic Park and one between Five Dock and The Bays.

The process for selecting potential sites for services facilities involved considering the suitability of the Sydney Metro West construction sites located directly above the tunnels. Constructing the services facilities within the existing construction sites would eliminate the need to acquire additional land. Where existing construction sites were not deemed suitable, existing public land or vacant land was identified as preferable for the services facility.

Between Parramatta and Sydney Olympic Park

Two services facilities are required between Parramatta and Sydney Olympic Park. Analysis identified that:

- The Clyde stabling and maintenance facility construction site provides an opportunity for a services facility located within an industrial area and adjacent to other operational infrastructure
- An additional site directly above the tunnel alignment was identified in Silverwater. This site is currently vacant land and is within an industrial area.

Between Five Dock and The Bays

The location of the services facility is currently being investigated. The following locational and design criteria would be used as part of determining the preferred location as described in Chapter 9 (Stage 1 description):

- The site would not be located on existing residential land
- There would be no removal of vegetation that constitutes a locally occurring Plant Community Type
- There would be no direct impacts on items listed on the State Heritage Register
- There would be no direct impacts to significant elements of any locally listed heritage items
- The construction of the facility would not result in any negative impacts to groundwater users, groundwater dependent surface flows or groundwater dependent ecosystems.

In addition to the above, the facility would need to achieve the performance outcomes set for the Concept – refer to Chapter 8 (Concept environmental assessment).

3.8 Barge or ship transport

Three options have been evaluated by Sydney Metro for the transport of spoil from Stage 1 construction sites.

Options investigated were:

- Road transport
- Rail transport
- Barging and shipping transport.

An assessment of each option is provided below.

The transport and management of spoil is discussed further in Chapter 10 (Transport and traffic – Stage 1) and Chapter 24 (Spoil, waste management and resource use – Stage 1).

3.8.1 Road transport

Road transport would be the primary transport method from most construction sites. Road transport was considered feasible for all construction sites due to their location directly adjacent to the existing road network, in particular the proximity to the motorway and arterial road network.

Haulage routes have been developed in consultation with relevant sections of Transport for NSW and Sydney Coordination Office and have aimed to minimise the use of local roads and use the most efficient route to the arterial road network. Further information regarding the haul routes to and from each site are provided in Chapter 10 (Transport and traffic – Stage 1).

3.8.2 Rail transport

Rail transport options were investigated for the Westmead metro station, Clyde stabling and maintenance facility, North Strathfield metro station and The Bays Station construction sites due to their proximity to the rail network.

Rail transportation of spoil from the Stage 1 construction sites would require the following elements:

- Access to the Metropolitan Freight Network, the Southern Sydney Freight Line and/or the Northern Sydney Freight Corridor
- Adequate train storage at (or very close to) the construction site, including a siding to store at least one train
- Train loading facilities and/or stockpiling space.

Access to the freight network from these locations would require substantial track works and signalling upgrades, road transport from the spoil generation site to train loading facilities, and/or shared use of the suburban and/or light rail networks. At some locations, spoil would need to be triple handled (at the generation site, at the loading site and at the unloading site). At both Westmead metro station and North Strathfield metro station construction sites, substantial property acquisition and/or road closures would be required to secure space for train storage, loading and stockpiling.

Based on the above constraints, rail transport was not considered a viable option for Stage 1.

3.8.3 Barge or and ship transport

Barge transport options were investigated for the Clyde stabling and maintenance facility and The Bays Station construction sites due to their respective proximity to Parramatta River and Sydney Harbour.

Barging of spoil from The Bays Station construction site could be achieved by using the existing port areas at White Bay. Spoil could be barged from this construction site to Camellia for re-use opportunities at the Clyde stabling and maintenance facility construction site or for other local re-use opportunities. Spoil could be unloaded from barges at Camellia using barging infrastructure developed for Sydney Metro City & Southwest.

Spoil could also be barged and/or shipped from the Clyde stabling and maintenance facility and The Bays Station construction sites outside of Sydney Harbour to locations such as Port Kembla or Port Newcastle for regional re-use opportunities.

Barge transport of spoil to and from these construction sites may be feasible at this site subject to further investigations and/or approvals and the agreement of NSW Ports and/or Port of Newcastle. Further investigations would consider the following elements:

- Restrictions on barge or ship transport due to factors such as low tides within Parramatta River, or adverse weather conditions outside of Sydney Harbour
- Timing of fill requirements for re-use opportunities
- Suitability of spoil generated for re-use opportunities
- Construction traffic impacts of any road or rail transport required to deliver spoil from the barging sites to the final destinations.

Barged spoil could also be disposed of at sea (offshore). Licenced disposal grounds are in operation off Sydney Harbour and Newcastle. Offshore disposal would be conducted outside NSW and is regulated under the *Environment Protection (Sea Dumping) Act 1981*. Material would be required to satisfy the requirements of the National Assessment Guidelines for Dredging (Department of Environment, Water, Heritage and the Arts, 2009) before being considered suitable for disposal at the designated offshore disposal site.

Further consideration of barge options would be carried out during further construction planning for Stage 1 and in future stages of Sydney Metro West.

4 Planning and assessment process

4 Planning and assessment process

This chapter describes the statutory planning process for Sydney Metro West, and identifies other NSW and Commonwealth legislation and approvals which may apply.

4.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to the planning and assessment process, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 4-1.

Table 4-1: Secretary's Environmental Assessment Requirements – Planning and assessment process

Reference	Secretary's Environmental Assessment Requirements	Where addressed
1. Environmental Impact Assessment Process		
1.1	The Environmental Impact Statement (EIS) must be prepared in accordance with Part 3 of Schedule 2 of the Environmental Planning and Assessment Regulation 2000 (the EP&A Regulation).	Appendix B
1.2	It is the Proponent's responsibility to determine whether the Proposal needs to be referred to the Commonwealth Department of the Environment and Energy (DoEE) for an approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). If DoEE has determined that an approval is required under the EPBC Act, supplementary environmental assessment requirements may need to be issued to ensure a streamlined assessment under an Accredited Assessment can be achieved.	Section 4.5
2. Environmental Impact Statement		
2.1	The EIS must include, but not necessarily be limited to, the following: h. statutory context of the proposal (as a whole) including: • how it meets the provisions of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the EP&A Regulation; • a list of any approvals that must be obtained under any other Act or law before the Proposal may lawfully be carried out; • identification of the existing environmental planning instruments and other current government strategic plans and policies relevant to the land subject to the Proposal (including State environmental planning policies, land use and infrastructure strategies and local strategic planning statements).	Sections 4.2, 4.3, 4.4 and 4.5

4.2 NSW environmental planning approvals

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

Clause 79 of the State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP) provides that development for the purpose of a railway and rail infrastructure facilities may be carried out by or on behalf of a public authority without development consent on any land. Sydney Metro West is characterised as being for the purpose of a railway and rail infrastructure facilities for the purposes of the Infrastructure SEPP, and is to be carried out by Sydney Metro, being a public authority. Accordingly, Sydney Metro West is permissible without obtaining development consent under Part 4 of the EP&A Act.

4.2.1 State significant and critical State significant infrastructure

Sections 5.12 and 5.13 of the EP&A Act provide for the declaration of State significant infrastructure and critical State significant infrastructure. Sydney Metro is seeking a specific declaration for Sydney Metro West as State significant infrastructure and critical State significant infrastructure under sections 5.12(4) and 5.13 of the EP&A Act respectively. Schedule 5 of State Environmental Planning Policy (State and Regional Development) 2011 would also be amended to include Sydney Metro West as critical State significant infrastructure.

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

4.2.2 Planning approval process under Part 5, Division 5.2 of the EP&A Act

The assessment and approval process for a State significant infrastructure project is established under Part 5, Division 5.2 of the EP&A Act. Staged infrastructure applications can be made under section 5.20 of the EP&A Act. A staged infrastructure application sets out the concept for the proposed infrastructure and can also set out details of Stage 1. The assessment and approval process for staged State significant infrastructure is shown in Figure 4-1.

Sydney Metro submitted a State significant infrastructure application and supporting document to the Secretary of the Department of Planning, Industry and Environment 21 October 2019 (as required by section 5.15 of the EP&A Act). The Secretary's Environmental Assessment Requirements for the Concept and Stage 1 were issued on 11 December 2019 (as per section 5.16 of the EP&A Act). The Secretary's Environmental Assessment Requirements are provided in Appendix A.

This Environmental Impact Statement has been prepared in accordance with the Secretary's Environmental Assessment Requirements and the requirements of Schedule 2, Part 3 of the EP&A Regulation (as per section 2.16(2) of the EP&A Act).

The Department of Planning, Industry and Environment will place the Environmental Impact Statement on public exhibition for a minimum of 28 days (as per Schedule 1, Division 2, clause 12 of the EP&A Act). During the exhibition period, the community, stakeholders and government agencies will be able to review the Environmental Impact Statement and provide a written submission to the Department of Planning, Industry and Environment for consideration in its assessment of the Concept and Stage 1.

At the completion of the public exhibition period, the Department of Planning, Industry and Environment will collate and provide Sydney Metro with a copy of all submissions received during the exhibition period. After reviewing the submissions, Sydney Metro will prepare a submissions report that responds to the relevant issues raised. If changes are required to the Concept or Stage 1 as a result of the issues raised or to minimise environmental impacts, a Preferred Infrastructure Report/Amendment Report may also be required. If this is required, Sydney Metro would prepare the report to address the changes to the design to minimise impacts and submit this for review to the Department of Planning, Industry and Environment. This report would be made available to the public.

Approval from the Minister for Planning and Public Spaces is required before Sydney Metro can proceed with the Stage 1 (as per section 5.14 of the EP&A Act). Further Environmental Impact Statement(s) will be required for subsequent stages of the Concept.

Figure 4-1: The assessment and approval process for State significant infrastructure

4.3 NSW environmental planning instruments

The declaration of the Sydney Metro West as critical State significant infrastructure would be made through the provisions of the State Environmental Planning Policy (State and Regional Development) 2011. As discussed in Section 4.2.1 State significant and critical State significant infrastructure of this chapter, Section 5.22 of the EP&A Act provides that environmental planning instruments (such as local environmental plans and SEPPs) do not, with some exceptions, apply to State significant infrastructure projects. Notwithstanding this, the environmental planning instruments that have been considered for consistency, are detailed below.

4.3.1 State Environmental Planning Policies

State Environmental Planning Policy (State and Regional Development) 2011

State Environmental Planning Policy (State and Regional Development) 2011 identifies development that is State significant development, State significant infrastructure and critical State significant infrastructure. Schedule 5 of this SEPP would be amended to include Sydney Metro West as critical State significant infrastructure and State significant infrastructure.

The approvals process for future integrated station and precinct development is separately discussed in Section 4.6 of this Environmental Impact Statement.

State Environmental Planning Policy (State Significant Precincts) 2005

The State Environmental Planning Policy (State Significant Precincts) 2005 identifies precincts which are of State importance. This policy aims to (among other things) facilitate the orderly use, development or conversation of State significant precincts for the benefit of the State.

Sydney Olympic Park is identified in the State Environmental Planning Policy (State Significant Precincts) 2005 as one such site. This policy takes precedence over the local environmental plan for this area (i.e. Auburn Local Environmental Plan 2010).

The State Environmental Planning Policy (State Significant Precincts) 2005 therefore provides for master planning, zoning, zone objectives, height and floor space controls, and heritage conservation development standards, amongst others for land within this precinct.

Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005

Some elements of the Concept and Stage 1 are within the defined boundary of the Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005. This plan aims to protect, enhance and maintain the catchment, foreshores, waterways and islands of Sydney Harbour for existing and future generations.

Clause 20 of Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 requires public authorities and others to consider the matters listed in Clauses 21 to 27 of the SEPP before they carry out activities to which Part 5 of the EP&A Act applies. Those matters relevant to the Concept and Stage 1 are listed in Table 4-2, along with the sections of the Environmental Impact Statement where the matters have been addressed. Clause 21 to 27 matters not relevant to Sydney Metro West have not been included.

Table 4-2: Summary of relevant considerations in the Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005

Summary of relevant considerations	Where addressed
Clause 21: Biodiversity, ecology and environmental protection	
Development should have a neutral or beneficial effect on the quality of water entering the waterways (Clause 21(a))	Section 8.13 (Soils and surface water quality – Concept) and Chapter 19 (Soils and surface water quality – Stage 1).
Development should protect and enhance terrestrial and aquatic species, populations and ecological communities and, in particular, should avoid physical damage and shading of aquatic vegetation (such as seagrass, saltmarsh and algal and mangrove communities) (Clause 21(b))	Section 8.16 (Biodiversity –Concept) and Chapter 22 (Biodiversity – Stage 1).
Development should avoid indirect impacts on aquatic vegetation (such as changes to flow, current and wave action and changes to water quality) as a result of increased access (Clause 21(d))	Section 8.16 (Biodiversity – Concept) and Chapter 22 (Biodiversity – Stage 1).
Development should retain, rehabilitate and restore riparian land (Clause 21(f))	Section 8.16 (Biodiversity – Concept) and Chapter 22 (Biodiversity – Stage 1).
Development on land adjoining wetlands should maintain and enhance the ecological integrity of the wetlands and, where possible, should provide a vegetative buffer to protect the wetlands (Clause 21(g))	Section 8.16 (Biodiversity – Concept) and Chapter 22 (Biodiversity – Stage 1).
Consideration of the cumulative environmental impact of development, in relation to biodiversity, ecology and environment protection (Clause 21(h))	Section 8.21 (Cumulative – Concept).
Consideration of whether sediments in the waterway adjacent to the development are contaminated, and what means will minimise their disturbance (Clause 21(i))	Section 8.14 (Contamination – Concept) and Chapter 20 (Contamination – Stage 1).
Clause 22: Public access to, and use of, foreshores and waterways	
Development should maintain and improve public access to and along the foreshore, without adversely impacting on watercourses, wetlands, riparian lands or remnant vegetation (Clause 22(a))	The Concept would not affect public access to the foreshore.
Development should maintain and improve public access to and from the waterways for recreational purposes (such as swimming, fishing and boarding) without adversely impacting on watercourses, wetlands, riparian lands or remnant vegetation (Clause 22(b))	The Concept would not affect public access to waterways.
If foreshore land made available for public access is not in public ownership, development should provide appropriate tenure and management mechanisms to safeguard public access to, and public use of, that land (Clause 22(c))	Not relevant to the Concept.
The need to minimise disturbance of contaminated sediments (Clause 22(e))	Section 8.14 (Contamination – Concept) and Chapter 20 (Contamination – Stage 1).
Clause 23: Maintenance of a working harbour	
In the case of development on land that adjoins land used for industrial and commercial maritime purposes, development should be compatible with the use of the adjoining land for those purposes (Clause 23(c))	Section 8.8 (Property and land use – Concept) and Chapter 14 (Property and land use – Stage 1). Section 8.19 (Hazards – Concept) and Chapter 25 (Hazards – Stage 1).
Clause 24: Interrelationship of waterway and foreshore uses	
Development on foreshore land should minimise any adverse impact on the use of the waterway, including the use of the waterway for commercial and recreational uses (Clause 24(b))	The Concept would not affect the use of waterways for commercial and recreational uses.
Development on foreshore land should minimise excessive congestion of traffic in the waterways or along the foreshore (Clause 24(c))	Section 8.4 (Transport and traffic – Concept) and Chapter 10 (Transport and traffic – Stage 1).
Development should avoid conflict between the various uses in the waterways and along the foreshores (Clause 24(e))	The Concept would not result in conflicts between uses in waterways or along foreshores (such as at The Bays).
Clause 25: Foreshore and waterways scenic quality	
The scale, form, design and siting of any building should be based on an analysis of: the land on which it is to be erected; the adjoining land; and the likely future character of the locality (Clause 25(a))	Section 8.9 (Landscape and visual – Concept) and Chapter 15 (Landscape character and visual amenity – Stage 1).
The development should maintain, protect and enhance the unique visual qualities of Sydney Harbour and its islands, foreshores and tributaries (Clause 25(b))	Section 8.9 (Landscape and visual – Concept) and Chapter 15 (Landscape character and visual amenity – Stage 1).
The cumulative impact of water-based development should not detract from the character of the waterways and adjoining foreshores (Clause 25(c))	The Concept does not include water-based development.
Clause 26: Maintenance, protection and enhancements of views	
Development should maintain, protect and enhance views (including night views) to and from Sydney Harbour (Clause 26(a))	Section 8.9 (Landscape and visual – Concept) and Chapter 15 (Landscape character and visual amenity – Stage 1).
Development should minimise any adverse impacts on views and vistas to and from public places, landmarks and heritage items (Clause 26(b))	Section 8.9 (Landscape and visual – Concept) and Chapter 15 (Landscape character and visual amenity – Stage 1).
The cumulative impact of development on views should be minimised (Clause 25(c))	Section 8.21 (Cumulative – Concept).

Referral of development proposals not requiring development consent

Clause 31 of Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 requires a public authority to notify the Foreshores and Waterways Planning and Development Advisory Committee, or in certain instances other public authority(s) responsible for the provision of services (including water, sewerage or stormwater systems), prior to carrying out certain development.

While the provisions of Clause 31 of the SEPP do not apply to State significant infrastructure, Sydney Metro would comply with the intent of the policy and would consult with the Foreshores and Waterways Planning and Development Advisory Committee during the development of Sydney Metro West.

Development on land comprising acid sulfate soils

Clause 36 of Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 relates to approval for works that involve the excavation, dredging, filing or contouring of, or the extraction of soil or other extractive material that has the potential to impact on acid sulfate soils.

While these provisions do not apply to State significant infrastructure, appropriate management of acid sulfate soils would be undertaken for any excavation works proposed to be carried out in those areas with a high probability of encountering acid sulfate soils. Management measures would be consistent with the principles and practices outlined in the Acid Sulfate Soils Assessment Guidelines (NSW Acid Sulfate Soil Management Advisory Committee, 1998).

Sydney Harbour Foreshores Area Development Control Plan

The Sydney Harbour Foreshores and Waterways Area Development Control Plan 2005 (Sydney Harbour Foreshores and Waterways Area DCP) supports the Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 by specifying detailed design guidelines for water-based and land-based developments, as well as developments located at the land/water interface.

Part 5 of the Sydney Harbour Foreshores and Waterways Area DCP specifies design guidelines for land-based developments. While the development control plan does not apply to State significant infrastructure, as the development control plan is part of a deemed State environmental planning policy, the relevant design guidelines would be considered for applicable aboveground elements of the Concept.

State Environmental Planning Policy No. 55 – Remediation of Land

The State Environmental Planning Policy No. 55 provides a state-wide approach to the remediation of contaminated land for the purpose of minimising the risk of harm to the health of humans and the environment. In accordance with Clause 7(1), a consent authority must not consent to the carrying out of development on any land unless:

- It has considered whether the land is contaminated
- If the land is contaminated, it is satisfied that the land is suitable in its contaminated state (or would be suitable, after remediation) for the purpose for which the development is proposed to be carried out
- If the land requires remediation to be made suitable for the purpose for which the development is proposed to be carried out, it is satisfied that the land would be remediated before the land is used for that purpose.

A contamination assessment has been carried out as part of this Environmental Impact Statement (Section 8.14 (Contamination – Concept), Chapter 20 (Contamination – Stage 1) and Technical Paper 8 – Contamination).

Sydney Regional Environmental Plan No. 26 – City West

Sydney Regional Environmental Plan No.26 – City West is relevant to The Bays. The Plan repeals local environmental plans and other planning instruments that would otherwise apply to this land.

The Plan sets land use, urban design and public domain principles. Consistency with these principles would be considered during the future environmental impact assessment(s) for subsequent stages of Sydney Metro West.

State Environmental Planning Policy (Coastal Management) 2018

The State Environmental Planning Policy (Coastal Management) 2018 gives effect to the objectives of the *Coastal Management Act 2016* from a land use planning perspective, by specifying how development proposals are to be assessed if they fall within the coastal zone. Some elements of the Concept are within the defined boundary of the policy (within land defined as Coastal Environment Area). An assessment of the Concept against the management objectives, as specified in the *Coastal Management Act 2016*, for land defined as Coastal Environment Area is provided in Table 4-3.

Table 4-3: Consistency with management objectives (as specified in the *Coastal Management Act 2016*) of land identified as a Coastal Environment Area

Objective	Consistency
To protect and enhance the coastal environmental values and natural processes of coastal waters, estuaries, coastal lakes and coastal lagoons, and enhance natural character, scenic value, biological diversity and ecosystem integrity	Mapped areas of wetland listed under State Environmental Planning Policy (Coastal Management) 2018 are present within 200 metres of the Concept, which includes vegetation along the Parramatta River, Duck River and Mason Park wetlands (refer to Section 22.4.9 (Biodiversity – Stage 1)). Sydney Metro West would require the removal of 0.15 hectares of mangrove habitat, along with new road link crossings of, and realignment of short sections of, A'Becketts Creek and Duck Creek. Any impacts to the coastal environment are expected to be minimal as the aquatic biodiversity of A'Becketts Creek and Duck Creek, and the adjoining Duck River and Parramatta River, are already considerably modified due to habitat degradation. The design of A'Becketts Creek and Duck Creek crossings would provide for fish passage, incorporate suitable scour protection and not worsen existing flow velocities downstream from the crossing locations. Where possible, a vegetated riparian zone would be incorporated within the realigned open channel sections of A'Becketts and Duck Creek.
To reduce threats to and improve the resilience of coastal waters, estuaries, coastal lakes and coastal lagoons, including in response to climate change	Most of the Concept would be underground in tunnels, thereby minimising impacts to the coastal environment. Climate change predictions, such as sea level rise, have been considered in the design and material selection of the Concept. This is discussed further in Section 8.20 (Sustainability and climate change – Concept) of this Environmental Impact Statement.
To maintain and improve water quality and estuary health	The aquatic habitats of A'Becketts Creek and Duck Creek, and downstream, may experience reduced water quality due to increased turbidity, in-stream works and disturbance of potentially contaminated soils during construction. Where possible, measures would be implemented during construction to ensure sufficient flow and fish passage is maintained similar to current conditions to maintain water quality and estuary health.
To support the social and cultural values of coastal waters, estuaries, coastal lakes and coastal lagoons	The Concept supports the social and cultural values by aiming to avoid or minimise impacts on coastal areas. The impacted areas of A'Becketts Creek and Duck Creek are highly modified and located within an existing industrial area. Impacts to coastal wetlands in this area have been minimised where possible.
To maintain the presence of beaches, dunes and the natural features of foreshores, taking into account the beach system operating at the relevant place	The Concept would not impact on beaches, dunes or natural features of foreshores.
To maintain and, where practicable, improve public access, amenity and use of beaches, foreshores, headlands and rock platform	The Concept would maintain current public access to foreshores and other coastal features throughout construction and operation.

Assessment of potential impacts on coastal wetlands mapped by State Environmental Planning Policy (Coastal Management) 2018 near Duck River and Sydney Olympic Park) is provided in Section 8.16 (Biodiversity – Concept) and Chapter 22 (Biodiversity – Stage 1).

Sydney Regional Environmental Plan No. 24 - Homebush Bay Area

Some elements of the Concept and Stage 1, including the Sydney Olympic Park metro station, would be within the defined boundary of the Sydney Regional Environmental Plan No. 24 – Homebush Bay Area. The main aims of this plan are to:

- Define objectives for the Homebush Bay Area which encourage co-ordinated and environmentally sensitive development of the Homebush Bay Area
- Guide and co-ordinate the development of the Homebush Bay Area
- Replace planning instruments previously applying to the Homebush Bay Area with a simplified planning framework
- Provide flexible development controls by allowing a wide mix of uses in the Homebush Bay Area
- Provide for the preparation of detailed planning controls to complement the flexible controls in this plan
- Facilitate the development and management of Sydney Olympic Park by the Department of Planning, Industry and Environment (previously the responsibility of the former Sydney Olympic Park Authority) based on:
  - Master plans (whether adopted by the Minister under this Plan or approved by the Minister under section 18 of the *Sydney Olympic Park Authority Act 2001*)
  - Other guidelines and management strategies adopted by the Department of Planning, Industry and Environment for the management of Sydney Olympic Park
- Provide for public consultation in the planning and development of the Homebush Bay Area.

The development of Sydney Metro West has taken into consideration the masterplan development for the Homebush Bay Area and Sydney Metro has consulted the former Sydney Olympic Park Authority.

State Environmental Planning Policy No. 19 - Bushland in Urban Areas

State Environmental Planning Policy 19 – Bushland in Urban Areas applies to bushland within the urban areas identified in Schedule 1 of the SEPP. Local government areas of relevance to the Concept which the policy applies to include City of Parramatta, Strathfield, City of Canada Bay, Inner West and City of Sydney. The aim of the Policy is to protect and preserve bushland for its natural heritage aesthetic, recreational, educational and scientific resource values.

An assessment of the concept against the aims of the policy has been provided at Table 4-4.

Table 4-4: Aims of State Environmental Planning Policy 19 – Bushland in Urban Areas

Objective	Consistency
To protect and preserve bushland within the urban areas referred to in Schedule 1 because of: **b. its value to the community as part of the natural heritage** **c. its aesthetic value, and** **d. its value as a recreational, educational and scientific resource**	Most of the Concept would be underground or in pre-existing built-up areas. Measures would be implemented to avoid impacts to vegetation outside and adjacent to the Concept corridor. Direct impacts to bushland have been avoided and/or minimised where possible. Where disturbance was not able to be avoided, the vegetation is of poor to moderate quality.
To protect the remnants of plant communities which were once characteristic of land now within an urban area	Two Plant Community Types are present within the Concept corridor; Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 849) and Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion (PCT 920). Measures would be implemented to protect retained vegetation during construction, including all vegetation outside and adjacent to the Concept corridor. Potential impacts to these plant communities have been minimised where possible. Impacts would be limited to 0.03 hectares of Grey Box – Forest Red Gum within the Westmead metro station construction site and 0.15 hectares of Mangrove Forests within the Clyde stabling and maintenance facility construction site.
To retain bushland in parcels of a size and configuration which will enable the existing plant and animal communities to survive in the long term	Due to the urban setting of the Concept, existing bushland parcels are fragmented and highly isolated. Where possible, impacts to native bushland have been avoided in order to retain existing bushland parcels within the Concept corridor.
To protect rare and endangered flora and fauna species	No rare or endangered flora or fauna species have been identified within the Concept corridor.
To protect habitats for native flora and fauna	Habitats within the Concept corridor are highly disturbed. It is unlikely that the Concept would impact on native flora and fauna habitats.
To protect wildlife corridors and vegetation links with other nearby bushland	The Concept is located within a highly disturbed landscape and habitats that do remain are fragmented and highly isolated. It is unlikely that any existing corridors or vegetation links would be affected.
To protect bushland as a natural stabiliser of the soil surface	The Concept is located in a highly disturbed, urbanised environment. Where possible, impacts to existing bushland have been avoided.
To protect bushland for its scenic values, and to retain the unique visual identity of the landscape	The Concept is located in a highly disturbed, urbanised environment. Where possible, bushland would be protected, and existing visual identity retained.
To protect significant geological features	The Concept would not impact any geological features of significance.
To protect existing landforms, such as natural drainage lines, watercourses and foreshores	Most of the Concept would be underground or in pre-existing built-up areas. Direct impacts to existing landforms, such as natural drainage lines, watercourses and foreshores have been avoided and/or minimised where possible. New waterway crossings would be required at A'Becketts Creek and Duck Creek, along with short sections of realignment. Where possible, these would be designed to retain the existing passage of flow.
To protect archaeological relics	Where possible, heritage items and significant archaeology would be avoided. Where impacts cannot be avoided, management measures would be put in place to minimise or offset impacts.
To protect the recreational potential of bushland	The Concept is located in a highly disturbed, urbanised environment. Where possible, the recreational potential of bushland would be protected.
To protect the educational potential of bushland	The Concept is located in a highly disturbed, urbanised environment. Where possible, the educational potential of bushland would be protected.
To maintain bushland in locations which are readily accessible to the community	The Concept is located in a highly disturbed, urbanised environment. Where possible, existing community access to bushland would be maintained.
To promote the management of bushland in a manner which protects and enhances the quality of the bushland and facilitates public enjoyment of the bushland compatible with its conversion	The Concept is located in a highly disturbed, urbanised environment with fragmented and highly isolated bushland parcels. Where possible, impacts to existing bushland have been avoided. Measures would be implemented to protect remaining vegetation outside and adjacent to the Concept corridor.

4.3.2 Local environmental plans

The Concept passes through the local government areas of Cumberland, City of Parramatta, Strathfield, City of Canada Bay, Burwood, Inner West and City of Sydney. Development within these local government areas is regulated by the following local environmental plans:

- Holroyd Local Environmental Plan 2011
- Parramatta Local Environmental Plan 2011
- Auburn Local Environmental Plan 2010
- Strathfield Local Environmental Plan 2012
- Burwood Local Environmental Plan 2012
- Canada Bay Local Environmental Plan 2013
- Leichhardt Local Environmental Plan 2013
- Sydney Local Environmental Plan 2012.

As indicated above at Section 4.2 of this Environmental Impact Statement, the EP&A Act provides that environmental planning instruments (including local environmental plans) do not apply to State significant infrastructure projects. Notwithstanding this, relevant environmental planning instruments have been considered during design development and assessment.

4.4 Other NSW legislation

4.4.1 Approvals that would otherwise apply

In accordance with sections 5.23 and 5.24 of the EP&A Act, some environment and planning legislation does not apply to State significant infrastructure that has been approved or must be applied consistently with an approval for State significant infrastructure.

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

Section 5.23 of the EP&A Act specific approvals that are not required for State significant infrastructure. Those approvals that would otherwise be required for Sydney Metro West should it be declared as State significant infrastructure would be:

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

In addition, Division 8 of Part 6 of the *Heritage Act 1977* does not apply to prevent or interfere with the carrying out of the Stage significant infrastructure.

Similarly, section 5.23 of the EP&A Act specifies directions, orders or notices that cannot be made or given so as to prevent or interfere with the carrying out of approved Critical State significant infrastructure. Those that would otherwise apply if not for Sydney Metro West being State significance infrastructure would be:

- An interim protection order (within the meaning of *National Parks and Wildlife Act 1974*)
- An order under Division 1 (Stop work orders) of Part 6A of the *National Parks and Wildlife Act 1974*, or Division 7 (Stop work orders) of Part 7A of the *Fisheries Management Act 1994*
- A remediation direction under Division 3 (Remediation directions) of Part 6A of the *National Parks and Wildlife Act 1974*
- An order or direction under Part 11 (Regulatory compliance mechanisms) of the *Biodiversity Conservation Act 2016*
- An environment protection notice under Chapter 4 of the *Protection of the Environment Operations Act 1997*
- An order under section 124 of the *Local Government Act 1993*.

Section 5.24 of the EP&A Act identifies approvals or authorisations that cannot be refused if they are necessary for carrying out approved State significant infrastructure and must be substantially consistent with the Part 5, Division 5.2 approval. Statutory approvals or authorisations of potential relevance to Sydney Metro West include:

- An Environment Protection Licence under Chapter 3 of the *Protection of the Environment Operations Act 1997*
- Consent under section 138 of the *Roads Act 1993*.

4.4.3 NSW legislation that may still be applicable

Some environmental planning related legislation and regulations may still apply to approved critical State significant infrastructure. Based on the scope of Sydney Metro West those that may be relevant are identified in Table 4-5.

Table 4-5: NSW legislation and regulations of potential relevance

Legislation/regulation	Requirement
Aboriginal Land Rights Act 1983	This Act establishes the NSW Aboriginal Land Council and local Aboriginal land councils. The Act requires these bodies to: • Take action to protect the culture and heritage of Aboriginal persons in the council's area, subject to any other law • Promote awareness in the community of the culture and heritage of Aboriginal persons in the council's area. The preamble of the Act states that land was traditionally owned and occupied by Aboriginal people and accepts that as a result of past government decisions, the amount of land set aside for Aboriginal people was reduced without compensation. To redress the loss of land, Aboriginal land councils can claim Crown land which, if granted, is transferred as freehold title. 'Claimable Crown lands' includes Crown lands that are not lawfully used or occupied and that are not needed, nor likely to be needed, for an essential public purpose.
Biosecurity Act 2015	Under this Act, all plants are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Section 22 requires that any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.
Contaminated Land Management Act 1997	This Act outlines the circumstances in which notification to the Environment Protection Authority is required in relation to the contamination of land. This may become relevant during construction and / or operation of Stage 1 and subsequent stages. Contamination is assessed and further discussed in Section 8.14 (Contamination – Concept) and Chapter 20 (Contamination) of this Environmental Impact Statement.
Crowns Land Management Act 2016	This Act sets out the requirements for the management of Crown land in NSW, including where councils and other organisations can deal with Crown land. Sydney Metro West passes underneath a number of parcels of Crown land.
Greater Sydney Commission Act 2015	This Act establishes the Greater Sydney Commission which has a principal objective of leading metropolitan planning for the Greater Sydney Region. The core functions of the Greater Sydney Commission are to provide advice to Government and assist local councils' plans or proposals relating to development in the Greater Sydney Region. The Greater Sydney Commission will not have a formal statutory role for Sydney Metro West but will be consulted with respect to its core functions.
Heritage Act 1977 (section 146)	If a relic is discovered or located, the Heritage Council must be notified 'of the location of the relic, unless he or she believes on reasonable grounds that the Heritage Council is aware of the location of the relic'.
Land Acquisition (Just Terms Compensation) Act 1991	This Act would apply to the acquisition of land required for Sydney Metro West.
Marine Pollution Act 2012	This Act includes provisions to protect the sea and waters from pollution by oil and other noxious substances discharged from vessels. Any construction activities requiring the use of a vessel (e.g. a barge) must comply with the requirements of this Act and the Marine Pollution Regulation 2014.

Legislation/regulation	Requirement
Native Title (NSW) Act 1994	This Act provides for native title in relation to land or waters. Sydney Metro West does not affect land subject to a native title claim or determination, or land to which an Indigenous Land Use Agreement applies.
Protection of the Environment Operations Act 1997	An environment protection licence is required for scheduled activities or development work listed by the Act. Schedule 1 lists activities that require a licence and relevantly includes Part 1, clause 33 railway systems activities meaning: (a) the installation, on site repair, onsite maintenance or on site upgrading of track, including the construction or significant alteration of ancillary work, or (b) the operation of rolling stock on track. Section 120 of the Act prohibits the pollution of waters. Air pollution-related sections 124 to 126 (Chapter 5, Part 5.4, Division 1) of the Act require activities to be conducted in a proper and efficient manner, while section 128 (Chapter 5, Part 5.4, Division 1) of the Act requires that all necessary practicable means are used to prevent or minimise air pollution. Pollution of land and waste is covered by Part 5.6 of the Act. It defines offences relating to waste and sets penalties and establishes the ability to set various waste management requirements via the Protection of the Environment Operations (Waste) Regulation 2014.
Protection of the Environment Operations (Waste) Regulation 2014	This regulation provides for exemptions from environment protection licencing for certain resource recovery activities and establishes tracking and reporting requirements for the transport of waste. Any waste generated must be tracked and recorded in accordance with the requirements of the Regulation.
Roads Act 1993	Section 138 of this Act states: A person must not (a) erect a structure or carry out a work in, on or over a public road, or (b) dig up or disturb the surface of a public road, or (c) remove or interfere with a structure, work or tree on a public road, or (d) pump water into a public road from any land adjoining the road, or (e) connect a road (whether public or private) to a classified road, otherwise than with the consent of the appropriate roads authority. Under section 38N of the *Transport Administration Act*, section 138 of the *Roads Act 1993* does not apply to Sydney Metro activities in relation to classified roads for which a council is the roads authority. However, consent from Roads and Maritime is still required under section 38N(2) of the *Transport Administration Act 1988* for those activities described in section 138(1) of the *Roads Act 1993*, when carried out in relation to a classified road.
Transport Administration Act 1988	This Act applies to compulsory acquisitions for the purpose of Sydney Metro exercising its functions under the Act.
Waste Avoidance and Resource Recovery Act 2001	This Act encourages the most efficient use of resources in order to reduce environmental harm.
Water Management Act 2000 and the Water Act 1912	Temporary dewatering and construction activities that interfere with aquifers are generally identified as aquifer interference activities in accordance with the *Water Management Act 2000* and the NSW Aquifer Interference Policy (Department of Primary Industries, 2012). However, the aquifer interference approval provisions of the *Water Management Act 2000* have not commenced, and licensing of these activities is carried out under Part 5 of the *Water Act 1912*. A licence under Part 5 is required for dewatering activity that would require the extraction of more than three megalitres of groundwater per year.

4.5 Commonwealth legislation

4.5.1 Environment Protection and Biodiversity Conservation Act 1999

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

Matters of national environmental significance

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

Current matters of national environmental significance are:

- World heritage properties
- National heritage places
- Wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed)
- Nationally threatened species and ecological communities
- Listed migratory species
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mining)
- A water resource, in relation to coal seam gas development and large coal mining development.

Issues with respect to matters of national environmental significance are discussed in Section 8.6 (Non-Aboriginal heritage – Concept) and Chapter 12 (Non-Aboriginal heritage – Stage 1), and Section 8.16 (Biodiversity – Concept) and Chapter 22 (Biodiversity – Stage 1) of this Environmental Impact Statement. No significant impacts in relation to these matters have been identified during the assessment. Accordingly, Sydney Metro West has not been referred to the Department of Agriculture, Water and the Environment.

Actions taken on Commonwealth land

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

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

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

a. Ecosystems and their constituent parts, including people and communities
b. Natural and physical resources
c. The qualities and characteristics of locations, places and areas
d. Heritage values of places
e. The social, economic and cultural aspects of a thing mentioned in (a), (b), (c) or (d).

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

Based on the nature of the Concept and the type of Commonwealth Land identified within the study area, there are not anticipated to be any significant impacts on the environment on Commonwealth Land. Typically impacts (if they occur) would be limited to Commonwealth leased land such as post offices. Potential land use and property impacts for the project have been identified and assessed in Section 8.8 (Property and land use – Concept) and Chapter 14 (Property and land use – Stage 1) of this Environmental Impact Statement.

4.5.2 Native Title Act 1993

An objective of the Commonwealth *Native Title Act 1993* is to recognise and protect native title. Section 8 of the Act states that the *Native Title Act 1993* is not intended to affect the operation of any law of a State or a Territory that is capable of operating concurrently with the Act. Searches of the register maintained by the National Native Title Tribunal indicate there are no native title claims registered with respect to land within the area of the Concept.

4.5.3 Disability Discrimination Act 1992

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

4.5.4 Disability Standards for Accessible Public Transport 2002

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

4.6 Planning approvals process for integrated station and precinct development

Sydney Metro West stations would be designed to provide for other requirements associated with possible integrated station and precinct development and ancillary development.

Typical examples of the infrastructure requirements of integrated station and precinct development include structural elements and space provisioning for building foyers and entrances, lift wells, and building services. Elements incorporated into the design for the purposes of making provision for future integrated station and precinct development are identified in Chapter 6 (Concept description).

All future integrated station and precinct developments will be subject to a separate planning approvals process, including community and stakeholder engagement, in accordance with the provisions of the EP&A Act.

There is a possibility that the assessment and approvals process relating to future integrated station and precinct development may result in changes to elements incorporated in the station design for this Concept. Any changes required to the design for the station(s) would be assessed in accordance with statutory requirements.

4.7 Summary of approval requirements

In summary:

- Sydney Metro West would be (subject to the requested declaration) critical State significant infrastructure, requiring approval from the Minister for Planning and Public Spaces under Part 5 of the *Environmental Planning and Assessment Act 1979*
- Sydney Metro West is permissible without consent
- An Environment protection licence under the *Protection of the Environment Operations Act 1997* is required for Stage 1. The terms of the licence must be substantially consistent with the project approval
- Approval under section 138 of the *Roads Act 1993* is required for any works to classified roads. The terms of the approval must be substantially consistent with the project approval
- A licence would be sought under Part 5 of the *Water Act 1912* if extraction of more than three megalitres of groundwater per year is required for Stage 1
- No significant impacts in relation to matters of national environmental significance have been identified during the assessment. Accordingly, Sydney Metro West has not been referred to the Department of Agriculture, Water and the Environment under the *Environment Protection and Biodiversity Conservation Act 1999*.

5 Stakeholder and community engagement

5 Stakeholder and community engagement

This chapter provides an outline of the consultation and engagement activities carried out for Sydney Metro West, and how this has influenced the project and the scope of the Environmental Impact Statement. It identifies who has been consulted, how the consultation was carried out, the issues raised and how those issues have been addressed.

5.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to stakeholder and community engagement, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 5-1.

Table 5-1: Secretary's Environmental Assessment Requirements – Stakeholder and community engagement

Reference	Secretary's Environmental Assessment Requirements	Where addressed
4. Consultation		
4.1	The Proposal must be informed by consultation, including with relevant local, State and Commonwealth government agencies, infrastructure and service providers, special interest groups, affected landowners, businesses and the community with specific consultation for each station precinct and ancillary facility.	Section 5.4 to Section 5.8
4.2	The Proponent must document the consultation process and demonstrate how the Proposal has responded to the inputs received.	Section 5.7
4.3	The Proponent must describe the timing and type of community consultation undertaken, the mechanisms for community feedback, the mechanisms for keeping the community informed, and procedures for complaints handling and resolution.	Section 5.7

5.2 Overview

Stakeholder and community consultation forms an integral part of the development of Sydney Metro West as well as informing and scoping investigations for this Environmental Impact Statement.

In November 2016 the NSW Government announced Sydney Metro West, an underground metro railway which would connect Parramatta and Sydney CBD.

Engagement with the community and stakeholders began in June 2017 and has continued during preparation of the Environmental Impact Statement for the Concept and Stage 1. The consultation has pro-actively sought feedback and comments on Sydney Metro West through many forums and channels to inform the development phase and the scope of issues to be assessed in the Environmental Impact Statement.

This chapter describes the consultation and engagement activities carried out up to, and during, preparation of the Environmental Impact Statement.

Key stakeholders for Sydney Metro West include (but are not necessarily limited to):

- Directly impacted communities
- State government agencies (including but not limited to the Department of Planning, Industry and Environment, Greater Sydney Commission, other sections of Transport for NSW including the former Roads and Maritime Services, NSW Environment Protection Authority and the former Office of Environment and Heritage)
- Local government (Cumberland City Council, City of Parramatta, Municipality of Burwood, Municipality of Strathfield, City of Canada Bay, Inner West Council and the City of Sydney)
- Public utilities and business and industry groups near Sydney Metro West
- Local Aboriginal Land Councils and Aboriginal stakeholders
- Special interest groups such as peak bodies and sporting associations
- The broader community.

5.3 Communication and engagement objectives

Sydney Metro is committed to continuing extensive community and stakeholder engagement on Sydney Metro West. The communication and engagement objectives are:

- Communicate the rationale, concept and timing for Sydney Metro West and the broader network benefits it would deliver, including how it fits into the NSW Government's plans to increase Sydney's rail capacity and integrated transport and strategic land use plans
- Build community and key stakeholder relationships and maintain goodwill
- Encourage participation and obtain government, community and stakeholder input for consideration in development of Sydney Metro West and its future implementation
- Provide information about the planning approval process and encourage community participation
- Clearly communicate the corridor protection and property acquisition process
- Understand community and stakeholder priorities and concerns so they can be considered in the ongoing refinement and delivery of Sydney Metro West.

Sydney Metro has developed a comprehensive community and stakeholder engagement program and has been proactive in engaging with local communities, key stakeholders, industry and government agencies.

5.4 Summary of consultation activities during development phase

Since the announcement of Sydney Metro West by the NSW Government, consultation has been undertaken with state government departments and agencies, local government and peak bodies. Community and industry consultation has been undertaken over two rounds as follows:

- First round of community and industry consultation from June 2017 to September 2017
- Second round of community and industry consultation from March 2018 to May 2018.

The key consultation and engagement activities carried out during project development are described in Sections 5.4.1 and 5.4.2. Consultation carried out during preparation of the Environmental Impact Statement is described in Section 5.7.

5.4.1 Stakeholder consultation

Key stakeholders including state government agencies, local government, industry groups and peak bodies were briefed via meetings, presentations and phone calls. The objectives of the briefings were to:

- Ensure stakeholders were consulted, including on station location options
- Ensure issues and concerns were understood, captured and addressed in the development of Sydney Metro West
- Receive feedback.

Consultation briefings have occurred with key stakeholders listed in Table 5-2.

Table 5-2: Key stakeholders

Stakeholder group	Stakeholder
State government agencies	• Department of Planning, Industry and Environment • Transport for NSW (including Sydney Trains, NSW Trains and the former Roads and Maritime Services) • Infrastructure NSW (formerly UrbanGrowth) • Greater Sydney Commission • Sydney Olympic Park Authority (now part of Department of Planning, Industry and Environment) • Ministry of Health • Port Authority of NSW
Local councils	• Cumberland City Council • City of Parramatta • City of Canada Bay • Municipality of Burwood • Municipality of Strathfield • Inner West Council • City of Sydney
Industry groups and peak bodies	• Sydney Business Chamber • Olympic Park Business Association • Royal Agricultural Society • Committee for Economic Development of Australia • Infrastructure Partnerships Australia • Sydney Olympic Park Business Association • Tourism Accommodation Australia • Urban Taskforce • Western Sydney Business Chamber • Committee for Sydney

High level project information was provided at these briefings including:

- Broader transport context
- Western Sydney Rail Needs scoping study
- Sydney Metro West network objectives
- Announced precincts at Parramatta, Sydney Olympic Park, The Bays and the Sydney CBD
- Features of the Sydney Metro Northwest and Sydney Metro City & Southwest projects to meet the needs of customers.

Stakeholder deliberative forum

A stakeholder deliberative forum was held on 30 August 2017 and was attended by 37 senior stakeholders from a range of state government departments and agencies, local government industry groups and peak bodies. The primary objective of the forum was to identify:

- Work already done on developing a future vision for the corridor by local stakeholders
- Relevant issues and constraints around the announced precincts
- Stakeholder preferences regarding the number and location of stations, journey times, land use opportunities and feedback on how to connect important destinations
- Possible stabling locations for metro trains.

Ongoing stakeholder engagement

Sydney Metro has attended meetings and workshops with stakeholders and responded to requests for advice and information. This enabled Sydney Metro to consider ongoing stakeholder input throughout the development phase.

5.4.2 Community consultation

Two rounds of community consultation have been undertaken to:

- Increase awareness
- Help define and refine the scope
- Collect community feedback.

During round one, consultation was completed along a broad study area between Greater Parramatta and the Sydney CBD as shown in Figure 5-1.

Round two of community consultation activities occurred over a refined area as shown in Figure 5-2.

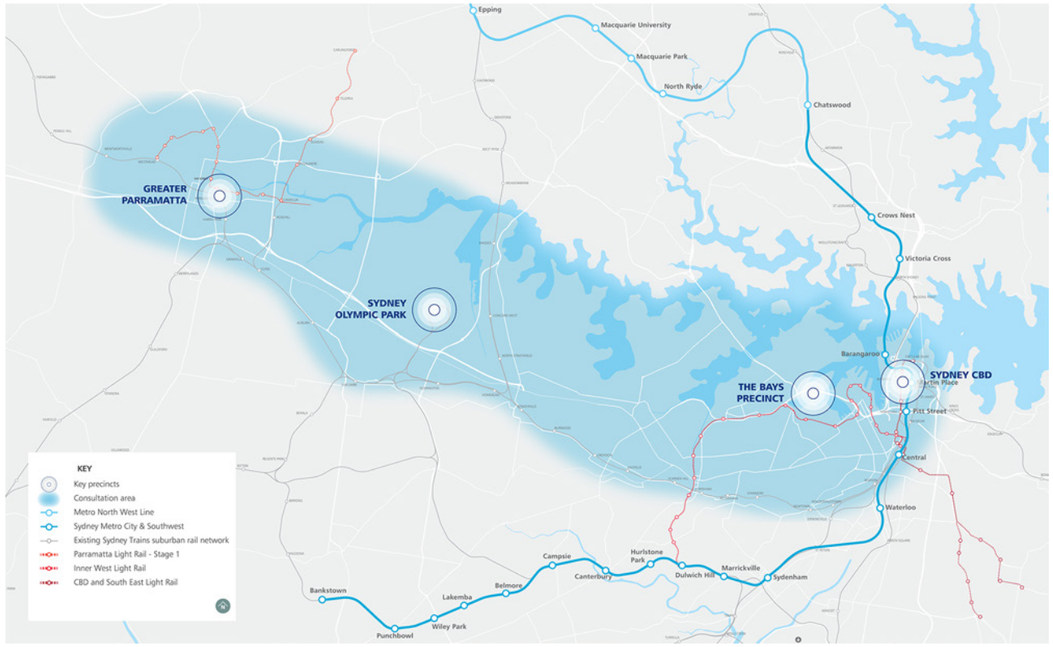

Figure 5-1: Sydney Metro West consultation area – round one

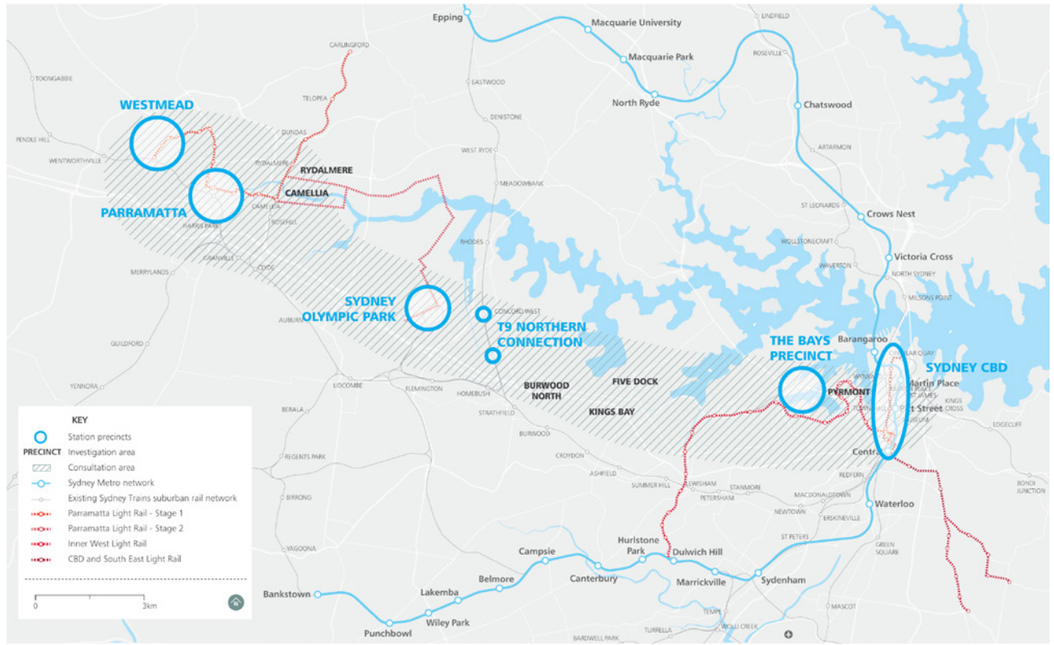

Figure 5-2: Sydney Metro West consultation area – round two

5.5 Public information and engagement

Public consultation was carried out to engage with the community prior to the planning approvals process. Sydney Metro has used all feasible channels so that it reaches as many people as possible to inform them about Sydney Metro West and call for submissions and feedback. Consultation channels were targeted to reach different geographic areas, demographics, cultural groups and interest groups. Public consultation included:

- Two rounds of community information sessions (2017 and 2018)
- Letterbox drop to more than 220,000 residents and businesses
- Proactive media strategy, which resulted in broad coverage across Sydney metropolitan and local print, radio and television outlets
- Advertisements in local and multicultural newspapers
- Email alerts to registered community members and stakeholders
- Social media via the Sydney Metro Facebook page, which has a reach of more than 50,000 people
- Paper survey – via completing a form at a public information session
- Online survey – 'Have your say' on the Sydney Metro and Transport for NSW websites
- Two 'Project Overview' information booklets (published in June 2017 and March 2018)
- Newsletter – 'Sydney Metro West – the city's next underground metro railway' (September 2018), delivered via letterbox drop and placed on the project website.

In addition, since June 2017, a number of channels have been used to provide current information to the community and stakeholders and invite feedback. These are outlined in Table 5-3.

Table 5-3: Community contact and information channels

Activity	Details
Community toll free information line	1800 612 173
Community email address	sydneymetrowest@transport.nsw.gov.au
Website	www.sydneymetro.info
Postal address	Sydney Metro West PO Box K659, Haymarket NSW 1240
Facebook page	www.facebook.com/sydneymetro

5.5.1 Community consultation 2017

Round one of community consultation was carried out from 27 June 2017 to 3 September 2017 including the public release of a 'Project Overview' document to provide information to the community about Sydney Metro West. This document was made available on the Sydney Metro website and at all public information sessions. The residential and business community was invited to attend one of six information sessions staffed by Sydney Metro as outlined in Table 5-4. These sessions were advertised through several channels including leaflet drops to 220,000 properties, advertisements in the media, website updates, email alerts to registered community members and Facebook page updates.

Table 5-4: Community information sessions

Date	Time	Location
Thursday 20 July 2017	4-7pm	Novotel, Sydney Olympic Park
Saturday 22 July 2017	10am–2pm	
Wednesday 26 July 2017	4–7pm	Novotel, Sydney Parramatta
Saturday 29 July 2017	10am–2pm	
Thursday 3 August 2017	4–7pm	Concord Community Centre
Saturday 5 August 2017	10am–2pm	Leichhardt Town Hall

An online 'Have your say' survey was live during the first round of consultation and paper surveys were also available at public information sessions. The objective of the surveys was to provide people with the opportunity to provide feedback on potential station locations in addition to the four key areas that were initially identified at Parramatta, Sydney Olympic Park, The Bays and the Sydney CBD.

The survey also included questions about:

- What suburb do you live in? What do you like about your suburb? This section included specific questions relating to: homes and jobs, transport, local environment, local character, community facilities and what the respondents value most about their suburb
- What the most common modes of transport used are? How commonly do you use public transport? Modes included: school bus, local bus, train, community transport, cycle, walk, private vehicle, point to point transport services, car share/ride share
- What are the purposes for using public transport? Response options included: commuting to or from work, business trips, leisure, commuting to school/education facilities, shopping, personal errands, taking children to/from school, etc.
- What do you think should be the top transport priority for your suburb in the future? Response options included: more frequent public transport services, more public transport routes, more reliable bus and train services, more accessible public transport connections, improving cycling infrastructure, improving pedestrian infrastructure and reducing road congestion

- Building a metro station is an opportunity to give people a chance to live and work closer to a public transport connection. Do you support any of the following potential benefits of Sydney Metro West? Response options included: create more homes and jobs near metro station locations, provide the opportunity to renew and revitalise areas with more cafes, restaurants and shops, a metro train service with faster, more frequent services between Parramatta and the Sydney CBD, reduced crowding on trains, improved transport connections between other transport modes including existing trains, bus and light rail, improved transport options for Western Sydney
- Is there anywhere else you think would benefit from a metro station between Parramatta and the Sydney CBD including areas to the east and west? Why?
- Do you have any concerns about a metro station being built in your suburb?

During the first round of consultation:

- 280 people attended the public information sessions
- 1,000 people completed the 'Have your say' survey
- 39 people provided submissions
- 504 people registered for project updates.

The issues raised by local government, peak bodies, representative organisations and interest groups and the community during the 2017 consultation are summarised in Appendix C (Stakeholder and community engagement).

5.5.2 Community consultation 2018

The second round of community consultation was carried out between 23 March 2018 and 18 May 2018. A 'Project Overview' Sydney Metro West: A new railway for Western Sydney – Project overview, March 2018, provided further details of the current scope of Sydney Metro West. This included station locations at Westmead, Parramatta, Sydney Olympic Park, The Bays and the Sydney CBD, and was the basis on which to comment for those lodging submissions. This document was made available on the Sydney Metro website and hard copies were provided at all public information sessions.

This consultation round included 11 community information sessions staffed by the project team and advertised using the same channels as for the first round (refer to Table 5-5).

Table 5-5: Community information sessions

Date	Time	Location
5 April 2018	4pm–8pm	Skye Hotel Parramatta
7 April 2018	10am–2pm	Skye Hotel Parramatta
10 April 2018	10am–2pm	Westmead Hospital
11 April 2018	4pm–8pm	Concord Community Centre
18 April 2018	11am–1pm	Sydney Masonic Centre CBD
18 April 2018	4pm–7pm	Sydney Masonic Centre CBD
20 April 2018	8:30am–2:30pm	Parramatta Farmer's Market
21 April 2018	10am–2pm	Novotel Sydney Olympic Park
3 May 2018	4pm–8pm	Novotel Sydney Olympic Park
5 May 2018	10am–2pm	National Maritime Museum Pyrmont
8 May 2018	10am–2pm	Westmead Walkway

A number of these sessions also included representation from other relevant projects or agencies:

- The former Department of Planning and Environment
- NSW Health and the Westmead Alliance
- Parramatta Light Rail
- Sydney Metro City & Southwest
- The former Sydney Olympic Park Authority
- Infrastructure NSW (formerly UrbanGrowth).

An online community web forum, including an interactive map, was launched during the second round of consultation to allow people to provide comments and feedback on the alignment, station locations and other relevant issues to the Concept. Feedback was sought via an online survey ('Have Your Say' survey) and the interactive map and forum (Social Pinpoint). A number of questions were posed in both the online survey and interactive forum in a staged approach to ensure regular engagement with the community.

The interactive map and forum was in an icon drag-and-drop format where respondents could add their responses and comments and pinpoint it to a location on the online interactive map.

Examples of the questions posted on the interactive map and forum include:

- What defines your community? What words come to mind when you think of where you live?
- What benefits do you think Sydney Metro West might bring to you and your community? Response options included: More transport options, access to jobs, cafes and restaurants, local retail, access to recreational activities, faster and reliable transport service and reduced crowding on trains
- Tell us about your current modes of transport? What is the most common mode of transport you currently use? Modes included: train, bus, ferry, personal vehicle, light rail, other
- Are there local issues that Transport for NSW should consider when planning the alignment and station locations for Sydney Metro West?
- Click on any blue precinct area (information about the area pops up and scrolls down during the survey). Which amenities do you think will be the most important at the station? (please rate by order of importance). Options included open space or plaza area, retail shops, community facilities (such as libraries, community centres, cafes and restaurants, bike locking facilities, kiss and drop), other (please specify)).

The responses to the questions received were considered in ongoing design development.

During round two of consultation:

- There were 12,468 views of the Sydney Metro West overview web page
- 325 people registered for updates
- 1,245 people attended public information sessions
- 194 submissions were received via email, post, phone through the website or in person
- 854 comments were made on the interactive online map
- 600 survey questions were answered on the interactive online map.

The issues raised by local government, peak bodies, representative organisations and groups and the community during the 2018 consultation are summarised in Appendix C.

5.6 Industry engagement

The NSW Government has been working with industry on Sydney Metro West to foster innovation and to help share development by maximising industry input at the early stages.

5.6.1 Industry consultation 2017

The first stage of the industry engagement process took place in the second half of 2017 to build awareness of Sydney Metro West and to obtain market information to shape its scope and definition, so that the desired transport and land use outcomes are met. An industry briefing session was held by Sydney Metro on 2 November 2017 at the International Convention Centre. This briefing included information about Sydney Metro West.

There was a high level of interest with local and international industry stakeholders with:

- 209 enquiries from interested parties
- 178 registrations to participate in the industry engagement process
- 136 applications for one-on-one meetings
- 34 written submissions received
- 43 one-on-one meetings undertaken.

5.6.2 Industry consultation 2018

A second industry briefing session was held on 19 April 2018 which released an initial delivery strategy for Sydney Metro West and an industry survey. This stage also sought feedback on:

- The level of industry appetite and preference for packaging, contracting, and transaction process options as identified in the initial delivery strategy
- The initial delivery strategy, particularly the relation to the packaging of metro operations and maintenance, and integrated place-making, stations and development
- Specific issues to inform the development of the definition design and implementation considerations
- Options to enhance the benefits of Sydney Metro West through value sharing or the possible use of non-government land in partnership with the private sector to deliver greater value for money to the people of NSW.

Feedback has been used to develop a preferred delivery strategy for Sydney Metro West and inform the broader implementation strategy and objectives.

A broader industry briefing was also held on 6 December 2018 which outlined further development of the initial delivery strategy for Sydney Metro West.

5.7 Consultation during preparation of the Environmental Impact Statement

5.7.1 Community consultation

Community along the proposed Sydney Metro West corridor

A survey ('swipEngage') was open to the community along the proposed corridor between 6 November and 16 December 2019, with 135 people participating in the survey. Half of those who took the survey lived in Five Dock, Burwood North or North Strathfield. Survey responses identified the following:

- The largest first preference for getting around was by train
- More than 85 per cent of those surveyed had a strong attachment to their suburb
- Almost 80 per cent thought their area had a strong sense of community
- Over 85 per cent highly valued their open space and community spaces
- Almost 60 per cent of people were concerned about construction impacts
- More than 85 per cent of people looked forward to having a metro station in their suburb
- Around half of those surveyed spoke more than one language at home.

A summary of the key issues raised by survey comments and Sydney Metro responses is provided in Appendix C.

Community at Pyrmont and Rydalmere

In November 2019, Sydney Metro asked the community and stakeholders for feedback on Rydalmere and Pyrmont as strategic station options. Feedback was received via online survey, at stakeholder meetings or via emailed submissions. The feedback received will form part of the project team's assessment on Rydalmere and Pyrmont as station options. This will be subject to a separate assessment process and is not included as part of this Environmental Impact Statement.

5.7.2 Aboriginal stakeholder consultation

Aboriginal community consultation has been conducted in accordance with the Aboriginal cultural heritage consultation requirements for proponents 2010 (DECCW, 2010b). A consultation log has been maintained which details all correspondence with the registered Aboriginal parties for Metro West (see Technical Paper 4 – Aboriginal Cultural Heritage Assessment Report).

In accordance with Stage 4.1.2 of the Aboriginal cultural heritage consultation requirements for proponents 2010, correspondence was sent to Aboriginal Land Councils, Local Councils and Aboriginal stakeholders in May 2019 to identify Aboriginal people who may hold cultural knowledge relevant to determining the Aboriginal significance of Aboriginal objects and/or places within the Stage 1 study area.

In accordance with Stage 4.1.3 of the Aboriginal cultural heritage consultation requirements for proponents 2010, advertisements were also placed in the Koori Mail and Sydney Morning Herald on 8 May 2019 and 6 May 2019 respectively. The advertisement invited all Aboriginal persons and organisations who hold cultural knowledge relevant to determining the significance of Aboriginal objects and places in the study area to register their interest. Responses to the advertisements were requested by 22 May 2019.

Also, in accordance with Stage 4.1.3, letters and/or emails were sent on 23 July 2019 to all Aboriginal persons and organisations identified through responses from the agencies contacted during Step 4.1.2 as well as organisations which had previously been contacted during the development of Sydney Metro West. The letters provided details on the location and nature of Sydney Metro West, as well as an invitation to register as an Aboriginal stakeholder. Fourteen days were allowed for registrations.

Where initial stakeholder contact failed, secondary methods of contact were attempted for potential stakeholders. The registration of interest time period was extended to those groups who were contacted by secondary means with the final registration of interest period closing on 5 September 2019.

A total of 59 Aboriginal stakeholder groups registered their interest in the consultation process.

Deerubbin Local Aboriginal Land Council representatives carried out a site survey for construction sites between, and inclusive of, the Westmead metro station construction site and the Clyde stabling and maintenance facility construction site which fall within the boundaries of Deerubbin Local Aboriginal Land Council. Further assessment was recommended within the Clyde stabling and maintenance facility construction site and within the Parramatta metro station construction site.

Metropolitan Local Aboriginal Land Council representatives carried out a site survey for construction sites between, and inclusive of, the Silverwater services facility and The Bays Station construction sites which fall within the boundaries of the Metropolitan Local Aboriginal Land Council. Representatives identified construction sites within the vicinity of water sources as containing potential for archaeological remains given the importance of water as a resource. It was also acknowledged that many of the construction sites had been heavily modified by current development. It was recommended that the telling of Aboriginal stories through heritage interpretation within the future stations should be a priority.

5.7.3 Place managers

Sydney Metro has dedicated community relations specialists called Place Managers who can be contacted for information specific to an area. Place Managers have been available during the project development phase and during preparation of the Environmental Impact Statement to support Sydney Metro's role in creating places and achieving good outcomes for each station precinct. Place Managers continue to be available.

Sydney Metro has also appointed Personal Managers to offer affected residents and small businesses assistance and support throughout the property acquisition process.

5.7.4 Community contact information

Since June 2017, a number of channels have been used to provide current information to the community and stakeholders and invite feedback. These are outlined in Table 5-3 and have remained available during the project development phase and during preparation of the Environmental Impact Statement.

5.7.5 Government agency consultation

Consultation has been carried out with local Councils and government agencies during preparation of the Environmental Impact Statement (between October 2019 and April 2020). Consultation has been carried out with:

- Burwood Council
- City of Canada Bay Council
- Cumberland City Council
- Inner West Council
- City of Parramatta
- NSW Environment Protection Authority
- Heritage Council of NSW
- Transport Coordination
- Other relevant parts of Transport for NSW

The issues raised and Sydney Metro responses are provided in Appendix C.

5.7.6 Contact statistics

Table 5-6 outlines the contacts received by Sydney Metro during preparation of the Environmental Impact Statement (between October 2019 and February 2020).

Table 5-6: Contact statistics between October 2019 and February 2020

Activity	Number of contacts
Calls to 1800 612 173	410
Emails (in and out) sydneymetrowest@transport.nsw.gov.au	630
Project update subscriptions	1,926
Website visitors	317,557
Online survey	135
Doorknocks	683
Community information sessions	2
Stakeholder briefings and events	27
Industry engagement	2

5.8 Future consultation and engagement

5.8.1 Public exhibition of the Environmental Impact Statement

The Department of Planning, Industry and Environment will place this Environmental Impact Statement on public exhibition for a minimum of 28 days (as per Schedule 1 of the *Environmental Planning and Assessment Act 1979*). During the exhibition period, government agencies, stakeholders and the community will be able to review the Environmental Impact Statement and will have an opportunity to make a written submission to the Department of Planning, Industry and Environment for consideration in its assessment of the project.

Sydney Metro will ensure stakeholders and the community are provided with opportunities to view the Environmental Impact Statement and engage with the project team. The details of engagement activities will be advised at the commencement of public exhibition through advertising (print and digital), a newsletter delivered to properties, emails to registered parties and information provided on the Sydney Metro website.

As a minimum, consultation activities would meet relevant statutory requirements in place at the time.

Submissions report

At the completion of the public exhibition period for the Environmental Impact Statement, the Department of Planning, Industry and Environment will collate and provide Sydney Metro with a copy of all submissions received. After reviewing the submissions, Sydney Metro will prepare a submissions report that responds to the relevant issues raised. The submissions report will be made publicly available on the Department of Planning, Industry and Environment website. Anyone making a public submission will receive a letter notifying them of the publication of the submissions report on the Department of Planning, Industry and Environment website.

If changes are required to the Concept or Stage 1 as a result of the issues raised in submissions or to minimise environmental impact, a Preferred Infrastructure Report and/or an Amendment Report may also may also be required. If this is required, Sydney Metro would prepare the report to address the changes to the design and submit this for review to the Department of Planning, Industry and Environment. This report may be made available for public review.

5.8.2 Ongoing consultation and engagement activities

Sydney Metro will continue to work with stakeholders and the community to ensure they are informed about Sydney Metro West and have opportunities to provide feedback. A list of indicative activities is provided in Table 5-7.

Table 5-7: Ongoing consultation and engagement activities (indicative)

Activity	Design	Delivery (Construction)	Operation
Project overview document		●	
Media releases		●	
Community information sessions	●		
Traditional and social media engagement	●	●	●
Doorknocks with neighbouring properties	●	●	●
Newsletter letterbox drop	●	●	●
Project website and online forums	●	●	●
Newspaper advertising	●	●	●
Stakeholder meetings	●	●	●
Local business engagement	●	●	●
Government stakeholder engagement	●	●	●

Sydney Metro would also specifically consult with stakeholders to fulfil mitigation measures outlined in this Environmental Impact Statement. These consultation activities are identified in the relevant mitigation measures in Chapter 27 (Synthesis of the Environmental Impact Statement).

Should the Concept and Stage 1 be approved, Sydney Metro would continue to consult with the community and key stakeholders during construction and the planning for future stages. In general, this consultation would involve:

- Ongoing consultation with key stakeholders, local councils and other government agencies
- Provision of regular updates to the nearby communities
- Development and implementation of a community complaints and response management system.

Part B | Sydney Metro West Concept

6 Concept description

6 Concept description

This chapter describes the Sydney Metro West Concept including metro operations, key features of the alignment, the proposed stations and other ancillary infrastructure. An outline of the construction work is also provided. The Concept components are subject to further design and changes or clarifications which may be made during the ongoing design development and stakeholder and community engagement processes.

6.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to the Concept description, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 6-1.

Table 6-1: Secretary's Environmental Assessment Requirements – Concept description

Reference	Secretary's Environmental Assessment Requirements	Where addressed
2. Environmental Impact Statement		
2.1	b. a description of the Concept, including key components and activities including: • project overview; • station and ancillary facility locations and the proposed route (including use of plans);	Section 6.2 Sections 6.7 to 6.9
	c. a description of the staged approach to obtaining approval for the project	Section 6.11
	e. a description of associated strategic investigations (such as Pyrmont and Rydalmere stations) that do not comprise part of the Concept	Section 6.7.9

6.2 Overview

6.2.1 Key features

Sydney Metro West (the Concept) involves the construction and operation of about 24 kilometres of underground metro rail between Westmead and the Sydney CBD.

The indicative alignment and proposed station locations are shown on Figure 6-1. The key components of the Concept include:

- About 24 kilometres of twin tunnels between Westmead and the Sydney CBD
- New metro stations at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock, The Bays and Sydney CBD. The location of the Sydney CBD station will be determined following further investigations and community and stakeholder engagement. Strategic station locations at Rydalmere and Pyrmont are also under investigation
- A turn-up-and-go metro service operating early morning to late at night, between Westmead and the Sydney CBD
- Pedestrian links and connections to other modes of transport (such as the existing suburban rail network and other parts of the metro network) and surrounding land uses
- Modification to existing suburban stations and associated rail infrastructure (including overhead wiring, signalling, access tracks/paths and rail corridor fencing) at Westmead and North Strathfield
- Services within each of the metro stations, including mechanical and fresh air ventilation equipment and electrical power substations to supply power for operation
- A stabling and maintenance facility at Clyde, and associated aboveground and belowground tracks to connect to the mainline tunnels and other operational ancillary infrastructure
- Services facilities at Rosehill (within the Clyde stabling and maintenance facility construction site), Silverwater and between Five Dock and The Bays for fresh air ventilation and emergency evacuation
- Alterations to pedestrian and traffic arrangements, cycling and public transport (e.g. bus) infrastructure around the metro stations
- Subdivision of station sites to support integrated station and precinct development and ancillary facilities
- Ancillary facilities to support construction.

Components of the Concept are subject to ongoing design development and outcomes of stakeholder and community engagement.

The Concept does not include the following components:

- Integrated station and precinct developments
- Opportunities for strategic station locations at Rydalmere and Pyrmont, which are currently being investigated
- Road realignment works at The Bays. The impacts of this are assessed in the Review of Environmental Factors 'The Bays Road Relocation Works' April 2020
- Relocation of the Sydney Speedway to an alternative site. A proposed site has been identified within the Western Sydney Parklands. The preliminary impacts of development of a speedway facility at that site are identified in the scoping report 'Sydney International Speedway' March 2020
- Surveys, test drilling, test excavations, geotechnical or contamination investigations or other tests, surveys, sampling or investigation for the purposes of the design or assessment of Sydney Metro West.

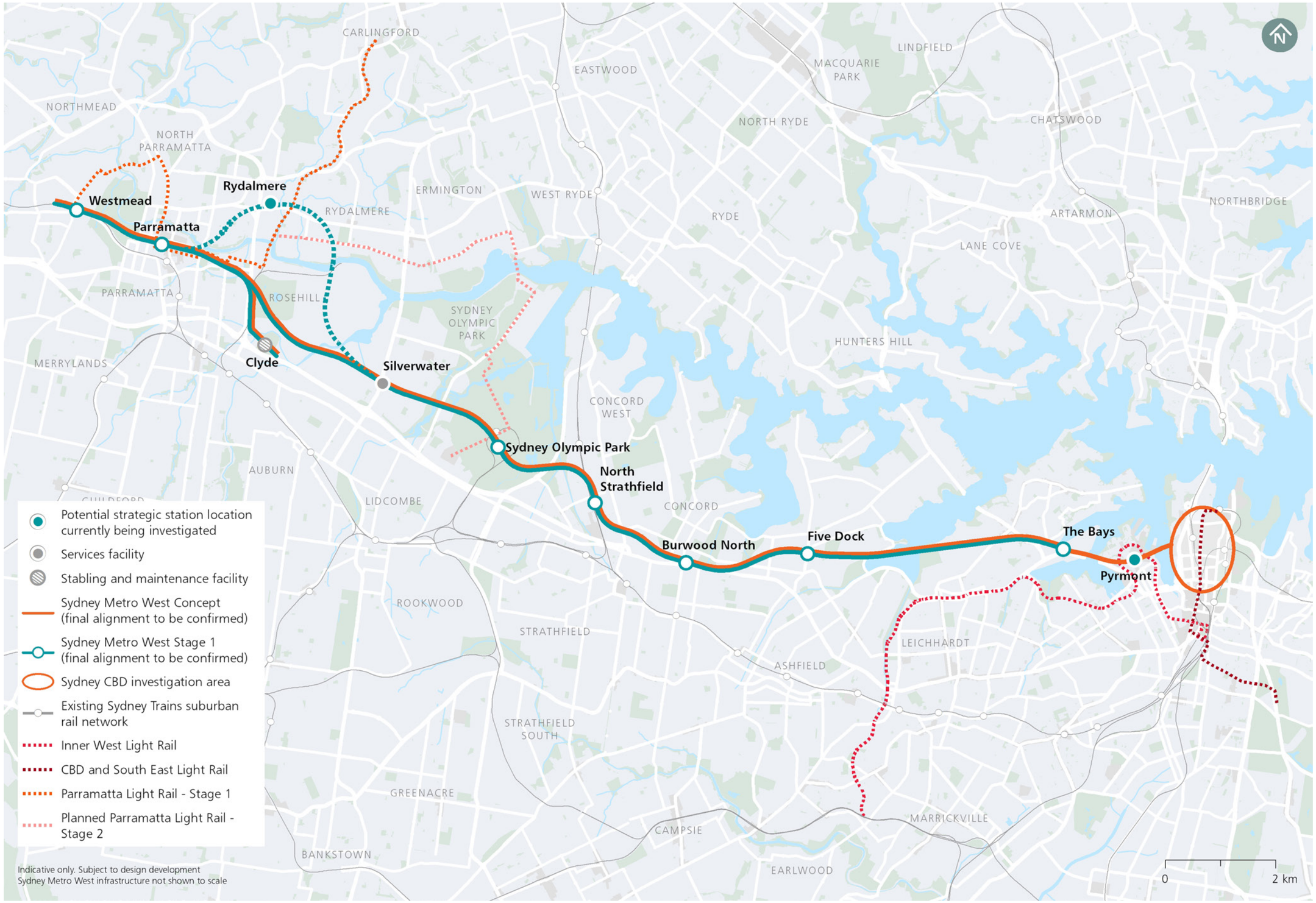

Figure 6-1: Overview of the Concept

6.2.2 Key metro characteristics

Customer experience underpins how Sydney Metro is being planned and designed and incorporates all aspects of travel associated with the transport network, service and Concept including:

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

A high quality door-to-door transport product is critical to attract and retain customers and also to meet broader transport and land use objectives. This includes providing a system that is inherently safe for customers on trains, at stations and at the interface with the public domain; providing direct, comfortable, legible and safe routes for customers between transport modes; and providing a clean, pleasant and comfortable environment for customers at stations and on trains.

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

Table 6-2: Key metro characteristics – Sydney Metro West Concept

Product characteristic	Description
Fast and reliable service	• Delivering fast journeys between stations with new generation single deck trains • Ensuring easy boarding and alighting to reduce dwell times at stations • Creating a highly reliable service.
Ability to move more people	• Designing infrastructure, trains and systems to be able to run 30 trains per hour at ultimate capacity • Ability to move more than 40,000 customers per hour in each direction at ultimate capacity.
Modern trains and technology	• Trains operate safely closer together with communications-based train control that allows automated train operations and driverless operation • On-board real time travel information and live electronic route maps.
Accessible system	• Fully accessible stations and single deck trains • At least three double doors per side per carriage for faster loading and unloading • Level access and reduced gaps between the platform and train - providing access for all • Designing for bicycles on trains • Delivering modern customer information systems.
Highly legible	• 'Turn-up-and-go' frequencies means there is no need for a timetable • Consistent stopping patterns that mean metro would stop at all stations.
Safe and secure	• Improving customer experience with customer service assistants at every station, and customer service assistants moving through the network during the day and night • Ensuring customers can see all the way along the train and move easily between carriages, including wide, open walkways between carriages • Providing platform screen doors at stations which keep people and objects away from the edge, improving customer safety and allowing trains to get in and out of stations much faster.
Comfortable service	• Air-conditioned trains with large windows, warm lighting and open walkways • Seating and standing room designed to maximise personal space • Easy boarding and alighting at stations.

6.3 Regional context

The Sydney Metro West corridor is highly urbanised and extends through densely populated and culturally and linguistically diverse regions. The Concept extends from Westmead and passes through a number of suburbs in Western Sydney and the Inner West of Sydney before reaching the Sydney CBD. Sydney Metro West spans seven local government areas – Cumberland City Council, the City of Parramatta, Strathfield Municipal Council, Burwood Council, the City of Canada Bay, Inner West Council and the City of Sydney. Figure 6-2 provides an overview of the local government areas within the corridor.

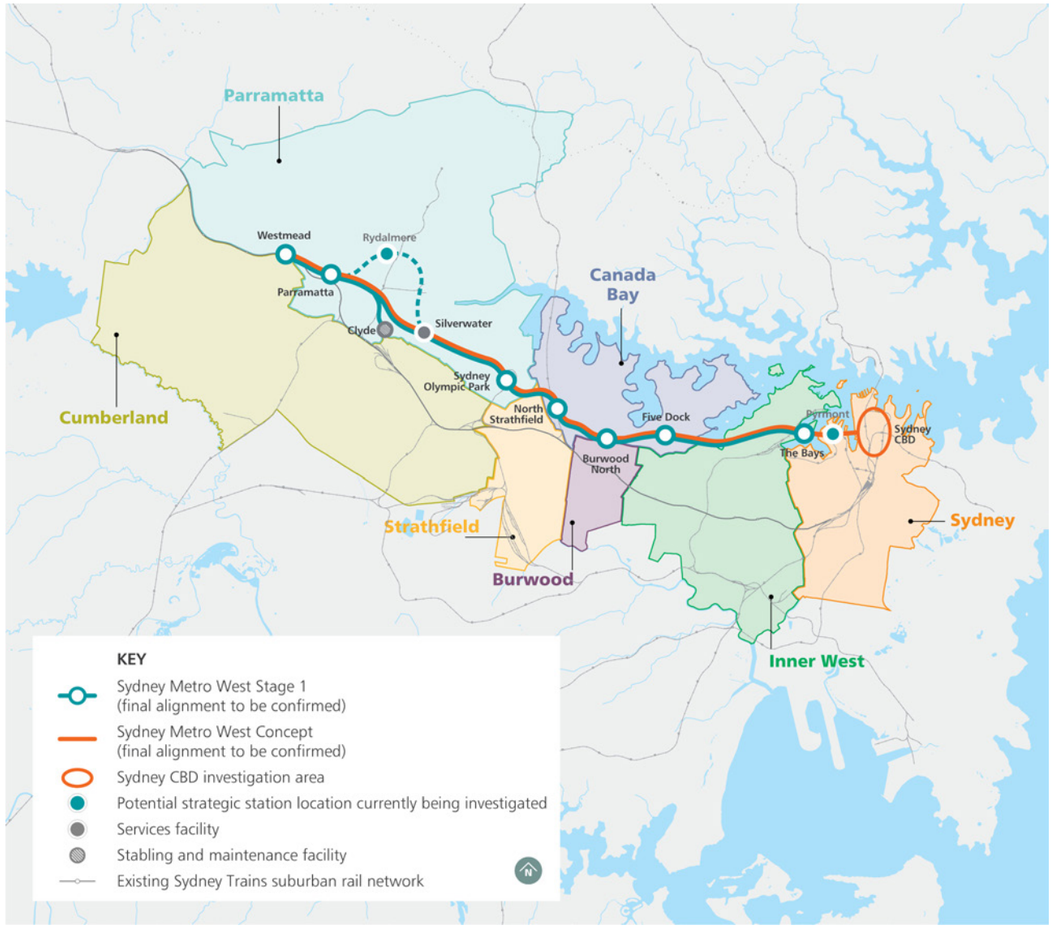

Figure 6-2: Local government areas across the Sydney Metro West corridor

The local government areas in which Sydney Metro West is located have a total population of about one million people and contain a number of sites of national and international importance including:

- Five out of nine major office markets in Sydney, including the Parramatta and Sydney CBDs
- One of Australia's largest health and education precincts at Westmead
- More than 10 sports, events and convention facilities and one of the largest urban parklands in Australia at Sydney Olympic Park, which attracts 10 million visitors each year and 5,600 business and entertainment events each year
- The Bays, which includes almost 100 hectares of largely government-owned land and 5.5 kilometres of harbour foreshore located two kilometres from Sydney CBD
- Significant heritage sites in Parramatta and the Sydney CBD including Old Government House and the former Parramatta Government Domain in Parramatta Park and the World Heritage-listed Sydney Opera House.

6.4 Sydney Metro West operations

The fully automated Sydney Metro delivers a significant improvement in the capacity and customer experience of Sydney's existing transport network, with a high capacity, turn-up-and-go service that would stop at all stations along the metro line. The Concept would operate as a standalone railway line separate from the existing suburban and intercity rail network and separate from the Metro North West Line (currently operating), Sydney Metro City & Southwest (opening 2024) and Sydney Metro Greater West (working towards opening at the same time as the airport).

Demand for the service would be managed through increased service frequency. The ultimate operational capacity of the Concept would be for 30 trains per hour in each direction – a train every two minutes each way.

6.4.1 Hours of operation

Sydney Metro West would operate from early morning to late at night, similar to the Sydney Trains suburban rail network and the Sydney Metro North West Line. To accommodate for planned special events, operating hours could be extended.

6.4.2 Train types

All trains would be new, single-deck metro trains. They would deliver a fast, safe and reliable journey for customers with high performance standards and good customer amenities including:

- At least three doors per side per carriage, allowing fast boarding and alighting
- Air conditioning
- Emergency help points
- Accessible priority seating for mobility impaired, the elderly and people with a disability or using a wheelchair or mobility device
- A mix of seating and standing arrangements for efficient boarding and alighting the metro
- Level access between the platform and train
- Clear transport information whilst on board the metro.

6.5 Design

6.5.1 Preliminary design considerations for metro stations

The detailed design of Sydney Metro West stations would take into account a wide range of considerations, provided in Table 6-3.

The approach to design and placemaking for the Sydney Metro West Concept, as well as site-specific place and design principles for each metro station and facility, are provided in Chapter 7 (Placemaking).

Table 6-3: Preliminary station design considerations

Station aspect	Design considerations
Customer experience	• Escalators, platforms, passageways, mezzanines and concourses would be designed to accommodate peak customer flows and ensure stations are easy to navigate • The station and public access areas would be designed as attractive spaces and include public art and landscaping (where appropriate) and would also maximise the use of natural daylight. The design would also protect customers from weather (covered access paths, waiting shelters etc.) at stations and also at interchange areas • Furniture on station platforms would be provided to cater for a range of customers including seating and standing spaces.
Customer information and wayfinding	• Real-time information would be delivered to customers through multiple media • An easy, intuitive and consistent wayfinding system would be developed that facilitates efficient customer movements to, from and through stations.
Operations and system requirements	Stations would be designed in accordance with the operations and system requirements, including: • Maintaining customer flows at an acceptable and safe level of service standard • Securing platforms and critical infrastructure spaces from public access when services are not operating.
Safety and security	• The safety of customers, staff and areas surrounding stations would be considered in station design in accordance with crime prevention through environmental design principles • Well-designed and efficiently controlled lighting systems and visible closed circuit television surveillance would contribute to safe station environments. Passive station design elements that promote safety would include clear visibility lines in and around stations, the use of natural daylight and adequately wide paths to avoid blind spots.
Accessibility and functionality	• Efficient transfer between metro and other types of transport (such as suburban network trains, walking, cycling, light rail and buses) is important to station design and supporting an integrated transport network approach • The Sydney Metro network would be integrated into the Opal ticketing system • Station design would be guided by an 'access for all' philosophy using 'priority of access' principles, with pedestrians and cyclists first, followed by buses, point to point transport services and kiss and ride customers • Station design would include emergency exit and access facilities, such as fire stairs to allow for customer evacuation and emergency services access.
Sustainability	• Sustainability measures at stations would include (where feasible) natural light, solar panels, reuse of rainwater, passive ventilation and shading, use of durable and low maintenance materials, and energy-efficient lighting.
Placemaking and activation	• Sydney Metro West stations and precincts would provide a new public domain as well as integration with the existing public realm and adjoining lands to develop and promote vibrant retail, community and other spaces, as appropriate to the context and locality • Each station location would include space for retail outlets that meet customer needs (e.g. café, newsagents, etc.), as well as providing spaces for temporary activation and public art where appropriate. Station entries would be designed to make a positive contribution to the local area.

6.5.2 Integrated station and precinct development

New metro stations create opportunities for integrated station and precinct developments that provide for community needs and include consideration of relevant planning controls and local character. An integrated station and precinct development refers to the proposed building(s) above and/or around the station that could deliver a range of uses such as community facilities, new homes, shops, restaurants and commercial office space.

Provision for integrated station and precinct developments would be made at Westmead, Parramatta, Sydney Olympic Park, Burwood North, Five Dock, The Bays and Sydney CBD.

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

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

Design integration would ensure future developments can be built efficiently and effectively.

Further details regarding elements incorporated into the station design for the purposes of making provision for future integrated station and precinct development will be identified and assessed as part of future stage Environmental Impact Statements.

Integrated station and precinct developments do not form part of the State significant infrastructure application, and would be subject to separate environmental assessments and planning approvals processes.

6.6 Tunnel alignment and configuration

The twin underground metro rail tunnels would be around 24 kilometres in length from Westmead to the Sydney CBD. The alignment is shown on Figure 6-1.

The tunnel alignment within the corridor would be refined by the functional requirements of a metro network and the specific constraints of station design, namely:

- The location, depth and platform configurations of preferred metro stations
- Having a maximum vertical grade of 4.5 per cent
- Locating station platforms along a straight and level section of track (that is, a zero per cent grade)
- Providing a tunnel depth with suitable competent rock cover above the tunnel crown (the top surface of the tunnel structure), where possible, to minimise the requirement for ground support
- Requiring appropriate curvature to accommodate proposed operating speeds, while having regard to subsurface constraints such as building basements and foundations.

The alignment has also been influenced by a number of environmental factors including (but not limited to) avoiding known built form constraints including existing buildings, basements, utilities, infrastructure (including other rail and road infrastructure), and minimising potential impacts on environmental and social features.

6.6.1 Key tunnel and underground track features

The metro rail tunnels would have a circular cross-section with a clear internal lined diameter of about six metres to accommodate the typical metro train, rail systems and infrastructure.

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

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

Cross passages for emergency evacuation would link the tunnels along the alignment. Cross passages may be modified or the spacing increased in some locations such as to avoid poor ground conditions, or where the alignment passes beneath water bodies.

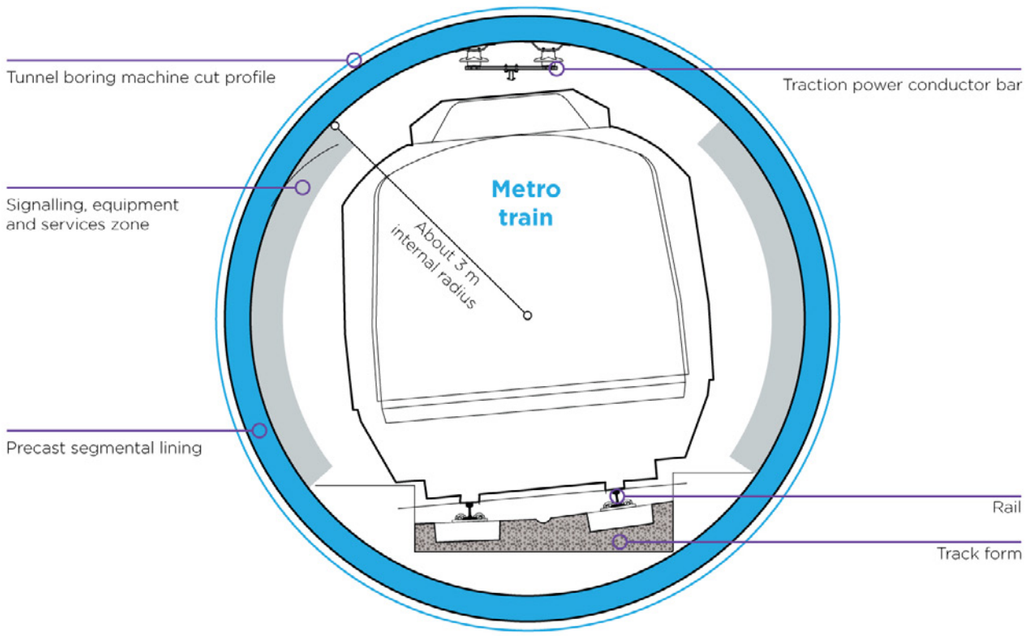

Figure 6-3: Indicative cross-section of a metro tunnel

6.6.2 Safeguarding for future extensions

The ability to extend Sydney Metro West, including beyond Westmead, would be future-proofed. The provision of stub tunnels would allow for minimal disruption of the operating line during the construction of future extensions, and also allow for overnight stabling and storage of trains during operations.

6.7 Stations

New metro stations would be located at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock, The Bays and Sydney CBD. The location of the Sydney CBD station will be determined following further investigations and community and stakeholder engagement. The potential for additional stations at Rydalmere and Pyrmont is currently being investigated.

The locations of the proposed new stations are identified below. The locations of the proposed stations between Westmead and The Bays are described in further detail in Chapter 9 (Stage 1 description).

6.7.1 Westmead metro station

Westmead metro station would be located immediately south of the existing Westmead Station to provide a direct interchange with the T1 Western Line and the T5 Cumberland Line, providing connectivity to the hospital precinct (through interchange with Parramatta Light Rail Stage 1).

Westmead metro station would provide increased accessibility to the Westmead employment, health and education hub, as well as residential areas experiencing growth and renewal.

Key features of Westmead metro station are provided in Table 6-4. A detailed description of Stage 1 at Westmead metro station is provided in Chapter 9 (Stage 1 description).

Table 6-4: Westmead metro station key features

Key features	Description
Proposed station entry	One entry on Hawkesbury Road
Customers	• Residents within walking and cycling distance • Employees and visitors to and from the Westmead health precinct • University students, employees and visitors to the education precinct • Customers transferring between rail and bus services.
Primary station function	Origin, destination and interchange
Catchment	Employment, residential, health and education
Transport interchange	• Suburban and intercity rail • Walk • Cycle • Bus • Light rail • Taxi/point to point transport • Kiss and ride.
Provision for future integrated station and precinct development (subject to separate future approvals)	Yes, including consideration of relevant planning controls and local character

6.7.2 Parramatta metro station

Parramatta metro station would be located within the block bounded by George, Macquarie, Church and Smith streets. Parramatta metro station would be located to the north of the existing Parramatta Station, within the commercial core of Parramatta CBD.

Parramatta metro station would serve and support the growth of Parramatta as Sydney's second CBD, including boosting jobs and improving connections to recreational and tourist attractions. The new metro station would improve customer experience at the existing Parramatta Station by relieving demand in peak times.

The key features of Parramatta metro station are provided in Table 6-5. A detailed description of Stage 1 at Parramatta metro station is provided in Chapter 9 (Stage 1 description).

Table 6-5: Parramatta metro station key features

Key features	Description
Proposed station entry	• One station entry on the future Civic Link (Horwood Place) • Potential additional entry to be determined.
Customers	• Residents within walking and cycling distance • Employees travelling to and from work in the Parramatta CBD • Visitors travelling to and from nearby education, retail, residential areas and recreational activities • Customers transferring to and from light rail and bus.
Primary station function	Origin, destination and interchange
Catchment	Employment, residential, education, recreation and entertainment
Transport interchange	• Suburban and intercity rail (indirect connection via Civic Link) • Walk • Cycle • Bus • Light rail • Taxi/point to point transport • Kiss and ride.
Provision for future integrated station and precinct development (subject to separate future approvals)	Yes, including consideration of relevant planning controls and local character

6.7.3 Sydney Olympic Park metro station

Sydney Olympic Park metro station would be located to the south of the existing Olympic Park Station in the growing Sydney Olympic Park town centre and central precinct. The metro station would be located to the east of Olympic Boulevard between Herb Elliott Avenue and Figtree Drive. The Sydney Olympic Park Master Plan identifies this precinct as a higher density, mixed-use neighbourhood with commercial offices, retail and residential uses. The broader precinct also caters for major sports and entertainment events and includes hotel accommodation.

Sydney Olympic Park metro station would support commercial, residential, retail, hotel, education, sports, recreation, parklands and entertainment uses. This location would offer easy transfer with a future Parramatta Light Rail Stage 2 and buses.

The key features of Sydney Olympic Park metro station are provided in Table 6-6. A detailed description of Stage 1 at Sydney Olympic Park metro station is provided in Chapter 9 (Stage 1 description).

Table 6-6: Sydney Olympic Park metro station key features

Key features	Description
Proposed station entry	• Main station entry between Herb Elliot Avenue and Figtree Drive • Second entry off Dawn Fraser Avenue.
Customers	• Residents within walking and cycling distance • Employees or visitors travelling to and from nearby residential and employment areas • Visitors to events, venues, recreational facilities and parklands • Customers transferring to and from light rail and bus.
Primary station functions	Origin, destination and interchange
Catchment	Residential, employment, events and recreation
Transport interchange	• Suburban rail (indirect connection) • Walk • Cycle • Bus • Light rail (planned) • Taxi/point to point transport • Kiss and ride.
Provision for future integrated station and precinct development (subject to separate future approvals)	Yes, subject to the Sydney Olympic Park Master Plan

6.7.4 North Strathfield metro station

North Strathfield metro station would be located adjacent to the existing North Strathfield Station and would provide direct interchange between the metro and suburban rail networks. The station would be positioned with an entrance on the eastern side of the existing rail line fronting Queen Street.

North Strathfield metro station would provide customers travelling on the busy T9 Northern Line an attractive interchange option to access key centres more quickly, as well as access to new centres.

The key features of North Strathfield metro station are provided in Table 6-7. A detailed description of Stage 1 at North Strathfield metro station is provided in Chapter 9 (Stage 1 description).

Table 6-7: North Strathfield metro station key features

Key features	Description
Proposed station entry	One new entry on Queen Street
Customers	• Residents within walking and cycling distance • Visitors travelling to and from nearby residential and education areas • Visitors to local entertainment, retail or dining attractions • Customer transferring between rail and bus services.
Primary station functions	Origin and interchange
Catchment	Residential, education and entertainment
Transport interchange	• Suburban rail, and potentially intercity services • Walk • Cycle • Bus • Taxi/point to point transport • Kiss and ride.
Provision for future integrated station and precinct development (subject to separate future approvals)	No

6.7.5 Burwood North Station

Burwood North Station would be located at the corner of Parramatta Road and Burwood Road with access from both the north and south sides of Parramatta Road. The site would be bound to the north by Burton Street and to the east by Loftus Street.

Burwood North Station would support new residential housing and employment growth in the surrounding catchment.

The key features of Burwood North Station are provided in Table 6-8. A detailed description of Stage 1 at Burwood North Station is provided in Chapter 9 (Stage 1 description).

Table 6-8: Burwood North Station key features

Key features	Description
Proposed station entry	Two entries with one on the north-east corner of Burwood Road and Parramatta Road, and one on the south-corner of Burwood Road and Parramatta Road
Customers	• Residents within walking and cycling distance • Students, staff and visitors travelling to and from nearby schools • Residents or employees travelling to and from nearby residential and employment areas.
Primary station functions	Origin and interchange
Catchment	Residential, education and employment
Transport interchange	• Walk • Cycle • Bus • Taxi/point to point transport • Kiss and ride.
Provision for future integrated station and precinct development (subject to separate future approvals)	Yes, including consideration of relevant planning controls and local character.

6.7.6 Five Dock Station

Five Dock Station would be located in the core of the Five Dock local centre off Great North Road with an entrance on Fred Kelly Place. Great North Road is the primary north-south spine through the locality leading from Parramatta Road to the peninsula suburbs of Abbotsford and Drummoyne.

Five Dock Station would support the local village centre and placemaking outcomes presented in the Five Dock Urban Design Study (City of Canada Bay Council, 2014) by providing rail services to the area for the first time. Five Dock also offers opportunity for a new bus interchange.

The key features of Five Dock Station are provided in Table 6-9. A detailed description of Stage 1 at Five Dock Station is provided in Chapter 9 (Stage 1 description).

Table 6-9: Five Dock Station key features

Key features	Description
Proposed station entry	One entry at Fred Kelly Place off Great North Road
Customers	• Residents within walking and cycling distance • Visitors to retail, commercial and recreational areas.
Primary station functions	Origin and interchange
Catchment	Residential
Transport interchange	• Walk • Cycle • Bus • Taxi/point to point transport • Kiss and ride.
Provision for future integrated station and precinct development (subject to separate future approvals)	Yes, including consideration of relevant planning controls and local character

6.7.7 The Bays Station

The Bays Station would be located at the apex of White Bay between Glebe Island and the White Bay Power Station. The station would have direct access to the future Bays Waterfront Promenade, which would run north and south along White Bay.

The station would support the renewal and development of The Bays and provide access to the established areas of Balmain and Rozelle.

The key features of The Bays Station are provided in Table 6-10. A detailed description of Stage 1 at The Bays Station is provided in Chapter 9 (Stage 1 description).

Table 6-10: The Bays Station key features

Key features	Description
Proposed station entry	One entry to the south of White Bay, near the future Bays Waterfront Promenade
Customers	• New residents within the precinct • Existing residents within walking and cycling distance • Employees and visitors to and from business, education, districts within The Bays • Visitors to and from retail, commercial and recreational attractions.
Primary station functions	Origin and destination
Catchment	Employment, residential and recreation
Transport interchange	• Walk • Cycle • Bus • Taxi/point to point transport • Kiss and ride.
Provision for future integrated station and precinct development (subject to separate future approvals)	Yes, subject to the finalisation of the NSW Government's Bays Precinct Transformation Plan

6.7.8 Sydney CBD Station

The preferred location for a Sydney CBD Station is being investigated. The metro station would enable interchange with existing public transport networks, including Sydney Metro City & Southwest, the existing Sydney Trains suburban rail network, the light rail and bus networks. The station strategy and key features for the Sydney CBD would be developed once the location is determined.

6.7.9 Strategic opportunities for optional stations

Potential strategic station locations at Rydalmere and Pyrmont are currently being investigated, however at this stage do not form part of the Concept.

If progressed, the location of stations at Rydalmere and Pyrmont would be refined during ongoing design development and an assessment of the station would be undertaken in accordance with the *Environmental Planning and Assessment Act 1979*, which may include a modification or as part of a future stage of the Concept.

Rydalmere

A metro station at Rydalmere would provide increased accessibility to employment and education destinations, as well as residential areas experiencing growth and renewal. It would also support the Greater Parramatta Olympic Peninsula vision, including supporting the concept of 30-minute cities, and the provision of high quality public spaces to enhance liveability.

Pyrmont

A metro station at Pyrmont would support existing residential, employment, entertainment and event land uses in the area and provide direct connections between Sydney CBD and The Bays. It would also provide interchange connections with existing light rail and bus services.

6.8 Operational ancillary facilities

6.8.1 Service facilities

Fresh air tunnel ventilation and emergency egress would generally be provided at the proposed stations. Additional facilities would also be required at Rosehill (within the Clyde stabling and maintenance facility construction site), Silverwater and between Five Dock and The Bays.

Service facilities would generally be located directly above the tunnel alignment. An aboveground building for mechanical, electrical and ventilation equipment would be provided at each location, with a shaft to connect to the tunnels below.

6.8.2 Traction substations

Traction power supply would be provided through dedicated traction substations. These would be co-located with other infrastructure where possible.

6.9 Stabling and maintenance

6.9.1 Infrastructure maintenance

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

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

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

6.9.2 Clyde stabling and maintenance facility

Operating trains would be stabled and maintained at a dedicated facility in Clyde. The Clyde stabling and maintenance facility would provide:

- Stabling roads to store trains
- Maintenance facility
- Train wash facility
- Wheel grinding and graffiti/train wash facilities
- Infrastructure maintenance sidings, depot and buildings
- Operations control centre
- A traction substation to provide power to the rail line and stations (described in Section 6.8.2 Traction substations)
- Operational water treatment plant to treat wastewater pumped from the tunnels, stations and other underground facilities
- Workshops for the maintenance of railway infrastructure components
- Offices, car parks, storage and vehicular and pedestrian roads.

Connecting track would be provided from the Clyde stabling and maintenance facility to the mainline tunnels. This would include a dive structure and tunnel portal, and underground tunnels.

6.10 Construction

Key construction elements of the Concept would include:

- Enabling works
- Tunnel excavation and associated tunnelling support activities such as segment production, segment storage and spoil management
- Station construction including excavation, fit-out and aboveground building construction
- Rail interchange support works at Westmead and North Strathfield stations
- Operational ancillary infrastructure construction including excavation of shafts, fit-out and aboveground building construction
- Construction of a stabling and maintenance facility, including the dive structure and tunnel portal
- Tunnel and rail systems fit-out.

Table 6-11 provides an overview of construction activities for the Concept. Further details on construction activities which form Stage 1 are provided in Chapter 9 (Stage 1 description).

Table 6-11: Construction activities

Construction activity	Overview of activity
Enabling works	Enabling works are activities that would typically be carried out before the start of substantial construction in order to make ready the key construction sites and provide protection to the public. • Enabling works may include: • Demolition of buildings • Utility supply, including power and water • Utility adjustments and protection • Transport network modifications to roads, public transport, and pedestrian and cyclist facilities • Heritage investigations, salvage and clearance (if required), protection and archival recordings • Additional geotechnical and contamination investigations and remediation where required.
Tunnel excavation	Tunnel excavation would be carried out using tunnel boring machines, with roadheaders used for caverns, stub tunnels and connection tunnels from the stabling and maintenance facility to the mainline tunnels via the Rosehill dive structure. Tunnel boring machines would be used to excavate the majority of the twin tunnels as they operate at a quicker rate than roadheaders and excavate the desired circular tunnel profile. It is anticipated the tunnel boring machines would be launched and supported from two sites, being: • Westmead metro station construction site • The Bays Station construction site. These sites would provide the necessary support for the tunnelling operation including spoil storage and removal, power supply to the tunnel boring machines, fresh air ventilation, grout batching, water treatment and disposal, material storage, office facilities, worker amenities and parking. Retrieval and dismantling of the tunnel boring machines would be carried at Sydney Olympic Park metro station construction site. Tunnel boring machine launch, retrieval and support sites to the east of The Bays through to the Sydney CBD would be assessed in the Environmental Impact Statement(s) for future stage(s). A concrete segment facility would be constructed at Clyde as part of the Clyde stabling and maintenance facility construction site to provide concrete segments for the tunnel lining.

Construction activity	Overview of activity
Station construction	Excavation of stations would generally be carried out in the following sequence: • Enabling works including protection or diversion of utilities and establishment of site access points • Demolition of structures on the site and clearance of landscaped vegetation • Excavation and structural works for station boxes and underground pedestrian passages including piled walls • Station fit-out including mechanical, electrical, lighting and fresh air tunnel ventilation equipment, signage and wayfinding equipment and station furniture • Station precinct works, such as public plazas and landscaping.
Rail interchange support works at Westmead	Construction sites within the existing rail corridor would be located on land owned by the NSW Government. Interchange support works at Westmead would potentially involve: • Potential demolition of existing station elements • Minor widening and lengthening of existing station platforms • Minor track slewing, rail systems and overhead wiring works • Construction of a new aerial concourse with new lifts and stairs to the existing platforms • Adjustments to existing station entry points and the overhead concourse.
Rail interchange support at North Strathfield	Interchange support works would involve the construction of a new aerial concourse with new lifts and stairs to the existing platforms, and potential demolition of existing station elements. At the current stage of design, it is not expected that any below grade works would be required.
Operational ancillary infrastructure construction	The operational ancillary infrastructure would be generally constructed in the following sequence: • Excavation of a vertical shaft to the tunnels below. This may be carried out using excavators and rock hammers, however, drill and blast or penetrating cone fracture techniques may also be used • Lining and reinforcement of the shaft • Building works for aboveground components • Installation of electrical equipment including transformers and electrical switchboards • Landscaping works.
Stabling and maintenance facility construction	Construction of the stabling and maintenance facility would involve: • Enabling works including protection or diversion of utilities and establishment of site access points • Demolition of structures on the site and clearance of vegetation • Import and placement of fill material • Structural works for crossings of A'Becketts Creek and Duck Creek • Site drainage works • Track and rail systems fit-out • Construction of buildings including the operations control centre • Fencing and landscaping works.
Dive structure and tunnel portal construction	Dive structure and tunnel portal construction would generally involve: • Cast in-situ concrete piling along the edge of the dive structure to form the walls • Excavating below track level • Placing of precast and cast in-situ concrete for the cut-and-cover section and to form the tunnel portal.
Tunnel rail systems fit-out	Tunnel and tunnel rail systems fit-out works would include: • Fresh air tunnel ventilation fit-out • Track slab and rail fastening • Rail installation, fixing and welding • Cable and equipment installation including signalling, communications and electricity systems • Overhead traction power supply installation for rolling stock • Other equipment including lighting (including emergency lighting), drainage works, and fire and life safety systems (including walkways connecting to emergency egress and fire hydrant systems).

6.10.1 Construction sites

Most of the construction sites would be contained within the footprints of operational stations and ancillary infrastructure. Additional construction areas would also be required to support tunnel excavation and fit-out work.

The location and indicative footprint of the proposed main construction sites between Westmead and The Bays are shown in Chapter 9 (Stage 1 description). Construction components to the east of The Bays through to the Sydney CBD would be subject to further design and would be described and assessed in the Environmental Impact Statement(s) for future stage applications.

6.11 Staging of planning approvals

The planning approvals and environmental impact assessment for Sydney Metro West will be broken down into a number of stages recognising the size of the project. This includes:

- Sydney Metro West at a Concept level
- Stage 1 – All major civil construction works between Westmead and The Bays including station excavation and tunnelling
- Stage 2 – All stations, depots and rail systems between Westmead and The Bays.
- Stage 3 – All major civil construction works including station excavation, tunnels, stations, depots and rail systems between The Bays and the Sydney CBD Station, and operation of the line.

Whilst the content of these stages may be varied, this Environmental Impact Statement covers the Concept and Stage 1 comprising all major civil construction works between Westmead and The Bays including station excavation and tunnelling.

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7 Placemaking

7 Placemaking

This chapter provides an overview of the approach to placemaking for the Concept. It outlines the integration with local strategic plans, place and design principles for stations and ancillary facilities, and the design process.

7.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to Stage 1, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 7-1.

Table 7-1: Secretary's Environmental Assessment Requirements - Placemaking

Reference	Secretary's Environmental Assessment Requirements	Where addressed
1. Place and Design		
1.1	Outline a design process that is informed, collaborative and iterative (including the use of design review panels and consultation with community and other stakeholders).	Section 7.11
1.2	Design principles and outcomes for each station and facility that are reflective of the design objectives in Better Placed.	Section 7.3 Section 7.10
1.3	Design principles and outcomes should include how crowd management and operational efficiency can be achieved for major events	Section 7.10.3

7.2 Strategic placemaking context

The Sydney Metro West corridor, from Westmead to Sydney CBD, is an important corridor which would significantly enhance the intercity linkage between the Central River City of Greater Parramatta and the Eastern Harbour City of the Sydney CBD. Sydney Metro West supports the key directions outlined in the Greater Sydney Region Plan: A Metropolis of Three Cities (Greater Sydney Commission, 2018a) by:

- Providing infrastructure to support the three cities including the '30-minute city' concept where people will have access to jobs, schools, hospitals and services within 30 minutes
- Connecting the Eastern Economic Corridor with the Greater Parramatta and Olympic Peninsula Economic Corridor
- Supporting greater housing supply.

The corridor provides a diverse mix of centres, ranging from established CBDs, to specialised precincts and local town centres. Sydney Metro West would be delivered within a context of significant renewal and potential change in many areas along the corridor.

Planned growth and renewal around stations offers opportunities to activate or revitalise the public domain, creating unique and safe places. In the design of each station, consideration would be given to the opportunities for the station to be more than just a transport node, but also an active and vibrant place, with public domains designed to encourage walking, cycling and social interaction that provides value and amenity to the wider community.

Further detail on the city-shaping benefits of Sydney Metro West, including how the Concept supports planned growth and renewal, is provided in Chapter 2 (Strategic need and justification).

Several strategies and policies are in place to guide the design of the built environment and public realm in NSW. These strategies and policies set the context for Sydney Metro's approach to placemaking.

7.2.1 Better Placed

Better Placed is the integrated design policy for the built environment of NSW (Government Architect NSW, 2017). The policy provides guidance for state government to achieve good design as both a process and outcome.

Better Placed sets seven design objectives which define the key considerations of a built environment to that is 'healthy, responsive, integrated, equitable, and resilient.' Sydney Metro's own objectives for design are aligned with those established in Better Placed (refer to Section 7.3.3).

7.2.2 Sydney Green Grid

As part of the Greater Sydney Region and District Plans, the Sydney Green Grid provides a spatial framework to underpin Greener Places, the draft green infrastructure policy (Office of the Government Architect, 2017). The Sydney Green Grid proposes the creation and consolidation of a 'network of high quality green areas that connect town centres, public transport networks and major residential areas,' enhancing open space throughout Greater Sydney.

With Sydney Metro West following the Parramatta River from Westmead to the Sydney CBD, there are opportunities for the stations and surrounding public domain to connect into or enhance the Sydney Green Grid. Key opportunities to improve connectivity to existing and future Green Grid projects are identified for relevant precincts in Section 7.10.

7.2.3 Greener Places

Greener Places – Draft for discussion (Government Architect NSW, 2017) builds on the Sydney Green Grid to guide the design, planning and delivery of green infrastructure across NSW. Green infrastructure refers to the network of open spaces, natural and semi-natural systems including parks, river, bushland and private gardens which support quality of life in urban environments. Greener Places identifies the NSW Government's infrastructure and urban renewal projects as an opportunity for the delivery of quality green infrastructure.

Sydney Metro West would support the principles of Greener Places, including:

- Integration – The design of the Concept would consider opportunities to integrate green infrastructure with metro stations and facilities
- Connectivity – The Concept offers opportunities to improve connectivity to open spaces, parklands, waterways and active transport routes. Opportunities to integrate with existing and planned walking and cycling networks would also be an important consideration in design.

7.3 Approach to placemaking

7.3.1 Understanding place

The delivery of Sydney Metro West offers the opportunity to transform areas with new places, or to reinforce and enhance existing places. The approach to placemaking for Sydney Metro West is based on a multi-faceted approach to the planning, design, and management of public spaces, which aims to create public spaces that promote people's health and wellbeing.

The approach to placemaking at each locality would be contextual, taking into consideration that metro stations would:

- Function as 'places' in their own right, creating focal points in the communities each station serves. The stations would attract a range of benefits and land uses, including reducing dependence on private vehicles, providing public places for gathering and human interaction supported by commercial and retail, as well as encouraging exercise by promoting walking and cycling to and from the stations
- Have a role in contributing to their surrounding environment or 'place' in which they are located by supporting planned growth and renewal, and acting as a catalyst for transit-oriented development within their catchments.

7.3.2 Role and scope for placemaking

Sydney Metro considers placemaking opportunities at different scales, starting from the station itself, extending to the interchange area, and to the broader precinct in which the station and interchange are located. These scales are shown on Figure 7-1.

Sydney Metro's role in delivery changes as the scale increases. Sydney Metro's scope to deliver and influence place outcomes is highest within the station and interchange area. The physical extent of this area differs from station to station depending on context, but generally includes station plazas and interchange infrastructure in the immediate surrounds of the station. In some locations this may include areas for integrated station and precinct development (refer to Section Reference.4), placemaking or transport integration purposes.

At all stations, Sydney Metro would deliver public domain elements and work with other parts of Transport for NSW to deliver transport integration elements. This would ensure that stations and interchanges are attractive, safe, functional and allow for the gathering and movement of people. Within station and interchange areas, Sydney Metro would also explore opportunities for activation, retail and other specialised spaces for the customer and community. These would be delivered subject to separate planning approvals or future stage(s) of Sydney Metro West as appropriate.

Beyond the interchange area, in the precinct, the role of Sydney Metro is generally to service key attractions and enable opportunities for land use change and placemaking more broadly.

Integration with broader land use planning led by state and local government agencies is an important consideration for the precinct. This can help ensure that mass transit amenity offered by the station is supported by appropriate land uses and density, which contribute to liveability of areas through supporting public transport use and reducing the need for private vehicle use.

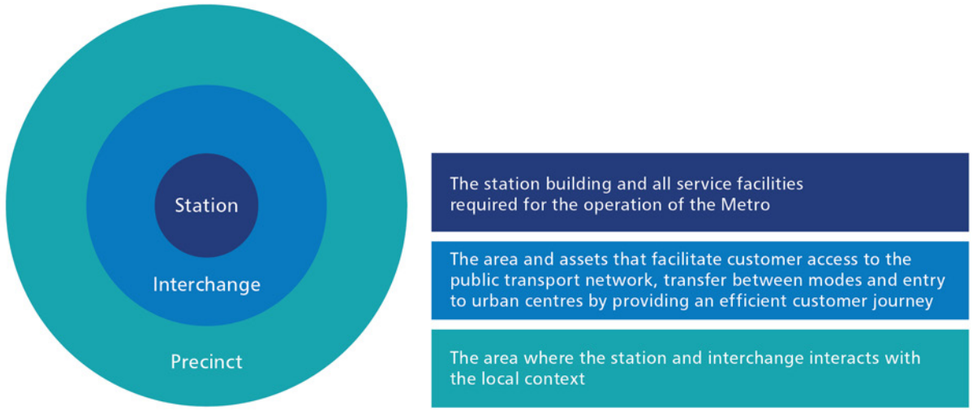

Figure 7-1: Placemaking at different scales

7.3.3 Sydney Metro Design Objectives

To help meet Sydney Metro's vision to transform Sydney with a world-class Metro, five design objectives have been identified to guide decision making and the design process. A design principle is prescribed to each design objective, describing the intention of the objective for the design of stations, station precincts and the wider metro corridor. The Sydney Metro design objectives, principles, and their alignment with Better Placed objectives are provided in Table 7-2.

Table 7-2: Sydney Metro Design Objectives

Objective	Principle	Relevant Better Placed objectives
Objective 1: Ensuring an easy customer experience	Sydney Metro places the customer first. Stations are welcoming and intuitive with simple, uncluttered spaces that ensure a comfortable, enjoyable and safe experience for a diverse range of customers	Objective 4: Better for people – safe, comfortable and liveable Objective 5: Better working – functional, efficient and fit for purpose
Objective 2: Being part of a fully integrated transport system	Sydney Metro is a transit-oriented project that prioritises clear and legible connections with other public and active transport modes within the wider metropolitan travel network that intersect with this new spine	Objective 5: Better working – functional, efficient and fit for purpose
Objective 3: Being a catalyst for positive change	Sydney Metro is a landmark opportunity to regenerate and invigorate the city with new stations and associated development that engage with their precincts, raise the urban quality and enhance the overall experience of the city	Objective 7: Better look and feel – engaging, inviting and attractive Objective 6: Better value – creating and adding value
Objective 4: Being responsive to distinct contexts and communities	Sydney Metro's identity is stronger for the unique conditions of centres and communities through which it passes. This local character is to be embraced through distinctive station architecture and public domain that is well integrated with the inherited urban fabric of existing places	Objective 1: Better fit – contextual, local and of its place Objective 3: Better for community – inclusive, diverse and connected
Objective 5: Delivering an enduring and sustainable legacy for Sydney	Sydney Metro is a positive legacy for future generations. A high standard of design across the corridor, stations and station precincts, that sets a new benchmark, is vital to ensuring the longevity of the metro system, its enduring contribution to civic life and an ability to adapt to a changing city over time	Objective 2: Better performance – sustainable, adaptable and durable Objective 6: Better value – creating and adding value

7.3.4 Integrated station and precinct development

Several of the Sydney Metro West stations would provide opportunity for integrated station and precinct development. This could be made up of buildings(s) above and/or around the station that could deliver a range of uses such as community facilities, new homes and green spaces, shops, restaurants and commercial office spaces.

Integrating a mix of uses and development into the station precinct would contribute to the success of places by:

- Encouraging precinct activation and use of Sydney Metro West across different times of the day and week
- Creating opportunities to provide facilities which meet customer and community needs, attracting people to stations
- Allowing stations to successfully integrate into their urban context and to contribute positively to the character of places at the stations.

Sydney Metro West stations would be designed with provisions for integrated station and precinct development at Westmead, Parramatta, Sydney Olympic Park, Burwood North, Five Dock, The Bays and Sydney CBD.

All future integrated station and precinct developments would be subject to separate planning approvals process which would include community and stakeholder engagement. Further detail about how the Concept would facilitate integrated station and precinct development is provided in Chapter 6 (Concept description).

7.4 Transport integration and connectivity

Safe and convenient connections to and from Sydney Metro West stations are an important part of the customer journey and experience of the station precinct. Connectivity between different transport modes, including walking, cycling, rail, light rail, buses, taxis and kiss-and-ride, must be legible and easy, acknowledging that Sydney Metro is part of an integrated transport system. This also includes recognising relevant accessibility guidelines and standards (including the Disability Discrimination Act 1992 and Disability Standards for Access to Public Transport), which provide good access for people with disabilities, the elderly and passengers with prams or luggage.

A modal access hierarchy, shown on Figure 7-2, would be applied in the design of Sydney Metro West stations. The objective of the hierarchy is to ensure that the design of stations, and their integration with other transport modes, gives the highest priority to the most efficient and sustainable access modes. This influences the design of stations and interchanges, highlighting the need to balance transport integration with 'place' elements.

The hierarchy prioritises walking and cycling connections to provide for the safety and wellbeing of customers and users of the station precinct. Every arrival to or departure from the station would be as a pedestrian – either from the precinct or after transferring to or from connecting modes.

Figure 7-2: Sydney Metro West modal access hierarchy

The Concept aims to provide transport services which meet the needs of customers, integrate with the broader transport network, and support future housing and employment growth in the corridor. Sydney Metro would work with relevant stakeholders (such as Transport for NSW, other transport operators and local councils) to deliver the following principles:

- Provide direct, legible, safe and accessible pedestrian routes to and from stations
- Provide cycling access that is consistent with local government plans for cycling routes
- Maximise connectivity with metro, Sydney Trains suburban rail, light rail and intercity rail networks to provide shorter journey times, better connectivity and congestion relief
- Where beneficial to customers, work with Transport for NSW to reorient bus and networks to connect with Sydney Metro West stations, providing feeder service functionality and extending the catchment from which customers can access stations
- Work with Transport for NSW to reduce service duplication by rationalising bus operations to, from and within major centres and along major congested corridors
- Work with Transport for NSW to realign services to major centres in line with customer travel patterns, aiming to minimise the need to transfer between services
- Minimise, where possible, the impact on customers of transferring between services at interchanges, for example by minimising the distance between transport nodes and providing legible wayfinding between nodes
- Provide for short-term private vehicle access, rather than long-term access, at stations through kiss-and-ride, taxi and rideshare spaces.

7.5 Aboriginal cultural design

The Concept corridor traverses the Country of the Burramattagal, Wangal and Gadigal. Westmead and Parramatta are situated on the Country of the Burramattagal, which extends from Rosehill to Prospect. Sydney Olympic Park to The Bays is situated on the Country of the Wangal, which stretches across the southern shore of the Parramatta River between Burramattagal Country and Gadigal Country. The Sydney CBD is situated on Gadigal Country, which runs from the south side of Port Jackson, extending from South Head to Darling Harbour.

During development of Sydney Metro West, targeted consultation was undertaken with the local Aboriginal community to gain an understanding of its culture and stories specific to locations across the Concept corridor. As part of this engagement, authorised representatives were clear that their cultures are very much alive along the Sydney Metro West corridor and seen to have their stories and connection to Country to be evident in the development of the Concept.

The design of the Concept should respect and respond to the culture and stories embedded within the land it passes through. Opportunities for interpretations of Aboriginal culture, including Aboriginal heritage, would be explored throughout design.

These interpretations should pay respect to the different nuances and experiences of diverse cultural groups along the Concept corridor, to acknowledge that Aboriginal stories and history have specific significance to specific places. Authentic interpretation would be achieved by continued engagement with authorised representatives of the different Aboriginal communities. Assessment of the potential impacts to Aboriginal heritage are provided in Chapter 8 (Concept Environmental assessment).

7.6 Non-Aboriginal heritage

Heritage plays a key role in defining a sense of place, identity and community. Heritage elements often provide a richness and depth that enhance the customer experience of places. New stations located in close proximity to heritage elements have the potential to further this function, with contemporary infrastructure integrated with the past in ways that both enhance heritage values and cater for the future growth of the city.

There are several heritage items located within close proximity to future Sydney Metro West stations. Impacts on these heritage items would be minimised, with the stations designed sympathetic to the item. Opportunities would be identified for heritage conservation to contribute to the celebration of local identity in station design. Assessment of the potential impacts to non-Aboriginal heritage are provided in Chapter 8 (Concept environmental assessment).

7.7 Public art

Successful public art recognises the particular character of a place, and can enrich the customer experience of the metro. Public art can interface with other design disciplines to create an identity for stations and the metro line, legible wayfinding, meaningful heritage interpretation and safe public spaces. Locally resonant art pieces can build a sense of ownership by local communities, of their station and its public domain, which potentially adds to both the sustainability and meaning of these places.

Opportunities to integrate public art into the customer environment, and a process for its curation and production, would be considered in the design of Sydney Metro West.

7.8 Crime prevention through environmental design

Safety is a fundamental consideration for the design of all elements of Sydney Metro West. The design of stations and interchange facilities would be informed by crime prevention through environmental design (CPTED) principles. This would involve incorporating, as a minimum, the three main CPTED strategies:

- Natural access control – public spaces would be designed to attract people to use them, and access would be restricted to areas where customers or the public are not permitted to enter
- Natural surveillance – design would enable visibility from surrounding areas, providing for passive surveillance of customers and the community using the station precinct
- Territorial reinforcement – clear demarcation would be provided between public and private spaces, encouraging people to use public spaces with a sense of care and ownership.

The station designs would be developed with consideration given to these principles, to provide safe and secure places for customers and the wider community.

7.9 Sustainability in design

Sustainable design initiatives would be considered throughout the design of Sydney Metro West, and applied where feasible. Examples of sustainable design initiatives which could be incorporated into metro stations include:

- Providing daylight to aboveground and underground station areas
- Incorporating water sensitive urban design strategies e.g. tree pits and planting beds in station plazas which filter overland flow
- Solar shading at the ground plane, including tree shading, building overhangs and awnings
- Station entry areas which are naturally ventilated
- High efficiency lighting in stations using LED lighting and on-demand controls
- Thermal insulation and high performance glazing.

A Sydney Metro West Sustainability Plan is being developed to set out the sustainability principles, objectives and initiatives including performance targets and outcomes which will be adopted for all project lifecycle phases, including design. Initial principles to govern sustainability outcomes are provided in Chapter 8 (Concept environmental assessment) (refer to Section 8.20).

7.10 Precinct considerations

The following section details the precinct-specific considerations to guide design and placemaking for the Concept. This includes integration with land use planning, and setting place and design principles.

Integration with existing and developing strategic plans and visions, and local planning provisions is a key consideration in the development of Sydney Metro West. Opportunities to integrate with local land use plans and strategies have been considered throughout development of the Concept (for example, in site selection and placement of station entries). This would continue to be a key consideration in design development, particularly in respect of the stations and their relationship with the surrounding public domain and precincts. An overview of the relevant plans and strategies is provided for each precinct.

Preliminary place and design principles have been developed for each Sydney Metro West station and facility. The purpose of the principles is to guide future design through identifying outcomes which would be achieved at the station and in the immediate public domain and interchange area. The principles build upon the five Sydney Metro-wide design objectives (refer to Section Reference.3) and have considered relevant local council strategies and Better Placed design objectives.

Sydney Metro would work with key stakeholders (including relevant local and state government agencies) to refine and implement these principles. These stakeholders would have an important role in ensuring the principles are achieved.

A description of each Sydney Metro West station and service facility is provided in Chapter 6 (Concept description).

7.10.1 Westmead metro station

Integration with strategic planning for the precinct

As identified in the Central City District Plan (Greater Sydney Commission, 2018b), the Westmead health and education precinct is a major attribute to Westmead, and its redevelopment has the potential to transform the precinct into a world-class innovation district.

A number of plans and strategies support this plan, which have informed the development of Westmead metro station, particularly raising the awareness of Westmead health and education precinct, and would guide future design, as outlined in Table 7-3.

Table 7-3: Integration with strategic planning - Westmead metro station

Plan or strategy	Overview
Cumberland 2030: Our Local Strategic Planning Statement	Within the Westmead locality, the area south of the existing rail corridor is part of the Cumberland local government area. Cumberland 2030: Our Local Strategic Planning Statement (Cumberland City Council, 2020) plans for the local government area's economic, social and environmental land use needs over the next 10 years. The Local Strategic Planning Statement reinforces the future role of the specialised health and education precinct at Westmead, and identifies that the land south of the existing rail corridor comprises an existing low density residential area with potential to facilitate housing opportunities for key workers and students from the Westmead health and education precinct. In this context, the Local Strategic Planning Statement advocates for improved transport options to increase access to local employment hubs such as Westmead and to Greater Sydney, and the revitalisation of Hawkesbury Road to become the civic, transport, commercial and community heart of Westmead. Sydney Metro West would support the potential urban renewal of south Westmead by improving transport accessibility to and from Westmead; and would support the activation of Hawkesbury Road. Sydney Metro would continue to work with Cumberland Council to integrate the station into its wider precinct, taking into account the priorities identified in the Local Strategic Planning Statement.
City of Parramatta Local Strategic Planning Statement	The area north of the existing rail corridor at Westmead is part of the City of Parramatta local government area. The City of Parramatta Local Strategic Planning Statement (City of Parramatta Council, 2020) provides strategic direction for the next 20 years and identifies how the local government area can achieve local, district and regional priorities. The Local Strategic Planning Statement includes a priority to increase commercial floor space in strategic centres, including Westmead. The Statement also identifies a need to encourage growth of the night-time economy at Westmead; and to limit residential development in the Westmead Health and Education Precinct in order to encourage commercial, entertainment, health and education development. The increase in transport amenity provided by Sydney Metro West would support these outcomes. Sydney Metro would continue to work with the City of Parramatta to integrate the station into its wider precinct, taking into account the priorities identified in the Local Strategic Planning Statement.
Precinct planning	The Department of Planning, Industry & Environment (DPIE) has identified a precinct planning process for the Westmead locality, including: • State-led strategic planning for the entire Westmead locality – which will include early work by DPIE, councils, state agencies and communities in the development of places and the planning frameworks that support them • Collaborative planning for the North and South Westmead precincts – which will involve DPIE having a coordination role to facilitate collaborative partnerships between DPIE, councils and state agencies. Sydney Metro would continue to work with stakeholders to support planned growth at Westmead.
The Westmead Health and Education Precinct Master Plan	The Westmead Health and Education Precinct Master Plan establishes a long term vision for Westmead to develop as a world-class innovation district (north of the existing rail corridor). The Master Plan includes targets to increase jobs and tertiary students in the precinct. Serving the health and education precinct was a key driver in the selection of Westmead as a core station location. The delivery of Sydney Metro West would provide the transport connectivity required to support the growth of Westmead.

Westmead metro station place and design principles

The preliminary place and design principles for Westmead metro station are:

- Facilitate an integrated transport hub with direct interchange between Sydney Metro and Sydney Trains services and safe, equitable and legible connections with active transport, buses and the future Parramatta Light Rail
- Provide a gateway to the Westmead Health and Education Precinct in recognition of its status
- Support greater activation along Hawkesbury Road, unifying North and South Westmead.
- Support growth and renewal opportunities by enhancing connections across the existing railway line with the station as a focal point
- Create an inviting public place at the station with high amenity and landscaped spaces that will encourage activation.

Indicative place and design principles for Westmead are shown in Figure 7-3.

Figure 7-3: Indicative Westmead place and design principles

7.10.2 Parramatta metro station

Integration with strategic planning for the precinct

As a priority in the Central City District Plan (Greater Sydney Commission, 2018b), Parramatta CBD has the potential to be transformed into one of Australia's most important business hubs.

To capitalise this plan, a number of plans and strategies have been developed which have informed the development of Parramatta metro station and would guide future design, as outlined in Table 7-4.

Table 7-4: Integration with strategic planning - Parramatta metro station

Plan or strategy	Overview
City of Parramatta Local Strategic Planning Statement	The City of Parramatta Local Strategic Planning Statement (City of Parramatta Council, 2020) provides strategic direction for the next 20 years and identifies how the local government area can achieve local, district and regional priorities. The Statement includes directions to enhance the cultural life of the Parramatta CBD with a particular focus on the Civic Link; and promote community and cultural infrastructure and the night-time economy. The Statement also includes direction to promote the expansion of recreational spaces, with a focus on the Green Grid and Parramatta Ways. Expanding rail connectivity to the Parramatta CBD from surrounding areas is identified as a priority in the Statement. Achieving this will involve working collaboratively to ensure that local character and street typology are considered in infrastructure planning and that the design of development supports accessibility to public transport. Sydney Metro would work with Council throughout design development to support the achievement of these outcomes.
Parramatta CBD Planning Strategy and Proposal	The Parramatta CBD Planning Strategy (City of Parramatta, 2015) was adopted by the City of Parramatta Council in April 2015. The strategy sets the vision for the growth of Parramatta CBD as Australia's next great city and provides a framework to achieve this vision. The Parramatta CBD Planning Proposal (City of Parramatta, 2018) has been prepared to implement the strategy. The planning proposal would amend the CBD boundary, land use mix, primary built form controls, and the mechanisms for infrastructure delivery. As the proposal is finalised and implemented, Sydney Metro West would support development enabled by the proposal.
The Civic Link Framework Plan	The Civic Link Framework Plan (City of Parramatta Council, 2017) establishes an aspiration for a new Civic Link to support the liveability, sustainability and productivity of the Parramatta CBD. The Civic Link would connect Parramatta Square to the Parramatta River at River Square via a green, pedestrianised public space and 'cultural spine'. Activation of and access to the future Civic Link was a key driver in the site selection and entry placement for Parramatta metro station and is reflected in the place and design principles for the station.
Sydney Green Grid	The Parramatta River Foreshore has been identified as a Green Grid priority project, which aims to create and connect a network of open spaces on both sides of the river. Sydney Metro West would improve connectivity to the foreshore via the future Civic Link at Parramatta, supporting its activation.

Parramatta metro station place and design principles

The preliminary place and design principles for Parramatta metro station are:

- Support the transformation, expansion and economic growth of the Parramatta CBD by facilitating a well-designed high quality station, public domain and development
- Strengthen the connectivity of the city centre between Parramatta Square and the Parramatta River by supporting the realisation of the Civic Link
- Facilitate activation of the ground plane at the station and the surrounds, encouraging pedestrian movement in the area
- Enhance permeability by introducing fine-grain pedestrian links between the station and surrounding streets, breaking down the large city block
- Facilitate intuitive interchange with pedestrian and cycle transport, the future Parramatta Light Rail (Stage 1), and bus services with legible, safe and direct connections from the station entry.

Indicative place and design principles for Parramatta are shown in Figure 7-4.

Figure 7-4: Indicative Parramatta place and design principles

7.10.3 Sydney Olympic Park metro station

Integration with strategic planning for the precinct

As identified in the Central City District Plan (Greater Sydney Commission, 2018b), Sydney Olympic Park provides world-class sporting and event venues and residential, commercial and recreational activities.

Since the Central City District plan actions initiatives to strengthen Sydney Olympic Park, further plans and strategies have been developed which have informed the development of Sydney Olympic Park metro station and would guide future design, as outlined in Table 7-5.

Table 7-5: Integration with strategic planning - Sydney Olympic Park metro station

Plan or strategy	Overview
City of Parramatta Local Strategic Planning Statement	The City of Parramatta Local Strategic Planning Statement (City of Parramatta, 2020) reinforces the role of Sydney Olympic Park as a mixed use lifestyle precinct and strategic centre. The planning statement includes a priority to increase commercial space and encourage commercial, entertainment and education development in Sydney Olympic Park. Sydney Olympic Park is also identified as a growth area for the night-time economy. Sydney Metro West would provide transport connectivity to Sydney Olympic Park across different times of the day and week, supporting a range of development and the night-time economy. Sydney Metro West would continue to work with the City of Parramatta to integrate the station into its wider precinct, taking into account the priorities identified in the Local Strategic Planning Statement.
Sydney Olympic Park Master Plan 2030	The Sydney Olympic Park Master Plan 2030 (Sydney Olympic Park Authority, 2018) guides the long term development of Sydney Olympic Park. A 2018 review of the Sydney Olympic Park Master Plan 2030 was endorsed in August 2018. This review provides for the continued growth of the precinct over the period to 2030, with the intention of protecting the role of Sydney Olympic Park as the premier destination for cultural, entertainment, recreation and sporting events while revitalising Sydney Olympic Park with a vibrant new town centre located centrally within the precinct. To ensure Sydney Olympic Park becomes an active and vibrant town centre, the Master Plan provides for: • A wide range of complementary civic, retail, commercial, educational, community and entertainment uses • A high density residential area around Figtree Drive • A new public urban park prominently located to provide informal recreation and to create a strong identity for the town centre precinct. Integration with the Master Plan was a key consideration in site selection for Sydney Olympic Park metro station. Sydney Metro would continue to work with the Department of Planning, Industry and Environment so that Sydney Olympic Park metro station is integrated with and supports the Master Plan.

Sydney Olympic Park metro station place and design principles

The preliminary place and design principles for Sydney Olympic Park metro station are:

- Support the creation of a new town centre and reinforce Sydney Olympic Park as a premier destination for major events in line with the principles outlined in the Sydney Olympic Park 2030 masterplan
- Deliver a station and public domain designed to support day to day activities and flexibility to accommodate major events and periodic large crowds
- Facilitate east-west access from Olympic Boulevard to the station and town centre to accommodate event crowds
- Enhance permeability with new pedestrian links and connections to places within the wider station precinct supported by active street frontages, and new open spaces
- Ensure the station provides easy, safe and intuitive interchange with other modes of transport, during day to day operation and events.

Indicative place and design principles for Sydney Olympic Park are shown in Figure 7-5.

Figure 7-5: Indicative Sydney Olympic Park place and design principles

Event considerations

As set out in the place and design principles, Sydney Olympic Park metro station would be designed with flexibility to accommodate major events and periodic large crowds. The metro would work with the existing T7 Olympic Park line on the suburban rail network to cater for events.

This design of Sydney Olympic Park metro station would include strategies to separate event and non-event customer flows, to enable operational efficiency to be achieved during major events. This would include the following:

- In addition to day-to-day entries, the station would include separate event mode entries, to separate customer flows. Dedicated vertical transport (lifts and escalators) could also be provided for event and non-event customers
- Adequate space would be provided both at grade in the precinct and in the station for crowd marshalling – including space for event customers to queue at grade and an internal station configuration which caters for crowds
- Extended dwell times (the time a train needs to stop in a station for customers to board and alight) at Sydney Olympic Park metro station could be considered in planning for 'event mode' operations of Sydney Metro West. This would need to be balanced with the efficient operation of the line
- Sydney Metro would work with Department of Planning, Industry and Environment, and Transport for NSW to deliver clear wayfinding to different transport nodes in the precinct.

7.10.4 North Strathfield metro station

Integration with strategic planning for the precinct

The Eastern City District Plan (Greater Sydney Commission, 2018c) identifies North Strathfield as a local centre within an urban renewal area. To capitalise this plan, a number of plans and strategies have been developed, which have informed the development of the North Strathfield metro station and guide the future design, as outlined in Table 7-6.

Table 7-6: Integration with strategic planning - North Strathfield metro station

Plan or strategy	Overview
City of Canada Bay Local Strategic Planning Statement	The City of Canada Bay Local Strategic Planning Statement (City of Canada Bay Council, 2020) is the core strategic planning document for the Canada Bay local government area. The planning statement prioritises land use opportunities and implications arising from Sydney Metro West. The Statement recognises that a station at North Strathfield would allow residents and commuters quick and easy interchange between metro and the T9 Northern Line. Key actions include to increase the diversity of dwelling types around North Strathfield Station. The planning statement also advocates for new open space and better walking and cycling connections for North Strathfield as part of any future land use change. Sydney Metro West would support renewal and an increased diversity of housing near the station. Sydney Metro would continue to work with Council in the development of the station, including opportunities to provide walking and cycling access to the station which is consistent with local cycle network plans, and any planned growth around the station.
Parramatta Road Corridor Urban Transformation Strategy	The Parramatta Road Corridor Urban Transformation Strategy (2016) provides the long-term vision and framework to support coordinated employment and housing growth in the Parramatta Road Corridor. North Strathfield is identified within the Homebush Precinct. The vision of Homebush is to transform the area into an 'active and varied hub, blending higher density housing and a mix of different uses, supported by a network of green links and open spaces with walking access to four train stations.' Sydney Metro West would support this vision, with the metro station increasing public transport accessibility and development opportunities in the area.
Precinct planning – Homebush, Strathfield & Burwood	In June 2017, DPIE announced Burwood, Strathfield and Homebush as a Planned Precinct. Following this, early investigations began to understand the required infrastructure and open space to meet growing demand. DPIE has now identified that these areas will be subject to a collaborative planning approach. This will involve DPIE having a coordination role to facilitate partnerships between the City of Canada Bay, Burwood Council and Strathfield Council and state agencies to drive quality place outcomes. Sydney Metro would continue to work with stakeholders to support planned growth at North Strathfield.
Sydney Green Grid	Powells Creek and Mason Park have been identified as a Green Grid project opportunity. Powells Creek and Mason Park form an important open space corridor linking the urban centres of Concord West, North Strathfield, Homebush and Strathfield to Parramatta Road, Bicentennial Park and the Parramatta River Foreshore. The Parramatta Road Urban Renewal Corridor is also identified as a project opportunity, with the potential to improve access to open space along the corridor as renewal occurs. Sydney Metro would support improved access to these open spaces by providing an easy connection across the existing rail corridor and station access to the west.

North Strathfield metro station place and design principles

The preliminary place and design principles for North Strathfield metro station are:

- Facilitate direct interchange between Sydney Metro and Sydney Trains services on the T9 Northern Line and easy connections with other modes
- Ensure legible, safe and intuitive station access to the east and west of the existing rail corridor
- Support an active public domain area focused on Queen Street
- Enable an easy connection across the existing rail corridor and to key destinations including the Bakehouse Quarter and the Powells Creek open space corridor.

Indicative place and design principles for North Strathfield are shown in Figure 7-6.

Figure 7-6: Indicative North Strathfield place and design principles

7.10.5 Burwood North Station

Integration with strategic planning for the precinct

With Burwood identified as a strategic centre in the Eastern City District Plan (Greater Sydney Commission, 2018c), an opportunity was sought to extend this centre to the north.

To support this plan, a number of plans and strategies have been developed, which have informed the development of the Burwood North Station and guide the future design, as outlined in Table 7-7.

Table 7-7: Integration with strategic planning - Burwood North Station

Plan or strategy	Overview
City of Canada Bay Local Strategic Planning Statement	The City of Canada Bay Strategic Planning Statement (City of Canada Bay Council, 2020) is the core strategic planning document for the Canada Bay local government area. The planning statement prioritises land use opportunities and implications arising from Sydney Metro West. It recognises a station at Burwood North would support the Burwood Strategic Centre and facilitate land use renewal along the Parramatta Road Corridor. Sydney Metro would continue to work with the City of Canada Bay to integrate the station into its wider precinct, taking into account the priorities identified in the Local Strategic Planning Statement.
Draft Burwood Local Strategic Planning Statement	Access would be provided to Burwood North Station from south of Parramatta Road, which is part of the Burwood Council local government area. The Draft Burwood Local Strategic Planning Statement (Burwood Council, 2019) sets a vision for Burwood as a 'great strategic centre with high density, quality urban design and inviting public spaces'. The planning statement advocates for improved transport options for Burwood, with a focus on new north-south transport connections and improved public and active transport options. Burwood North Station would support the development of Burwood as a dual-node centre, supporting the priorities of the Local Strategic Planning Statement. Sydney Metro would continue to work collaboratively with Burwood Council in the development of the station and any planned growth around the station.
Parramatta Road Corridor Urban Transformation Strategy	The Parramatta Road Corridor Urban Transformation Strategy (2016) provides the long term vision and framework to support coordinated employment and housing growth in the Parramatta Road Corridor. Burwood North is identified within the Burwood-Concord Precinct. The vision of Burwood-Concord Precinct is to be a 'commercial gateway to Burwood Town Centre based around an enlivened Burwood Road building upon existing amenity for new residents.' A Sydney Metro West station at Burwood North would provide a second node to the Burwood centre, supporting activation of Burwood Road between Burwood and Concord.
Precinct planning – Homebush, Strathfield & Burwood	In June 2017, DPIE announced Burwood, Strathfield and Homebush as a Planned Precinct. Early investigations began to understand the required infrastructure and open space to meet growing demand. DPIE has now identified these areas will be subject to a collaborative planning approach. This will involve DPIE having a coordination role to facilitate partnerships between the City of Canada Bay, Burwood Council and Strathfield Council and state agencies to drive quality place outcomes. Sydney Metro would continue to work with stakeholders to support planned growth at Burwood North.
Sydney Green Grid	St Lukes Park and Concord Oval Green Link have been identified as a Green Grid project opportunity, which would seek to connect active transport to these key open spaces. The Parramatta Road Urban Renewal Corridor is also identified as a project opportunity, with the potential to improve access to open space along the corridor as renewal occurs. A Sydney Metro West station at Burwood North would support improved access to these open spaces by significantly improve transport connectivity in the area.

Burwood North Station place and design principles

The preliminary place and design principles for Burwood North are:

- Improve amenity north and south of the Parramatta Road with Sydney Metro as a catalyst for positive change
- Facilitate transit-oriented development with public spaces and local services that support the station as a focal point for activity
- Deliver legible, safe and intuitive station entries that address both north and south of Parramatta Road
- Improve the priority and amenity for pedestrians in the area
- Facilitate activation and urban renewal around the station in accordance with the Parramatta Road Corridor Urban Transformation Strategy
- Enable provision of through-site links to enhance permeability in and around the station.

Indicative place and design principles for Burwood North are shown in Figure 7-7.

Figure 7-7 Indicative Burwood North place and design principles

7.10.6 Five Dock Station

Integration with strategic planning for the precinct

The Eastern City District Plan (Greater Sydney Commission, 2018c) identifies Five Dock as a local centre. A number of plans and strategies have been developed, which have informed the development of the Five Dock Station and guide the future design, as outlined in Table 7-8.

Table 7-8: Integration with strategic planning - Five Dock Station

Plan or strategy	Overview
City of Canada Bay Local Strategic Planning Statement	The City of Canada Bay Local Strategic Planning Statement (City of Canada Bay Council, 2020) is the core strategic planning document for the Canada Bay local government area. The planning statement prioritises land use opportunities and implications arising from Sydney Metro West. Key actions include to implement the expansion of Fred Kelly Place and encourage a diversity of dwellings within the vicinity of the Five Dock Town Centre. The planning statement also advocates for walking and cycling connections to be integrated with new metro stations. Sydney Metro West would support an increased diversity of housing near the station, and activate Fred Kelly Place. Sydney Metro would continue to work with the City of Canada Bay to integrate the station into its wider precinct, taking into account the priorities identified in the Local Strategic Planning Statement.
Five Dock Town Centre Revitalisation	The Five Dock Town Centre includes the commercial and retail area along Great North Road, with Fred Kelly Place as the focal point of the community. The Five Dock Town Centre Urban Design Study (City of Canada Bay Council, 2013) aims to ensure that the town centre provides for the community, creates opportunities for investment, is easy to get around and provides an enhanced built environment. Based on the Five Dock Urban Design Study, the City of Canada Bay Council has planned and begun to deliver public domain improvements to encourage activation. This will include an expansion of Fred Kelly Place. The opportunity to generate activity around Great North Road and reinforce Fred Kelly Place was a key consideration in site selection for Five Dock Station. Sydney Metro would work with the City of Canada Bay Council throughout design of Five Dock Station, taking into consideration the principles of the Five Dock Urban Design Study.

Five Dock Station place and design principles

The preliminary place and design principles for Five Dock metro station are:

- Facilitate improved public and active transport accessibility for the community by providing efficient access and interchange
- Respect and contribute to the local character and amenity of the Five Dock Town Centre
- Facilitate an active ground plane along Great North Road and Fred Kelly Place
- Support an enhanced Fred Kelly Place, in consideration of the principles outlined in the Five Dock Town Centre Urban Design Study
- Promote connectivity to and from the station through streets, lanes and public places.

Indicative place and design principles for Five Dock are shown in Figure 7-8.

Figure 7-8: Indicative Five Dock place and design principles

7.10.7 The Bays Station

Integration with strategic planning for the precinct

The Eastern City District Plan (Greater Sydney Commission, 2018c) identifies the Bays Precinct for urban renewal opportunities to transform the Harbour CBD, expanding the innovation corridor of the CBD.

To capitalise this plan, a number of plans and strategies have been developed, which have informed the development of The Bays Station and guide the future design, as outlined in Table 7-9.

Table 7-9: Integration with strategic planning - The Bays Station

Plan or strategy	Overview
Our Place Inner West – Local Strategic Planning Statement	Our Place Inner West (Inner West Council, 2019) is the Local Strategic Planning Statement which sets the land use planning framework for the Inner West Council local government area. One key focus of the Local Strategic Planning Statement is sense of place. With this in mind, the Statement includes priorities to provide for functional, safe and enjoyable urban spaces; and a diverse and increasing urban forest. A key priority of the Statement is to develop diverse and strong stakeholder relationships to deliver positive planning outcomes. This includes working with stakeholders to ensure The Bays develops as a waterfront, sustainable destination with employment, housing and public spaces to support a healthy and vibrant community. Sydney Metro would continue to work with Inner West Council during design development for The Bays Station, taking into account the priorities identified in the Local Strategic Planning Statement.
The Bays Precinct Sydney Transformation Plan	The Bays Precinct Sydney Urban Transformation Strategy (2015) sets out a strategy for the transformation of The Bays Precinct over 25 years. This transformation is envisaged to include a major new mixed use precinct around Glebe Island and White Bay (known as Bays West). This will comprise a new innovation precinct, including employment, civic, retail and residential uses in a high amenity harbour-side setting, while also retaining the deep water berths and critical working harbour facilities. Sydney Metro West would be a catalyst for the transformation of The Bays as envisaged in the Transformation Plan.
Precinct planning – Bays West	Bays West has been identified by DPIE as being subject to a collaborative planning approach. This will involve councils, state agencies and the community working together to drive quality place outcomes. Sydney Metro would work with stakeholders to support planned growth at The Bays.
Sydney Green Grid	White Bay and Blackwattle Bay Foreshore and Open Space are identified as a Green Grid project opportunity, which would improve foreshore access and allow for an increase in open space. Sydney Metro West would significantly improve transport connectivity to this project with a station at The Bays.

The Bays Station place and design principles

The preliminary place and design principles for The Bays metro station are:

- Support the establishment of Bays Precinct by facilitating well-designed high quality station, public domain and development
- Ensure station and precinct designs are coordinated with wider precinct planning frameworks
- Facilitate intuitive and accessible interchange between Sydney Metro and other modes
- Enhance legibility and accessibility through the Bays Precinct by facilitating connections to White Bay Power Station, Anzac Bridge and White Bay
- Promote active street frontages in development around the station to support a vibrant public domain and public amenity in this important harbourside precinct
- Ensure key view corridors frame the new precinct.

Indicative place and design principles for The Bays Station are shown in Figure 7-9.

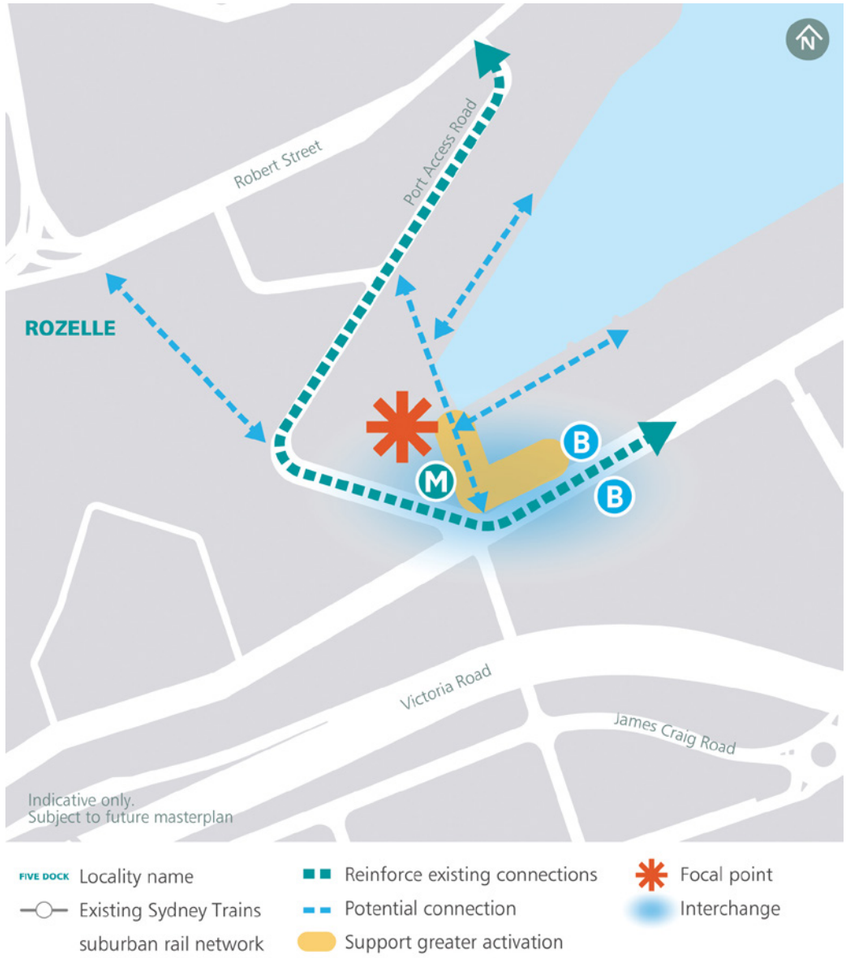

Figure 7-9: Indicative Bays Station place and design principles

7.10.8 Sydney CBD

Integration with local planning

Sydney CBD is the nation's financial and business capital and its connection to the world. A priority of the Eastern City District Plan (Greater Sydney Commission, 2018c) is to continue to grow the CBD stronger and more competitive. Relevant plans and strategies would inform the siting and design of a Sydney CBD station. The location of the Sydney CBD station will be determined following further investigations and community and stakeholder engagement.

City Plan 2036 Local Strategic Planning Statement (City of Sydney, 2020) sets out the 20-year vision for land use planning in the City of Sydney local government area. The planning statement sets priorities to deliver the vision of a 'green, global and connected' city. There is an opportunity for a Sydney Metro West station in the Sydney CBD to support several priorities of the plan, such as movement for walkable neighbourhoods and a connected city; aligning development and growth with supporting infrastructure; creating great places; and a stronger and more competitive Central Sydney. Opportunities to support the Draft Local Strategic Planning Statement would be considered as the Concept is further developed.

Sydney CBD Station place and design principles

The following initial place and design principles have been developed for the Sydney CBD Station. These would be further refined following the determination of a station location:

- Enhance accessibility by supporting a fine grain street network around the station with multiple entry points
- Respond to pedestrian desire lines around the station
- Support clear wayfinding with legible station entries and appropriately scaled spaces around the station and along key pedestrian routes
- Locate station entries to provide accessible and intuitive interchange between active transport, Sydney Metro, Sydney Trains, light rail and buses
- Provide active street frontages to support a vibrant public domain in the heart of the CBD.

7.10.9 Operational ancillary infrastructure – place and design principles

Clyde stabling and maintenance facility

The preliminary place and design principles for the Clyde stabling and maintenance facility are:

- Provide a well designed stabling and maintenance facility to support operations and integrated into its surrounding context
- Provide for the safe and legible staff pedestrian movement within site
- Minimise impact to Duck Creek and support rehabilitation to the riparian corridor adjacent to the site
- Maintain industrial uses on residual land (construction site), including access and integration with the surrounding uses.

Silverwater Services Facility

The preliminary place and design principles for the Silverwater services facility are:

- Provide services facility which is sensitive to its context, respecting the amenity and usability of the surrounding space. The design is to take into account the scale, context and purpose of the structure
- Design should minimise the impact of the built form on the precinct by integrating the facility to the landscape and topography.

7.11 Design process and approach

Development of the Sydney Metro West Concept to date has involved careful consideration of placemaking principles and local and state strategic directions.

In the development of the Concept, Sydney Metro evaluated options for station locations with consideration given to the urban renewal and placemaking opportunities around each potential station (refer to Chapter 3 – Sydney Metro West development and alternatives) as well as alignment with Sydney Metro Design Objectives (Section Reference.3). Early consultation was also undertaken with the community and stakeholders to inform Concept development (refer to Chapter 5 – Stakeholder and community engagement).

Preliminary place and design principles have been prepared for each station location (as detailed in Section 7.10 Precinct considerations) and will be further refined with local council to support the next phase of design.

Detailed design of stations, interchange and public domain elements would be developed and subject to assessment in future application(s). The design of the station and precincts would be informed by objective and principles and feedback from community and stakeholders.

The design development process would be guided by a suite of documents (see Figure 7-10) which include the following:

- Sydney Metro Design Objectives
- Design Quality Framework
- Place and design principles (preliminary principles are included in Section 7.10 Precinct considerations)
- Design guidelines.

These documents, along with community and stakeholder engagement and the establishment of a Design Review Panel will allow for high quality standards throughout the whole design process. At relevant stages in the design process, the design will be reviewed against the place and design principles and the design guidelines.

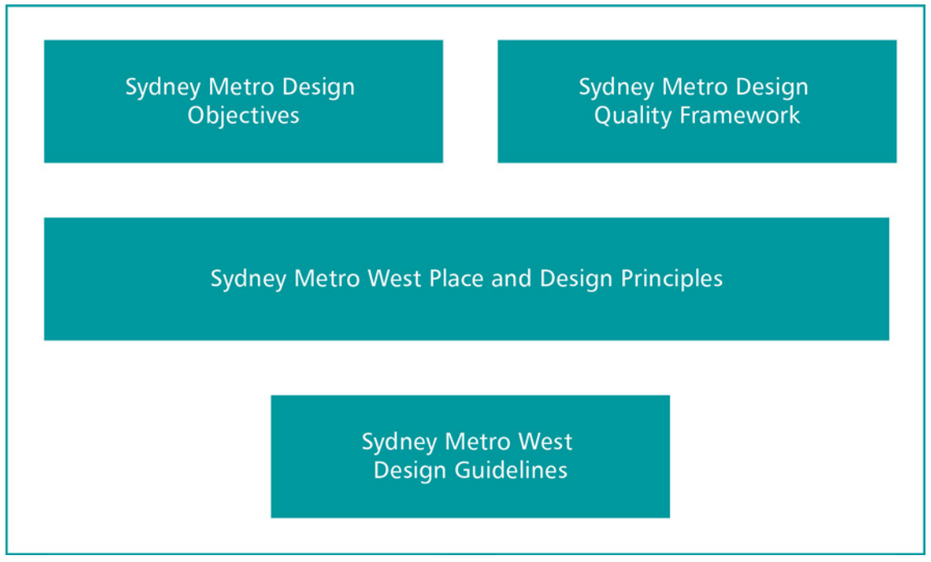

Figure 7-10: Sydney Metro suite of design documents

7.11.1 Design Process documents

Sydney Metro Design Objectives

Sydney Metro has developed five design objectives to help meet the transformational vision and world class aspirations of all Sydney Metro projects.

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

Further detail on these objectives are provided in Section Reference.3.

Sydney Metro Design Quality Framework

Sydney Metro is preparing a Design Quality Framework in consultation with Government Architect NSW. The Framework will establish the design quality assurance process for Sydney Metro projects and is intended to provide a structured process to integrate design quality assurance across the life cycle of the project.

Design quality assurance is important in the delivery of Sydney Metro West given design quality is integral to the achievement of the government's value for money. Design value is a balance of social, economic and environmental factors. For the Sydney Metro West project, these may include: how well the metro performs, how efficient the metro operates and what benefits the metro generates to the community and the environment.

As each Sydney Metro project differs in terms of timing, procurement and delivery, the Design Quality Framework intends to provide a high level process detailing how Sydney Metro ensures high quality design throughout the project lifecycle, regardless of the procurement and delivery strategy.

The components of the framework would include Sydney Metro's:

- Design Quality Statement defining Metro's ambition for design quality
- Design governance protocols
- Internal design gateway process
- Design Review protocol (including a Design Review Panel)
- Design Procurement protocol
- Design Integrity process.

Sydney Metro West Place and Design Principles

Preliminary place and design principles have been developed for each Sydney Metro West station and facility (refer to Section 7.10 Precinct considerations).

Sydney Metro would work with key stakeholders (including relevant local and state government agencies) to refine and implement these principles. These stakeholders would have an important role in ensuring the principles are achieved.

Sydney Metro West Design Guidelines

Design guidelines for Sydney Metro West would be developed to provide direction for the design of stations, transport interchange facilities, landscaping, public domain, rail corridor works and service facilities. The guidelines would be prepared in consultation with local councils and stakeholders ensuring consideration of the local and state strategic directions and urban design strategies.

The Design Guidelines would be appended to the Environmental Impact Statement(s) for future stage(s) of the Concept which include station fit-out and aboveground building construction.

The guidelines would establish the ongoing design approach by guiding the design of the interface between stations and ancillary infrastructure and their surrounding localities, including:

- Station entries
- Transport interchange facilities (bicycle facilities, bus stops, kiss and ride, taxi ranks, and connections to existing rail and light rail infrastructure)
- Landscaping and other public domain elements
- Station service buildings
- Services facilities
- The stabling and maintenance facility.

7.11.2 Design Review Panel

As part of the design process, Sydney Metro would establish a Design Review Panel (DRP) for the Sydney Metro West project. The DRP would provide independent, high level design review of stations and interchange areas, ancillary facilities and integrated station and precinct development.

The objective of the DRP would be to support the achievement of Sydney Metro's design objectives (Section Reference.3) and ensure quality design process and outcomes.

The DRP would support good design by:

- Having a remit which includes stations, ancillary infrastructure and associated integrated station and precinct development
- Providing independent design review of the integrated project throughout the design development
- Refining and endorsing design guidelines
- Reviewing and critiquing the design against the design guidelines.

The role of the DRP would be advisory and its recommendations would not be binding on Sydney Metro. The design of the DRP, including panel, size and membership will be determined in consultation with Government Architect NSW. At a minimum, panel members will include at least one member of the State DRP Panel. Membership will include a mix of skills and disciplines relevant for Sydney Metro West, such as architecture, urban design, placemaking, heritage, public domain and landscape design. The DRP can be supplemented with technical advisors as required.

Sydney Metro would also provide an independent secretariat to support the DRP. The responsibilities of the independent secretariat will include maintaining a register of actions and outcomes. This will allow transparency and accountability to the DRP.

Relevant councils and key stakeholders will be invited to participate in DRP meetings to advise on local issues and design outcomes as they relate to the local context.

7.11.3 Stakeholder engagement

Sydney Metro has commenced engagement with local councils and other relevant stakeholders in each precinct to seek feedback on preliminary place and design principles. Sydney Metro would continue to engage these stakeholders throughout detailed design development.

Sydney Metro is committed to a design approach that includes consultation with relevant government agencies and local councils. An appropriate governance structure will be developed which nominates the parties to be involved. Team members with specialist expertise and knowledge will be selected from government agencies and local councils to consult with Sydney Metro on the station and precinct designs.

Submissions to this Environmental Impact Statement would be considered in detailed design development. The community and stakeholders would also have the opportunity to provide feedback through submissions to future planning approval application(s).

An overview of ongoing and future community and stakeholder engagement and the process for providing submissions is provided in Chapter 5 (Stakeholder and community engagement).

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8 Concept environmental assessment

8 Concept environmental assessment

This chapter describes the existing environment of the Concept, how potential impacts have been avoided or minimised through strategic design, and where impacts have not been avoided, the types of impacts that could be expected during operation and construction of the Concept. Matters to be addressed in future stage applications have been provided.

8.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relevant to the Concept assessment, and reference to where they are addressed in this chapter and in the Environmental Impact Statement, are provided in Table 8-1. Scoping Report requirements are listed in Appendix A. Secretary's Environmental Assessment Requirements relating to the Concept assessment of Place and Design have been addressed in Chapter 7 (Placemaking).

Table 8-1: Secretary's Environmental Assessment Requirements – Concept assessment

Reference	Secretary's Environmental Assessment Requirements	Where addressed
General		
3. Assessment of Key Issues		
3.2	For each Concept key issue, to the extent it relates to the nature of the concept, the Proponent must: a. describe the overarching biophysical and socio-economic environment, as far as it is relevant to that issue;	Sections 8.4 to 8.20
	b. describe the policy context, as far as it is available and relevant to the issue;	
	c. address the listed matters in the 'Key Issues SEARs';	
	d. describe how potential negative impacts have been avoided (through strategic design);	Section 8.3
	e. identify how potential negative impacts that have not been avoided (through strategic design) will be minimised or managed;	Sections 8.4 to 8.20
	f. identification of potential positive impacts or benefits; and	
	g. outline further detailed assessment required to be carried out in subsequent stages (except Stage1).	
Key issues (Concept)		
3. Social and Economic (including property, land use and business impacts)		
3.1	Economic Commitments made in Section 7.11.3 of the Scoping Report, and strategic economic impacts.	Section 8.10
3.2	Social Commitments made in Section 7.10.3 of the Scoping Report, and how the community would experience the Proposal at a strategic level (from environmental, amenity and social changes).	Section 8.11
3.3	Property and Land Use Commitments made in Section 7.5.3 of the Scoping Report, and land use change potentially influenced by the Proposal.	Section 8.8
4. Noise and Vibration		
4.1	Commitments made in Section 7.2.4 of the Scoping Report; and the compatibility of the Concept with the adjoining noise environment.	Section 8.5
5. Transport and Traffic		
5.1	Commitments made in Section 7.1.3 of the Scoping Report.	Section 8.4
6. Aboriginal Heritage		
6.1	Commitments made in Section 7.4.3 of the Scoping Report.	Section 8.7
7. Non-Aboriginal Heritage		
7.1	Commitments made in Section 7.3.3 of the Scoping Report.	Section 8.6
8. Contamination and Soils		
8.1	Commitments made in Section 7.8.3 and 7.9.3 of the Scoping Report.	Sections 8.13 and 8.14
9. Water – Hydrology and Flooding		
9.1	Commitments made in Section 7.12.3 of the Scoping Report, including potential scale of impacts and where the Proposal will need to respond to the existing hydrological environment.	Section 8.15
10. Water - Quality		
10.1	Identify the ambient NSW Water Quality Objectives (NSW WQO) and environmental values for the receiving waters relevant to the Proposal, including the indicators and associated trigger values or criteria for the identified environmental values.	Section 8.13.3
11. Biodiversity		
11.1	Commitments made in Section 7.13.3 of the Scoping Report.	Section 8.16
12. Sustainability		
12.1	The sustainability of the Proposal in accordance with the Infrastructure Sustainability Council of Australia (ISCA) Infrastructure Sustainability Rating Tool and commit to an appropriate target rating.	Section 8.20 Chapter 26 (Sustainability and climate change – Stage 1)
13. Other Issues		
13.1	Air quality, greenhouse gas and energy, climate change adaptation, waste management and resource use, hazard and risk assessments should be undertaken in accordance with the commitments in Section 7 of the Scoping Report.	Sections 8.17, 8.20, 8.18 and 8.19

8.2 Overview

The Concept environmental assessment is generally based on a 'Concept corridor'. This is generally the area shown on Figure 6-1 in Chapter 6 (Concept description) and is defined as the area within which the Sydney Metro West alignment, stations and related infrastructure are likely to be located. For the Sydney CBD, this includes the Sydney CBD investigation area. Where the Concept assessment is based on different areas, this is specifically identified in the relevant section of this Chapter.

The Concept environmental assessment describes the legislative policy context (where available) and the overarching existing environment for each issue. Assessment of potential impacts associated with the Concept involved identifying potential types of impacts associated with each issue during both operation and construction of the Concept, and identifying performance outcomes for the Concept to be implemented during future stages.

Due to the varied nature of the environment within the Concept corridor and the breadth of issues to be assessed, the following three different approaches have been applied to the Concept assessment:

- Urban setting approach, where the types of impacts of a Concept issue would likely depend on the urban setting or broad land use pattern. Urban settings across the Concept corridor include CBDs, suburban areas, urban renewal precincts and industrial or urban services areas

- Natural process or features approach, where the types of impacts of a Concept issue are more likely to depend on the natural setting. This is most relevant for issues related to landscapes and natural sciences such as geology, hydrology, hydrogeology and biodiversity and also for Aboriginal heritage, where Aboriginal cultural patterns tend to follow natural landscapes and Country
- Strategic frameworks and guidelines approach, where the types of impacts of a Concept issue are governed mostly by compliance with relevant policies, guidelines and frameworks, irrespective of the urban or natural setting of the location.

These three approaches to the Concept assessment are described in more detail in Table 8-2.

Potential cumulative benefits and impacts of Concept issues are discussed in Section 8.21.

Table 8-2: Concept assessment approaches

Assessment approach	Description	Relevant assessments
Urban setting	This approach has been applied where the types of impacts would likely be similar within each setting, as the impacts are associated with sensitive receivers or built structures. Where there are similar types of land uses, receivers or commercial/social attributes within the Concept, these have been grouped into the following urban settings: • CBDs – Parramatta and Sydney CBDs. The CBDs are regional focal points for commerce, trade, employment, retail and recreation. They generally consist of medium to high density commercial, retail and residential • Suburban – North Strathfield, Burwood North, Five Dock and the services facility between Five Dock and The Bays. The suburban setting is characterised by a mix of low to medium rise retail, commercial, light industrial and residential uses, along with recreational and open space uses. These facilities are generally the focal point of the local neighbourhood • Urban renewal precincts – Westmead, Sydney Olympic Park and The Bays. Urban renewal precincts are areas of local re-development and/or transformation. They are generally mixed use precincts in the process of going through change from current land uses to new commercial, residential and recreational land uses • Industrial and urban services areas – Clyde and Silverwater. Industrial areas are centres of local industry and employment. They include a mix of general and heavy industrial uses, with industrial built form often including large warehousing buildings, heavy vehicle access roads and loading docks.	• Transport and traffic • Noise and vibration • Non-Aboriginal heritage • Property and land use • Landscape character and visual amenity • Business impacts • Social impacts • Contamination • Air quality.
Natural process or features	This approach has been applied where aspects or likely impacts are more associated with the natural environment or natural processes across the Concept and are generally not categorised by different types of urban settings.	• Aboriginal heritage • Groundwater and ground movement • Soils and surface water quality • Hydrology and flooding • Biodiversity • Hazards.
Strategic frameworks and guidelines	The assessment of spoil, waste management and resource use, and sustainability and climate change, is focussed on the relevant strategic frameworks, policies and guidelines that would be implemented to manage these processes through all stages of the Concept.	• Spoil, waste management and resource use • Sustainability and climate change.

Detailed environmental assessments would be carried out at each stage of the planning process, including:

- Stage 1 – major civil construction works between Westmead and The Bays (refer to Chapters 10 to 26 of this Environmental Impact Statement)
- Future stage(s) - related to major civil construction works from The Bays to the Sydney CBD, station fit-out and aboveground building construction and operation of the metro line (future applications).

8.3 Avoidance and minimisation of impacts

The design development process for the Concept aimed to avoid or minimise potential impacts. This included the following measures:

- Construction methodology:
  - Selection of tunnel boring machines to excavate the mainline tunnels rather than roadheaders. Tunnel boring machines cut a circular profile ideal for a rail tunnel and minimise spoil generation. Tunnel boring machines also operate faster than roadheaders/other excavation machinery, minimising the duration of impacts on the community
  - Selection of The Bays as a tunnel boring machine launch and support site to minimise the need for property acquisition by preferencing government-owned and under-utilised land
  - Selection of tunnel boring machine launch, retrieval and support sites where there is sufficient access to arterial roads, to enable efficient transportation of tunnel boring machines, segments, spoil and other materials, and minimise impact to local streets
  - Locating the stabling and maintenance facility construction site and services facilities within industrial areas where possible, and at distance from residential receivers, where sensitivity to noise, or landscape and visual impacts is lower
  - Inclusion of a concrete segment construction facility at Clyde to allow the manufacture of concrete segments away from sensitive receivers.
- Impacts to existing structures or development:
  - Development of tunnel alignment and surface sites to avoid direct impacts to World and National Heritage listed items and minimise impacts to State and Local Heritage listed items
  - Development of tunnel alignment to avoid underground structures such as major utilities and basements, where possible, and minimise the need to acquire property
  - Consideration of planning and land use plans, policies and strategies during station location selection in order to support planned development.
- Impacts to sensitive receivers:
  - Selection of station locations and locating the majority of the Concept underground to minimise impacts to businesses, residential and other sensitive receivers
  - Selection of sites for stabling, maintenance and services facilities with consideration to minimising potential noise and vibration impacts during both operation and construction by locating the facilities in existing high noise areas, or away from residential receivers.
- Impacts to natural features or processes:
  - Development of a tunnel alignment and site selection for stations and services facilities to avoid direct impacts to previously recorded Aboriginal sites, where possible
  - Inclusion of measures to avoid ongoing groundwater inflow and impacts to groundwater users, including tanking of tunnels and stations at Parramatta, Five Dock and The Bays
  - Development of design to avoid or minimise potential soil and surface water quality impacts where possible. This includes minimising the extent of soil disturbance and avoiding direct impact on watercourses where possible
  - Locating the majority of the Concept underground or in pre-existing built-up areas to largely avoid and/or minimise direct impacts to terrestrial biodiversity.
- Impacts to known hazards:
  - Development of a tunnel alignment and selection of construction sites at Clyde and Silverwater which avoids potential interaction with major hazard facilities, including Viva Energy's Clyde Terminal and associated high pressure fuel pipelines in the locality.

Measures proposed to avoid and/or minimise potential impacts which are specific to Stage 1 are included in the relevant assessment chapters (refer to Chapters 10 to 26).

8.4 Transport and traffic

8.4.1 Legislative and policy context

Traffic modelling for the relevant stages of the Concept would be undertaken in line with Transport for NSW Traffic Modelling Guidelines (2013). The guidelines were developed to provide consistency in traffic modelling practice and promote high quality model outputs.

8.4.2 Assessment approach

This assessment involved:

- Identifying the existing active transport network, public transport network (including rail, bus, light rail and ferry services), regional road network and future planned changes to the transport and traffic network
- Considering the potential impacts of the Concept on the transport and traffic network during the construction and operation of Sydney Metro West
- Consultation with local Councils and other sections of Transport for NSW, including the former Roads and Maritime Services, in regard to transport integration
- Identifying performance outcomes
- Identifying the proposed scope of transport and traffic assessments for future stages.

8.4.3 Existing environment

The Concept corridor contains a number of transport modes, including those described in Table 8-3 and shown on Figure 8-1.

Table 8-3: Transport modes around the Concept

Transport mode	Description
Regional active transport network	The regional active transport network around the Concept consists of footpaths, shared paths, signalised road crossings and cycle networks. Recreational cycle and pedestrian facilities are located: • In Parramatta Park • In Sydney Olympic Park • Along Parramatta River • Along the foreshores of Iron Cove (known as the Bay Run), Rozelle Bay, Blackwattle Bay and Jones Bay. Key off-road cycle corridors include: • Rouse Hill to Parramatta via the North-West Transitway • Liverpool to Parramatta running parallel to the rail line • Parramatta to Sydney Olympic Park running parallel to the M4 Western Motorway • Drummoyne to Sydney CBD via Victoria Road and ANZAC Bridge.
Rail network	Rail services are operated by Sydney Trains and NSW TrainLink, providing connections throughout Sydney, regional NSW and interstate. Major interchanges between rail lines are located at: • Parramatta • Lidcombe • Strathfield • Redfern • Central • Town Hall • Wynyard.
Metro	The Sydney Metro City & Southwest (currently under construction) in the vicinity of the Concept in the vicinity of the Sydney CBD.
Bus network	The bus network generally consists of cross-regional services; services that connect to metropolitan centres and strategic centres; local services that connect to rail stations, shopping centres, school and hospitals; and on-demand services. Major bus corridors in the vicinity of the Concept include: • North-West Transitway • Liverpool to Parramatta Transitway • Windsor Road • Parramatta Road • Victoria Road. Major bus interchanges are located at Parramatta CBD, Strathfield, Burwood, Railway Square and various locations throughout the Sydney CBD.
Light rail	The following light rail lines are within the Concept: • The L1 Dulwich Hill Line operates between Dulwich Hill and Central via Lilyfield and Pyrmont. Light rail stops between Leichhardt North and Central are located in the vicinity of the Concept • The Sydney CBD and south-east light rail operates between Randwick and the Sydney CBD. Various stops are within the vicinity of the Concept throughout the Sydney CBD • Stage one of the Parramatta light rail is currently under construction. Once complete, there will be stations in the vicinity of Westmead and the Parramatta CBD.
Ferry	Ferry services operate along the Parramatta River, including the F3 Parramatta River Line between Parramatta and Circular Quay via Sydney Olympic Park and Balmain. Ferry stops located in the vicinity of the Concept include Parramatta, Rydalmere and Sydney Olympic Park.

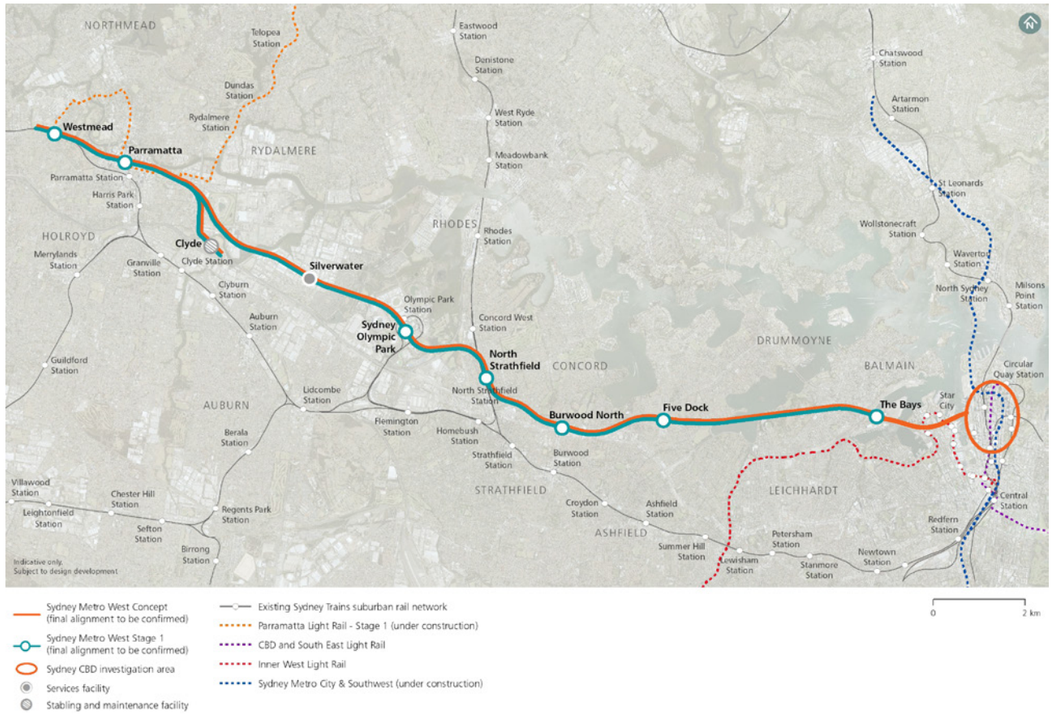

Figure 8-1: Existing public transport network surrounding the Concept corridor

The road network in the vicinity of the Concept is well-established. Most major roads carry high traffic volumes and experience significant congestion, particularly during peak periods. Motorways and principal arterial roads include (refer to Figure 8-2):

- The M4 Western Motorway, which is the major east-west high-capacity and high-speed corridor linking the Blue Mountains and Western Sydney with Sydney CBD
- The A4/A44 corridor consisting of Great Western Highway, Parramatta Road, City West Link and ANZAC Bridge, which is an alternative east-west corridor linking Western Sydney with Sydney CBD
- The A40 corridor consisting of Old Windsor Road, parts of James Ruse Drive and Victoria Road, which links Parramatta with the Hills District and Sydney CBD
- The A6 corridor, including Silverwater Road, which is a major north-south corridor linking Heathcote and Carlingford via Bankstown and Silverwater
- The A3 corridor, including Homebush Bay Drive, which is a major north-south corridor linking Blakehurst and Mona Vale via Hurstville, Ryde, Macquarie Park and Pymble
- WestConnex M4-M5 Link and Rozelle interchange (currently under construction) which will link the M4 and M5, along with connections to other major arterial roads such as the City West Link and Victoria Road.

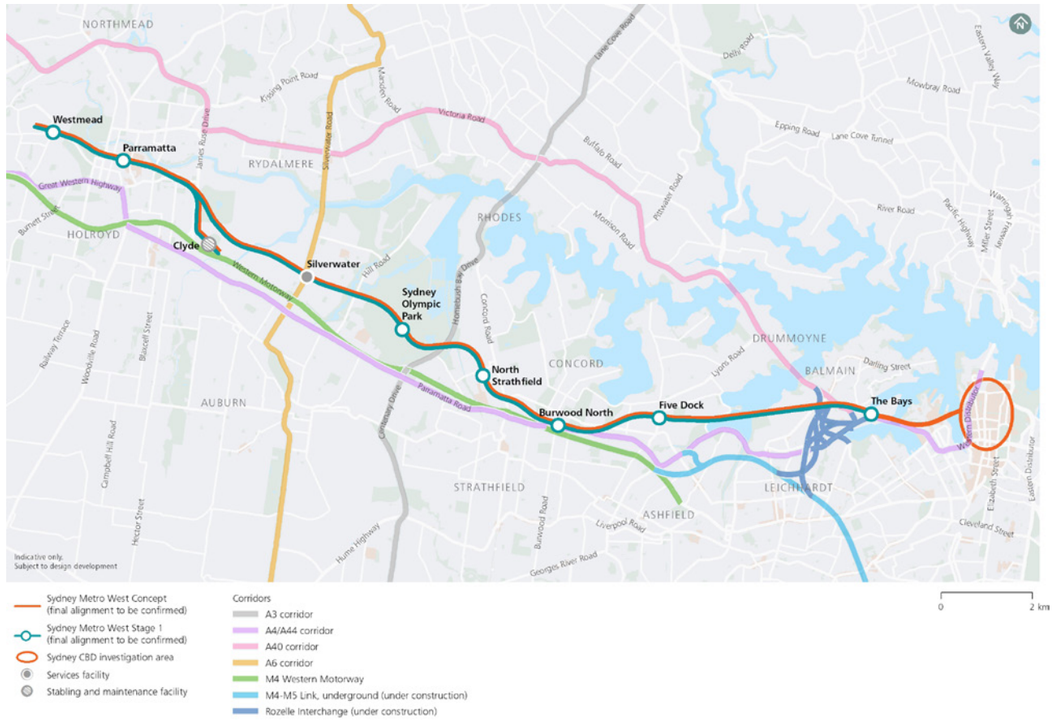

Figure 8-2: Road network surrounding the Concept corridor

The transport network is undergoing significant change to support the Greater Sydney Commission's vision for Greater Sydney as a metropolis of three cities, where people have access to jobs and services within 30 minutes by public transport. The substantial investment in the transport network seeks to respond to the challenges that will reshape Greater Sydney and the way people and goods move as population and employment continues to grow.

Key transport initiatives currently planned for within or adjacent to the Concept corridor include the Western Harbour Tunnel & Beaches Link.

The existing transport and traffic conditions within the Concept corridor are described in Table 8-4.

Table 8-4: Existing transport and traffic environment

Urban setting	Existing transport and traffic
CBDs • Parramatta • Sydney	The urban centres of Parramatta and Sydney CBDs have high pedestrian volumes which are well catered for through footpaths, shared paths and signalised road crossings. The urban centres are well serviced by public transport options with the T1 Western Line providing a connection between the Parramatta and Sydney CBDs. The Sydney CBD provides access to the Greater Sydney rail network, along with regional and interstate services. Both urban centres are serviced by ferry services, including the F3 Parramatta River Line. Light rail services are operating within the Sydney CBD and under construction in the Parramatta CBD. Parramatta and Sydney CBDs have well established road networks connecting the centres to the greater Sydney area and the Blue Mountains. Key links include the A4/A44 corridor, the A40 corridor and the M4 Western Motorway. Both Parramatta and Sydney CBDs are well serviced by both local and regional bus routes, with major interchanges near Parramatta Station and at various locations within the Sydney CBD.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	There are relatively high pedestrian volumes within the suburban settings, particularly within local town centres including North Strathfield and Five Dock. Pedestrians are generally catered for through footpaths, shared paths and signalised road crossings. The suburban centres are serviced by a number of public transport modes. North Strathfield is on the T9 Northern Line with Burwood North and Five Dock currently serviced by the regional bus network. The light rail services parts of Lilyfield and Rozelle. Arterial roads such as Parramatta Road, Victoria Road and the City West Link provide the major east-west network connection, with main roads such as Great North Road, Balmain Road and Concord Road providing north-south connections. There is generally direct access from the local road network to surrounding private properties, along with street access to commercial and retail properties. On-street parking is available at each of the suburban centres.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	There are well established pedestrian and cycle networks within Westmead and Sydney Olympic Park. High levels of pedestrian activity occur around the existing railway station and the health and education precinct in Westmead and within Sydney Olympic Park during special events. Pedestrian activity within the proposed site at The Bays is low given the port and industrial land uses present. However, there is a well-developed pedestrian network in the surrounding suburbs such as Rozelle, Balmain, Glebe and Annandale. The cycle network surrounding The Bays is well established with provision of a number of off-road shared paths and on-road cycle routes. Westmead is serviced by the T1 Western Line and T5 Cumberland Line services, along with some NSW TrainLink Blue Mountains Line services. Sydney Olympic Park is on the T7 Olympic Park Line which is connected to the T1 Western Line at Lidcombe. All precincts are serviced by local bus services. Westmead and Parramatta are also serviced by T-way bus services. Established road networks are present within each of the precincts, providing access to arterial roads and motorways such as the A4/A44 corridor and M4 Western Motorway. Car parking availability is generally associated with surrounding community facilities, such as Westmead hospital and sporting facilities within Sydney Olympic Park. Limited on-street parking is also available for public use.
Industrial and urban services • Clyde • Silverwater	There is limited pedestrian and cycle access within the industrial centres of Clyde and Silverwater. There are no railway stations in the vicinity of the industrial areas and there are limited bus services to these areas. The road network is important within these areas as the main mode of transportation. Key network connections include Silverwater Road and Parramatta Road. Parking is generally in dedicated carparks associated with industrial and business enterprises.

8.4.4 Potential operational benefits and impacts

Sydney Metro West would deliver a number of significant transport and traffic benefits. Chapter 2 (Strategic need and justification) details how these align with regional strategic plans and Chapter 7 (Placemaking) details how these align with local strategic plans These benefits are summarised as follows:

- Increased capacity and reliability of Sydney's rail network
- Improved travel times and customer comfort between key destinations within the Greater Parramatta to Sydney CBD corridor
- Reduced crowding on trains and at some stations on the existing Sydney rail network
- Improved journey times for bus customers and other road users
- Improved connectivity and transfer opportunities between public transport modes.

To provide integration of transport modes at metro stations, there may also be alterations to the transport and traffic network during operation. This may include potential changes to:

- Traffic arrangements on the surrounding road network due to required changes to local roads or traffic light phasing
- Availability, location or number of loading zones and/or parking spaces
- Pedestrian and cyclist arrangements, which are expected to be primarily positive
- Property access arrangements
- Bus stop locations, routes and timetables
- Special event access arrangements
- Emergency vehicle access arrangements.

Where possible, the design would aim to avoid or reduce impacts associated with operational transport and traffic.

The potential operational transport and traffic benefits and impacts for each setting within the Concept corridor are described in Table 8-5. Cumulative impacts are discussed in Section 8.21.

Table 8-5: Potential operational transport and traffic benefits and impacts

Urban setting	Potential operational benefits and impacts
CBDs • Parramatta • Sydney	Improved pedestrian and cyclist arrangements would likely be required to provide safe and convenient access and egress from the new metro stations within the Parramatta and Sydney CBDs. These improvement would be made as part of station design and placemaking objectives. There is also potential for permanent changes to property access for commercial and retail properties located adjacent to the stations due to altered pedestrian routes, removal or relocation of parking or loading zones, and changes to traffic conditions.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Improved pedestrian and cyclist arrangements would likely be required to access the new metro stations at North Strathfield, Burwood North and Five Dock. Station designs would take into account the need for pedestrian and cyclist integration with the surrounding network and provide safe, high quality and clearly signposted walking paths to stations, and between the stations and other transport modes. There would likely be some loss of on-street parking in the immediate vicinity of the stations, as well as loss or relocation of loading zones. Permanent changes to bus stop locations, routes and timetables may be required to better integrate the new metro service with the existing public transport network and continue to provide safe, convenient transitions between modes of transport. There is also potential for permanent changes to property access, particularly for adjacent commercial and retail properties, due to altered pedestrian routes, removal or relocation of parking or loading zones, and changes to traffic conditions.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Improved pedestrian and cyclist arrangements would likely be required to access the new metro stations at Westmead, Sydney Olympic Park and The Bays. These would allow for ease of access, along with improved pedestrian and cyclist safety and accessibility. There is also potential for changes to the local road networks around Westmead and Sydney Olympic Park. These may require some localised and minor changes to the emergency access arrangements to Westmead Hospital and special event access arrangements to Sydney Olympic Park.
Industrial and urban services • Clyde • Silverwater	Permanent changes to traffic arrangements have the potential to result in some minor impacts on workers, customers and visitors to industrial and business premises. There may be impacts to car parking, due to the lack of public parking facilities and reliance on on-street parking in these locations.

8.4.5 Potential construction impacts

Potential construction transport and traffic impacts would be appropriately managed in accordance with the performance outcomes in Section 8.4.6. Construction sites would be managed in accordance with the Construction Environmental Management Framework (CEMF) and Construction Traffic Management Framework (CTMF). The CEMF is a Sydney Metro project framework which sets out the environmental, stakeholder and community management requirements for construction. The CTMF provides an overall strategy and approach for construction traffic management for Sydney Metro West, and an outline of the traffic management requirements and processes that would be common to each of the proposed construction sites. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

Potential transport and traffic impacts anticipated to occur during the construction of the Concept include:

- Temporary changes to traffic performance on the road network in some locations around construction sites including a reduction in the level of service at some intersections due to construction vehicle access and egress from site, delivery of construction materials, spoil haulage routes and temporary road or lane closures
- Temporary changes to on-street parking or removal or relocation of loading zones, servicing access, taxi ranks, and/or kiss and ride areas
- Temporary removal or relocation of existing bus stops
- Temporary delays or other impacts to existing bus services including the potential diversions of bus services and/or the need to change bus timetables
- Temporary changes to pedestrian and cyclist access or flows including potential diversions. This would also include potential temporary altered access to and from the existing Westmead and North Strathfield stations
- Temporary access changes to private properties
- Increased construction vehicles on roads around construction sites and potential conflicts with motorists, pedestrians and cyclists, particularly in the Parramatta and Sydney CBDs
- Temporary changes to emergency access arrangements
- Temporary access changes during special events
- Temporary changes to the availability of rail services to allow works to occur safely within the rail corridor. These works would occur during planned rail possessions, generally at night or on the weekend, although some extended rail possessions may be required.

Impacts to regional road networks and public transport routes are not expected during construction. If construction is required within the existing rail corridor, or where work in the vicinity of existing railway stations cannot be undertaken safely with trains operating, these activities would be undertaken during scheduled rail possessions to minimise disruption to suburban and intercity rail services.

The potential construction transport and traffic impacts for each land use type within the Concept corridor are described in Table 8-6. Cumulative impacts are discussed in Section 8.21.

Table 8-6: Potential construction transport and traffic impacts

Urban setting	Potential construction impacts
CBDs • Parramatta • Sydney	Construction in the vicinity of existing railway stations has the potential to temporarily impact on the reliability of suburban and intercity rail services. These activities would be undertaken during scheduled rail possessions to minimise disruption to services.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Construction within the suburban setting would likely temporarily impact on the surrounding road network due to the requirement for heavy vehicles, construction equipment and construction personnel to access the sites. It is also likely that there would be temporary loss of on-street parking in the immediate vicinity of the construction sites. Reduced and/or altered pedestrian and cycle access may be temporarily required to provide ongoing public safety and access to nearby businesses and transport connections. Bus stops, taxi ranks and/or kiss and ride areas may require temporary relocation. Construction traffic and temporary road diversions may also result in delays to local bus services or require route diversions. Construction in the vicinity of the existing railway station at North Strathfield has the potential to temporarily impact on the reliability of suburban and intercity rail services. These activities would be undertaken during scheduled rail possessions to minimise disruption to services. There is also the potential for temporary changed access arrangements at North Strathfield Railway Station however, access would be maintained. There may also be the need to provide temporary alternative access to private properties and businesses where there are disruptions to local roads and access points.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Construction within the urban renewal precincts would likely have temporary impacts on the surrounding road network due to the requirement for heavy vehicles, construction equipment and construction personnel to access the sites. There may also be temporary loss of on-street parking in the immediate vicinity of the construction sites. Reduced and/or altered pedestrian and cycle access may be temporarily required to provide ongoing public safety and access to nearby businesses and transport connections. Bus stops, taxi ranks and/or kiss and ride areas may require temporary relocation. Construction traffic and temporary road diversions may also result in delays to local bus services or require route diversions. Construction in the vicinity of the existing railway station at Westmead has the potential to temporarily impact on the reliability of suburban and intercity rail services. These activities would be undertaken during scheduled rail possessions to minimise disruption to services. There is also the potential for temporary changed access arrangements at Westmead Railway Station however, access would be maintained. There may also be the need to provide temporary alternative access to private properties and businesses where there are disruptions to local roads and access points. Alternate access for emergency vehicles accessing Westmead Hospital may be required to avoid temporary road closures or diversions due to construction traffic or activities. Temporary changes to special event access may also be required at Sydney Olympic Park.
Industrial and urban services • Clyde • Silverwater	Access to the industrial areas is heavily reliant on the local road network. Construction traffic has the potential to temporarily reduce the level of service at surrounding intersections and increase the number of heavy vehicles on local and main roads surrounding the sites. Due to increased construction traffic, there is also the potential for temporary delays to existing bus services and potential diversions of bus services.

8.4.6 Performance outcomes

Identified performance outcomes in relation to transport and traffic for operation and construction of the Concept are provided in Table 8-7.

Table 8-7: Transport and traffic performance outcomes

Operational performance outcomes	Construction performance outcomes
• The modal access hierarchy is implemented at stations • Sufficient customer capacity in stations and station plazas is provided to limit crowding or queuing in accordance with Fruin's Level of Service C (for 2056 demand) • Stations and interchanges are fully accessible and compliant with the *Disability Discrimination Act 1992* and the Disability Standards for Accessible Public Transport 2002.	• Construction traffic and transport impacts on special events are minimised • Safe routes for pedestrians and cyclists are provided around construction sites • Safe access to properties is maintained • Road occupancy is minimised, particularly in the Parramatta and Sydney CBDs • Changes to the travel paths of road users, including bus routes, are minimised • Affected emergency services and public transport operators are provided early communication on changes in traffic conditions • Loss of on-street parking and loading zones is minimised • Heavy vehicle routes are developed in consultation with Sydney Coordination Office and relevant parts of Transport for NSW • The use of local roads by heavy vehicles is minimised • Safe access and egress is provided to and from construction sites.

8.4.7 Matters to be addressed in staged applications

Transport and traffic impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Transport and traffic assessments will include, as relevant to the stage:

- Assessment of construction traffic including number, frequency and size of construction-related vehicles, potential routes for construction traffic and spoil haulage, and impact on existing traffic conditions
- Assessment of access constraints and impacts on public transport, pedestrians, cyclists and road network performance arising from construction
- Assessment of cumulative traffic impacts
- Consideration of operational maintenance access requirements
- Assessment of how the transport network supports placemaking outcomes
- Assessment of the performance of existing and future operational transport network for all modes, including analysis of travel times
- Assessment of intersection performance during operations at locations where changes are required to facilitate access to new stations
- Consideration of opportunities to improve public transport links to stations
- Consideration of opportunities to integrate cycling and pedestrian elements with surrounding networks
- Further consultation with local Councils and other sections of Transport for NSW.

An assessment of transport and traffic impacts for Stage 1 is provided in Chapter 10 (Transport and traffic – Stage 1).

8.5 Noise and vibration

8.5.1 Legislative and policy context

The policy context for noise and vibration within the Concept is outlined in Table 8-8.

Table 8-8: Noise and vibration policy

Guideline/policy name	Description
Rail Infrastructure Noise Guideline (NSW Environment Protection Authority, 2013)	The Rail Infrastructure Noise Guideline was developed to ensure that potential noise impacts associated with rail infrastructure projects are managed effectively. The guideline specifies noise and vibration trigger levels and applies to both heavy and light rail infrastructure projects, including the construction of new rail lines.
Noise Policy for Industry (NSW Environment Protection Authority, 2017)	The Noise Policy for Industry (NSW Environment Protection Authority, 2017) replaced the NSW Industrial Noise Policy (NSW Environment Protection Authority, 2000). The policy applies to noise from stations and ancillary facilities.
NSW Road Noise Policy (Department of Environment, Climate Change and Water, 2011)	The NSW Department of Planning, Industry and Environment's Road Noise Policy (Department of Environment, Climate Change and Water, 2011) aims to identify the strategies that address the issue of road traffic noise and defines criteria to be used in assessing the impact of such noise. This policy applies to any roads that require reconfiguration as part of the Concept.
Sydney Metro Construction Noise and Vibration Standard (Transport for NSW, 2020)	The Sydney Metro Construction Noise and Vibration Standard sets out the assessment and management protocols for construction of Sydney Metro projects. The standard is based on the requirements of the NSW Environment Protection Authority's Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009), as appropriate to Sydney Metro.
Assessing Vibration: a technical guideline (Department of Environment and Conservation, 2006)	The NSW Environment Protection Authority's Assessing Vibration: a technical guideline (Department of Environment and Conservation, 2006) presents preferred and maximum vibration values that should not be exceeded; and recommends effective measurement and evaluation techniques. It is based on guidelines contained in BS 6472-1992, Evaluation of human exposure to vibration in buildings (1-80 Hz). The guideline applies to the assessment of vibration for the Concept.
Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (Australian and New Zealand Environment Council, 1990).	The NSW Environment Protection Authority's Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009) requires vibration and overpressure from blasting to be assessed against this guideline. Criteria in the ANZECC standard are, however, applicable to long-term operations, such as those at mining sites. The Sydney Metro CNVS recognises the restrictive nature of the ANZECC criteria and recommends have applied the following vibration and overpressure limits (as outlined in the Sydney Metro CNVS): • Vibration (PPV): 25 mm/s • Overpressure: 125 dBL.

8.5.2 Assessment approach

This assessment involved:

- Describing the existing noise environment surrounding the Concept corridor, including the types and sensitivity of receivers in the area surrounding the Concept
- Identifying features of the Concept which have the potential to produce noise and vibration impacts, including station sites, services facilities, stabling and maintenance facilities, tunnels and road reconfigurations
- Undertaking a qualitative assessment (see below) of the potential noise and vibration impacts due to construction and operation of the Concept
- Consultation with the NSW Environment Protection Authority to discuss the approach to the noise and vibration assessment
- Identifying performance outcomes
- Identifying the proposed scope of noise and vibration assessments for future stages.

As the Concept noise and vibration assessment is qualitative (i.e. no modelling has been undertaken), potential impacts are described in terms of the likely subjective response of people affected by the impacts during standard construction hours. These are described further in Chapter 11 (Noise and Vibration – Stage 1). The ratings have been applied based on experience on similar projects, such as Metro North West Line, and are representative only of potential exceedances that may be experienced during operation and construction of the Concept.

8.5.3 Existing environment

The existing noise environment varies along the length of the Concept. Sources of background noise within the Concept corridor are described in Table 8-9.

Table 8-9: Sources of background noise within the Concept corridor

Noise source	Description
Road traffic noise	Road traffic noise is the main source of existing noise within the Concept corridor, with most stations and facilities located in urban areas within 100 metres of busy roads.
Suburban rail lines and stations	There are existing rail lines and stations near Westmead, Parramatta, Sydney Olympic Park and North Strathfield metro station sites and the Clyde stabling and maintenance facility.
Aircraft noise	Much of the Concept corridor is under flight paths and affected by aircraft noise. The noise levels vary depending on proximity to the airport, with areas such as the Inner West experiencing higher and more frequent aircraft noise.
Industrial areas	There are several industrial areas within and adjacent to the Concept corridor that generate noise, such as Clyde, Silverwater and The Bays.
Commercial areas	Noise is generated from commercial areas within and adjacent to the Concept corridor in areas such as Westmead, Parramatta, Silverwater, Five Dock, and Sydney CBD.
Occasional/sporting events	Noise is generated from occasional and sporting events at facilities such as at Western Sydney Stadium (Parramatta), Rosehill Gardens racecourse, Sydney Speedway (location on NSW Government owned land), Sydney Olympic Park, Concord Oval and Leichhardt Oval.

Potential noise and vibration sensitive receivers are within the Concept corridor and depending on location, they could include residential, 'other sensitive' (i.e. schools, childcare centres, places of worship, medical facilities and recreation areas), commercial and industrial uses. Types of sensitive receivers are discussed in Table 8-10.

Table 8-10: Ambient noise environment and types of sensitive receivers around the Concept corridor

Urban setting	Ambient noise environment and types of sensitive receivers
CBDs • Parramatta • Sydney CBD	The CBD areas are generally high noise environments, particularly during weekdays. The noise environment is dominated by traffic and transport noise, along with noise from other construction activities. The CBD areas are dominated by commercial and retail uses, with large numbers of receivers. There is a mix of residential receivers within the Parramatta CBD, with high density residential dwellings/buildings closer to the centre of the CBD, and low-medium density on the edges of the CBD area. There are multi-level high density residential dwellings/buildings within the Sydney CBD. Other types of receivers include schools, childcare centres, places of worship, medical facilities, recreation areas, hotels, restaurants/bars and cafes.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Noise in the suburban settings is dominated by traffic and transport noise, with some aircraft noise. The main receivers within the suburban areas are residential comprising a mix of low to medium density. Other types of receivers include schools, childcare centres, places of worship, medical facilities, restaurants/bars, cafes and recreation areas. There are numerous commercial receivers near: • The existing railway station at North Strathfield • Along the Parramatta Road corridor at Burwood North • Surrounding Great North Road at Five Dock.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	The existing noise environments within the urban renewal precincts are reflective of the existing land uses, such as existing commercial enterprises and transport facilities at Westmead, large scale sporting and entertainment events at Sydney Olympic Park and industrial activities at The Bays. There are low to medium density residential areas near Westmead and The Bays, and multi-level high density residential also at Westmead and Sydney Olympic Park. Other types of receivers include schools, childcare centres, places of worship, medical facilities (including the Westmead health and education precinct), restaurants/bars, hotels, cafes and recreation areas. There are numerous commercial receivers near the existing railway stations at Westmead and Sydney Olympic Park. The Bays has some commercial/industrial receivers associated with White Bay, Glebe Island and Rozelle Bay.
Industrial and urban services areas • Clyde • Silverwater	The Clyde and Silverwater areas are dominated by industrial and commercial receivers. The noise environment is generally higher due to existing industrial activities.

8.5.4 Potential operational benefits and impacts

It is expected that the Concept can be designed to meet relevant operational noise and vibration guidelines including:

- The Rail Infrastructure Noise Guideline in relation to potential airborne noise, ground-borne noise and vibration impacts
- Assessing vibration: a technical guidelines (Department of Environment and Conservation, 2006) in relation to potential human comfort vibration impacts to vibration impacts to sensitive equipment
- The Noise Policy for Industry (EPA, 2017) in relation to potential noise from fixed facilities such as station and services facilities.

Where there is the potential for ground-borne noise and vibration impacts from operational rail lines in tunnels, the use of resilient track forms would be considered. There are several types of resilient track form that may be used, depending on the likely level of impact at locations along the Concept corridor. The need for resilient track forms would also depend on the extent of the predicted ground-borne noise and vibration impacts (to be determined during future stage assessments), which can be influenced by a range of operational factors including train speed, tunnel depth, tunnel design and position of track turnouts.

Permanent reconfigurations of existing roads may be required surrounding some of the proposed stations and facilities. This has the potential to affect receivers near to these altered roads. Any potential impacts would be assessed during later design stages and mitigated in line with the NSW Department of Planning, Industry and Environment's NSW Road Noise Policy (Department of Environment, Climate Change and Water, 2011a).

Following assessment in future stages, the need for appropriate noise attenuation measures at stations and services facilities would be determined, such as equipment selection, positioning of plant and ventilation discharges, in-duct attenuators, and acoustic enclosures.

In addition to these, the potential operational noise and vibration benefits and impacts associated with new infrastructure within each setting in the Concept are outlined in Table 8-11. Cumulative impacts are discussed in Section 8.21.

Table 8-11: Potential operational noise and vibration benefits and impacts

Urban setting	Potential operational benefits and impacts
CBDs • Parramatta • Sydney CBD	The new station sites within the Parramatta and Sydney CBDs would mostly be underground, however aboveground elements such as ventilation systems and mechanical services have the potential to introduce new sources of airborne noise. Given the existing high noise environment of the CBD areas, any impacts are expected to be minimal and mitigated to comply with the Noise Policy for Industry (EPA, 2017). Standard engineering solutions would be designed and implemented to control operational impacts in order to comply with all relevant noise and vibration criteria. Solutions may include selection of low noise systems, enclosure of noisy items, or transmission path controls such as noise barriers.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock to The Bays	The new station sites within suburban settings would mostly be underground, however aboveground elements such as ventilation systems and mechanical services have the potential to introduce new sources of airborne noise. Potential impacts within suburban settings may be slightly higher than in the CBDs due to the lower ambient noise levels, however impacts are still expected to be minimal and able to be mitigated to comply with the Noise Policy for Industry (EPA, 2017). The services facility between Five Dock and The Bays would mostly be underground, however above ground elements have the potential to introduce new sources of airborne noise. Given this is an existing high noise area, any impacts are expected to be minimal and comply with the Noise Policy for Industry (EPA, 2017). Standard engineering solutions would be designed and implemented to control operational impacts in order to comply with all relevant noise and vibration criteria. Solutions may include selection of low noise systems, enclosure of noisy items, or transmission path controls such as noise barriers.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Within the urban renewal precincts, aboveground elements such as ventilation systems and mechanical services associated with new station sites have the potential to introduce new sources of airborne noise. Impacts are expected to be minimal and able to comply with the Noise Policy for Industry (EPA, 2017). With the implementation of standard engineering solutions, it is expected that any impacts would be minimal and comply with all relevant noise and vibration criteria. Solutions may include selection of low noise systems, enclosure of noisy items, or transmission path controls such as noise barriers.

Urban setting	Potential operational benefits and impacts
Industrial and urban services areas • Clyde • Silverwater	Operational noise from the proposed stabling and maintenance facility at Clyde, which includes maintenance areas that can generate high noise levels, has the potential to impact the surrounding receivers. The design of the site would consider options to minimise operational noise impacts such as positioning of noise generating facilities away from site boundaries and provision of noise barriers if required. It is anticipated the operational procedures for the stabling and maintenance facility would include noise management measures such as no horn testing as part of train departure. The facility is expected to operate 24 hours per day, 7 days per week but is in an area of high existing noise levels. Given this is an existing high noise area and located away from residential receivers, it is expected that any impacts would be minimal. The services facility at Silverwater would mostly be underground, however above ground elements have the potential to introduce new sources of airborne noise. Given this is an existing high noise area, any impacts are expected to be minimal and comply with the Noise Policy for Industry (EPA, 2017). With the implementation of appropriate engineering and management measures, it is expected both locations would comply with all relevant noise and vibration criteria. Solutions may include selection of low noise systems, enclosure of noisy items, or transmission path controls such as noise barriers.

8.5.5 Potential construction impacts

Potential construction noise and vibration impacts would be temporary and appropriately managed in accordance with the performance outcomes in Section 8.5.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

The NSW Environment Protection Authority's Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009) acknowledges that due to the nature of construction works, it is inevitable that there will be impacts where construction is near to sensitive receivers. The principal contractors appointed to construct each stage would be required to implement and adhere to the requirements of the Sydney Metro Construction Environmental Management Framework and Construction Noise and Vibration Standard which sets out the environmental, stakeholder and community management requirements for construction.

Where noise management level exceedances are predicted for works during the more sensitive out-of-hours periods or for works that would be conducted over a long period of time, all potentially feasible and reasonable mitigation measures would be considered to reduce predicted noise management level exceedances as far as possible. This would likely include the use of acoustic sheds or other acoustic measures at locations where construction works would regularly be undertaken 24 hours per day, 7 days per week.

Reduction of construction ground-borne noise and vibration impacts may require consideration of alternative construction methodologies such as the use of controlled blasting in lieu of continuous rock breaking.

The level of impact on sensitive receivers during construction would be dependent on a number of factors including distance of individual sensitive receivers to construction activities, the nature of the construction activities, and the time of day or night that the activities take place.

Excavation of the tunnels would be performed by tunnel boring machines on a 24 hours per day, 7 days per week basis. Ground-borne noise impacts are generally not expected for receivers where the tunnel is more than 50 metres deep. Where tunnel depth is less than 50 metres, ground-borne noise impacts from tunnelling during the daytime are predicted to generally be compliant with noise management levels or result in only 'minor' temporary impacts. There is potential for 'moderate' temporary ground-borne noise impacts near proposed construction sites as this is where tunnel depth would be shallowest. Given that night-time noise management levels are more stringent, there is potential to temporarily exceed the night-time ground-borne noise management level where tunnel depth is less than 25 metres. This exceedance would only be expected to occur in any one location for a few days, depending on the rate of progress of the tunnel boring machines.

Roadheaders and rockbreakers are likely to be used for the excavation of caverns, cross passages and the connecting tunnels to the stabling and maintenance facility. Depending on excavation method, geological conditions and depth, this has the potential to result in temporary ground-borne noise and vibration impacts.

While temporary exceedances of human comfort vibration management levels may occur above some tunnel sections, it is unlikely that there would be exceedances of cosmetic damage screening criteria.

In some circumstances, controlled blasting may be used to reduce the duration of potential noise impacts. Blasting would be managed to meet relevant criteria, including the limits stated in the Sydney Metro CNVS (refer to section 8.5.1).

There is potential for vibration sensitive medical and manufacturing equipment to be temporarily affected during the excavation of tunnels, cross passages, and caverns, however these impacts would be limited to the short time frame where tunnelling construction passes under the affected receiver or during short-term vibration intensive works.

Construction of new metro stations and services facilities would generally include the following activities:

- Site clearing and demolition of existing structures
- Excavation of shafts and station boxes including spoil handing
- Civil works and earthworks.

The use of highly noise and vibration intensive equipment, such as rockbreakers, would be required during certain periods, which has the potential to result in temporary impacts to nearby receivers. While most of these works would likely occur during standard daytime construction hours, some works may be required to be completed during out-of-hours construction periods.

Heavy vehicles would be required to transport spoil away from surface construction sites and for the delivery of construction materials. Deliveries and spoil haulage may be required during out-of-hours construction hours to minimise impacts on the local road network and allow for delivery of oversized plant, equipment and materials. There is potential for temporary impacts where haulage routes are along local roads and required during out-of-hours periods.

Permanent reconfigurations of existing roads may be required surrounding some of the proposed stations and facilities. This would likely require works during both standard daytime hours and out-of-hours works periods to minimise impacts on the surrounding road network. This has the potential to temporarily impact receivers near the proposed road work. Where high noise construction equipment is required to be used, there is the potential for wider noise management level exceedances.

Potential construction noise and vibration impacts by receiver type within each setting in the Concept are discussed in Table 8-12. Cumulative impacts are discussed in Section 8.21.

Table 8-12: Potential construction noise and vibration impacts

Urban setting	Potential impacts
CBDs • Parramatta • Sydney CBD	Noisy works, such as rock breaking and piling during excavation of shafts and station boxes, have the potential to generate temporary noise impacts that may exceed noise management levels during both standard and out-of-hours work. This may impact on commercial and other sensitive receivers adjacent to the proposed station sites. Impacts may be greater during out-of-hours works when the ambient noise environment is quieter, with the potential to affect residential receivers, along with late night/weekend commercial and retail operations, such as restaurants/bars and cafes, as well as recreation areas. Where possible, these activities would be undertaken during standard hours to minimise potential impacts. Tunnelling activities within the CBD areas also have the potential to generate temporary vibration impacts on sensitive receivers such as research and medical facilities, particularly near the proposed station sites where tunnel depths would be shallower. Noise management measures to reduce impacts at surrounding sensitive receivers would need to be considered for any long-term out-of-hours works.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Noisy works, such as rock breaking and piling during excavation of shafts and station boxes, have the potential to generate temporary high noise impacts during both standard and out-of-hours work. This may impact on commercial and other sensitive receivers adjacent to the proposed station sites. Other construction activities, such as demolition of existing structures, may also generate moderate noise impacts. Where possible, these activities would be undertaken during standard hours to minimise potential impacts. However, there may be the need to undertake activities out-of-hours for safety reasons or to minimise impacts on traffic or pedestrian movement. Noise management measures to reduce impacts at surrounding sensitive receivers would need to be considered for any long-term out-of-hours works. Tunnelling activities near the proposed stations and services facility site also have the potential to generate temporary ground-borne noise and vibration impacts on sensitive receivers, particularly where tunnel depths would be shallower.

Urban setting	Potential impacts
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Noisy works, such as rock breaking and piling during excavation of shafts and station boxes, have the potential to generate temporary high noise impacts during both standard and out-of-hours work. This may impact on commercial and other sensitive receivers adjacent to the proposed station sites. Other construction activities, such as demolition of existing structures, may also generate moderate noise impacts. Where possible, these activities would be undertaken during standard hours to minimise potential impacts. However, there may be the need to undertake activities out-of-hours for safety reasons or to minimise impacts on traffic or pedestrian movement. Noise management measures to reduce impacts at surrounding sensitive receivers, including acoustic sheds, would need to be considered for any long-term out-of-hours works. It is proposed to launch and support tunnel boring machines from both Westmead and The Bays. There is the potential for temporary noise impacts during times when the machines are working close to the surface. Measures such as acoustic sheds would be considered for these activities. Excavated spoil would need to be removed from these sites, and tunnel construction materials brought in. These activities have the potential to temporarily generate noise, particularly during out-of-hours work, as they would be carried out 24 hours a day, 7 days a week. Retrieval and dismantling of the tunnel boring machines would be carried at Sydney Olympic Park metro station construction site.
Industrial and urban services areas • Clyde • Silverwater	Construction of the stabling and maintenance facility would generally include: • Site clearing and demolition of existing structures • Ground excavation works • Civil works and earthworks. Demolition and excavation activities have the potential to generate temporary high noise levels. However, the site is in an area of high existing noise, so impacts are expected to be moderate. There may be the need to undertake activities out-of-hours for safety reasons or to minimise impacts on traffic movements. A temporary concrete segment facility would also be constructed at the Clyde stabling and maintenance facility construction site to provide concrete segments for the tunnel lining. This facility, along with transport of the concrete segments has the potential to generate noise. Given these activities are consistent with the existing industrial land use of the area, any impacts are expected to be minor.

8.5.6 Performance outcomes

Identified performance outcomes in relation to noise and vibration for operation and construction of the Concept are provided in Table 8-13.

Table 8-13: Noise and vibration performance outcomes

Operational performance outcomes	Construction performance outcomes
• Operational noise and vibration levels comply with the rail noise trigger levels in the Rail Infrastructure Noise Guidelines (Environment Protection Authority, 2013) and external noise criteria in the Noise Policy for Industry (Environment Protection Authority, 2017), where applicable.	• Construction noise and vibration impacts on local communities are minimised by controlling noise and vibration at the source, on the source to receiver path and at the receiver • Structural damage to buildings and heritage items from construction vibration is avoided • Local communities are engaged during construction, including on noise mitigation in areas predicted to be affected by high noise impacts.

8.5.7 Matters to be addressed in staged applications

Noise and vibration impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Noise and vibration assessments will include, as relevant to the stage:

- Description of the existing noise environment
- Explanation of the applicable standards, guidelines and environmental planning requirements
- Explanation of the construction methodology, design and operational procedures relevant to noise and vibration emissions
- Description of the methodology used to predict and assess the potential impacts
- Assessment of construction noise and vibration impacts
- Assessment of the potential cumulative impacts with other major projects
- Assessment of operational noise and vibration impacts
- Identification of feasible and reasonable construction and operational mitigation measures
- Further consultation with the NSW Environment Protection Authority.

An assessment of noise and vibration impacts for Stage 1 is provided in Chapter 11 (Noise and vibration impacts – Stage 1).

8.6 Non-Aboriginal heritage

8.6.1 Legislative and policy context

World and Commonwealth

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a legislative framework for the protection and management of matters of national environmental significance. This includes heritage places of national and international importance which are protected through their inclusion on the World Heritage List, Commonwealth Heritage List or the National Heritage List.

New South Wales

The *NSW Heritage Act 1977* (Heritage Act) provides protection for items of 'environmental heritage' in NSW. 'Environmental heritage' includes places, buildings, works, relics, movable objects or precincts considered significant based on historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic values. Items considered to be significant to the state are listed on the State Heritage Register.

Although the permits under the Heritage Act are not required for an approved State significant infrastructure project, the Heritage Act is relevant in that it guides assessment and defines statutory listed items. Certain sections of the Heritage Act are also still applicable to approved State significant infrastructure projects, such as Section 146 (notification of a relic).

Statutory registers provide legal recognition for heritage items. The State Heritage Register, government agency Heritage and Conservation Registers established under Section 170 of the Heritage Act, and the environmental heritage schedules of Local Environmental Plans (LEPs) are statutory listings.

Determining the significance of heritage items or a potential archaeological resource is undertaken by using a system of assessment centred on The Burra Charter: the Australia ICOMOS Charter for Places of Cultural Significance, 2013 (Burra Charter) by the International Council on Monuments and Sites (ICOMOS). The principles of the Burra Charter are relevant to the assessment, conservation and management of sites and relics.

8.6.2 Assessment approach

The assessment involved:

- Identifying known heritage items and areas of potential archaeological remains within the Concept corridor that could be encountered during construction and operation of the Concept
- Considering the potential impacts of the Concept on the values, settings and integrity of heritage areas, items and archaeological resources, including items both above and underground and, where such potential exists, the likely significance of those impacts

- Consultation with the Sydney Metro Heritage Working Group and NSW Heritage Council to discuss the approach to the non-Aboriginal heritage assessment
- Identifying performance outcomes
- Identifying the proposed scope of non-Aboriginal heritage assessments for future stages.

8.6.3 Existing environment

The Concept corridor includes a range of historical values as outlined in Table 8-14.

Table 8-14: Non-Aboriginal heritage historical values

Historical setting	Description
Convict settlement	Convict settlements were developed shortly after the landing of the First Fleet in 1788. The settlement at Sydney Cove flourished and grew from the first days of settlement. At Westmead and Parramatta, the Government Domain of Government House was constructed primarily by convict labour; and the Government Farm was established, providing food resources to the greater colony. Convict settlements were also constructed along the route of Parramatta Road. At Burwood North, the Government's Longbottom Stockade and Farm was established providing an overnight gaol and accommodation for convict road gangs at the centre point between Sydney and Parramatta.
Agriculture and industry	A number of farms were established during the 1790s along the newly convict-built Parramatta Road. Government Farms were established at Parramatta and Westmead, and at the Government's Longbottom Stockade providing resources to the wider colony. Early land grants at Clyde, Silverwater, Sydney Olympic Park and The Bays provided the means to create centres for agriculture during early development. Industry flourished within these areas including oil refinery works at Clyde, slaughterhouses and saltworks at Silverwater, State Abattoirs at Sydney Olympic Park, and maritime industry and the White Bay Power Station at The Bays.
Residential development	Early land grants at Westmead, Parramatta, North Strathfield, Burwood, Five Dock and White Bay were in place before the rise of residential development. Grants within these areas changed hands a number of times before being subdivided from the mid-nineteenth century, although significant housing and a residential layout was not established in these areas until the 1890s and early twentieth century.
Maritime industry	Subdivision of White Bay occurred throughout the late 1820s with wealthy and prominent members of Sydney society establishing a number of industrial businesses which changed and developed over time, consolidating White Bay's maritime industry function. White Bay became synonymous with John Booth's Steam Saw Mills, the Australian Gas Light Company, the Glebe Island Abattoir and the Lever Brothers Factory. These businesses ultimately closed, with the area developing as residential throughout the twentieth century. The turn of the twentieth century was marked by the establishment of the White Bay Power Station, arguably the most prominent landmark at The Bays. The power station was decommissioned in 1983. Other maritime industries where also present along Parramatta River including transport services; and gas, coal and smelting industries which used water frontages, although these were largely closed during the latter half of the twentieth century for the preservation of the river.
Civic development and the railway	Sydney Cove was first settled in 1788, which quickly grew into a commercial and administrative centre of the colony of New South Wales. Temporary tents and convict huts quickly transitioned into substantial sandstone and brick residences. Well-known structures and precincts took form throughout the nineteenth century including Hyde Park, the Hyde Park Barracks, the Mint, St James Church, Customs House, Government House, and the Government Domain. The Sydney to Parramatta railway line was opened in 1855 and Central Station took its third and current form by the early twentieth century.

Heritage register searches were carried out across April and May 2019 including relevant State and Commonwealth statutory and non-statutory heritage registers. The Concept corridor extends beneath the curtilage of one World Heritage Site – Old Government House and Government Domain (Australian Convict Sites) (Ref. 1306); one Commonwealth Heritage listed site – Pyrmont Post Office (ID 105510); three items on the National Heritage List – Old Government House and the Government Domain (ID 105957), First Government House Site (ID 105761) and Hyde Park Barracks (ID 105935); and more than 70 State Heritage listed items.

The existing non-Aboriginal heritage context for the land use types within the Concept corridor are described in Table 8-15.

Table 8-15: Non-Aboriginal heritage and archaeological context

Urban setting	Existing heritage and archaeology
CBDs • Parramatta • Sydney	The Parramatta and Sydney CBDs contain representations of early convict settlement, civic development, and the development of transportation routes between the two centres, such as Parramatta Road and the railway. Local and State significant heritage items are present within both the Parramatta and Sydney CBDs, along with a number of National, Commonwealth and World heritage items including Old Government House and Government Domain (Australian Convict Sites) (Ref. 1306, ID 105957), Pyrmont Post Office (ID 105510), and Hyde Park Barracks (ID 105935). The CBDs are considered to have areas of State significant archaeological potential including low-moderate potential for archaeological remains relating to convict huts, yards and gardens, and early colonial residences and yards within Parramatta. State significant remains within the Sydney CBD are likely to relate to early European settlement, convict occupation and labour, early residential and commercial development, early infrastructure and the development of transport modes and routes. There are a number of State and World significant items with archaeological potential within the Parramatta CBD and the Sydney CBD investigation area including the Old Government House and Government Domain (Australian Convict Sites) (Parramatta CBD, Ref. 1306; ID 105957), Hyde Park (Sydney CBD investigation area, SHR 01871) and the Tank Stream (Sydney CBD investigation area, SHR 00636).
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	The suburban settings are representative of the transition from farming and agricultural areas established post convict settlement, to land subdivision and residential development in the early to mid-twentieth century. It is expected that any heritage items in these areas would mostly be of local heritage significance. North Strathfield and Five Dock are unlikely to have any archaeological potential due to previous ground disturbance following the transition from agricultural practices to suburban residential communities including the development of the railway. Burwood North has moderate archaeological potential associated with late 19th century development including potential archaeological remains associated with former residences. Between Five Dock and The Bays lies Callan Park which is listed on the National Trust of Australia register (Ref 6912), Register of the National Estate (Ref 1674) and State Heritage Register (SHR 00818). White Bay Power Station (SHR 01015) is located in Rozelle, close to The Bays.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	The urban renewal precincts represent areas of more recent industrial and agricultural uses that are in current transition to other land uses. It is expected that heritage items present would mostly be of local heritage significance, with a number of State significant items, such as the State Abattoirs (SEPP (State Significant Precincts) 2005 Listing No. A; SREP No 24 – Homebush Bay Area Item No. 1) and White Bay Power Station (SHR 01015). There is low potential for archaeological remains within Westmead and Sydney Olympic Park associated with former land uses and the railway line, with these areas unlikely to contain archaeological remains which reach the threshold for local or State significance. The Bays contains varying potential (low-high) for locally significant archaeology related to former structures, reclamation fill and rail infrastructure.
Industrial areas • Clyde • Silverwater	The river frontage at Clyde and Silverwater has been used for industrial purposes since the late nineteenth century. These uses expanded in the mid-twentieth century and continue to the present day. It is expected that any heritage items present would be of local heritage significance. Potential archaeological remains are likely to be associated with post-1950 commercial/ industrial development and are unlikely reach the threshold for local or State significance.

8.6.4 Potential operational benefits and impacts

The operation and use of Sydney Metro West provides an opportunity to acknowledge and incorporate heritage values through heritage interpretation. Heritage interpretation would aim to partially offset the impact to heritage values that may occur due to the Concept.

It is unlikely there would be any direct impacts to heritage items during operation of the Concept, as activities with the potential to cause direct impacts, such as demolition and construction of facilities, would be confined to the construction stages.

Where heritage items are located close to metro stations or other infrastructure, the design would be sympathetic and reflect the heritage context and values of these heritage items. This would effectively manage the potential impacts associated with changes to the setting and views to and from heritage items.

The potential for vibration impacts during operation of the Concept would be assessed as part of the noise and vibration assessments for future stages. However, as the average tunnel depth is greater than 50 metres, any impacts are expected to be minimal and would be managed in accordance with relevant vibration guidelines and criteria, including the Rail Infrastructure Noise Guideline (Environment Protection Authority, 2019).

A discussion of likely impacts and benefits associated with the different settings within the Concept corridor is provided in Table 8-16.

Table 8-16: Potential operational non-Aboriginal benefits and impacts

Urban setting	Potential operational benefits and impacts
CBDs • Parramatta • Sydney	Potential operational impacts within the CBDs relate to permanent changes to the streetscape, setting and views to and from heritage items near new metro stations or ancillary infrastructure. This may include State and National heritage items given the presence of both within the Parramatta and Sydney CBDs.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	It is expected that any impacts at sites within suburban settings would be related to permanent changes to streetscape, setting and views to and from heritage items near new metro stations or ancillary infrastructure. This may include State and local heritage items.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Within urban renewal precincts, there is the potential for permanent changes to streetscape, setting and views to and from local and State listed heritage items.
Industrial areas • Clyde • Silverwater	Potential impacts within industrial areas are expected to be minor and relate to impacts to streetscape, setting and views to and from local heritage items as a result of vegetation removal and ancillary infrastructure.

8.6.5 Potential construction impacts

Development of Sydney Metro West has generally avoided direct impacts to World, National and State heritage listed items. Where there are potential residual impacts to non-Aboriginal heritage items during construction, these would be appropriately managed in accordance with the performance outcomes in Section 8.6.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

The potential for impacts on non-Aboriginal heritage would be dependent on the final locations and layout of construction sites across the Concept corridor. Construction of surface infrastructure such as stations and ancillary facility sites would likely require demolition and excavation activities, with the potential for direct impacts to heritage items.

While tunnel construction would mostly be deep enough to avoid areas of archaeological significance, there remains the potential for impacts to occur due to settlement or vibration caused by tunnelling and other construction activities. The potential for vibration impacts from construction activities would be considered as part of the noise and vibration assessments for each stage.

Potential construction impacts on non-Aboriginal heritage may include:

- Direct impact to heritage listed items including demolition, impacts within curtilages and potential impacts as a result of demolition of adjacent structures
- Indirect impacts to heritage items including visual impacts, impacts to setting and views
- Impacts to significant archaeological remains as a result of subsurface excavation at station sites, tunnel exits and entries and services facilities
- Impacts to heritage items relating to vibration and settlement as a result of tunnelling across the alignment.

A discussion of likely construction impacts associated with the different settings within the Concept corridor is provided in Table 8-17.

Table 8-17: Potential construction non-Aboriginal heritage impacts

Urban setting	Potential construction impacts
CBDs **Parramatta** **Sydney**	There is potential for direct impacts to local and State heritage items during construction of stations within both the Parramatta and Sydney CBDs. Local and State significant archaeological remains are likely to be present and demolition and ground excavation work may result in impacts to these remains. There is also the potential for temporary indirect impacts to local, State and National heritage items, including changes to views and settings during construction.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	There is potential for direct impacts to local and State heritage items during construction of stations and the proposed services facility. Impacts to State Heritage items would be avoided or minimised. Impacts would be associated with the demolition of existing structures, where required, and construction of new infrastructure. Significant archaeological remains are not expected at station locations and therefore impacts are unlikely. There is the potential for moderate indirect visual impacts where heritage items may be located directly adjacent to construction sites.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	There is potential for construction activities to impact both local and State heritage items within urban renewal precincts, particularly at Sydney Olympic Park and The Bays. While direct impacts to State Heritage Register listed items would be avoided where possible, indirect impacts are likely due to changed views and settings during construction. Impacts to significant archaeological resources may occur at The Bays Precinct during demolition and excavation works, however impacts are not expected at other locations.
Industrial and urban services • Clyde • Silverwater	Construction within the industrial and urban services settings has the potential to impact on local heritage items, however these are expected to be minor due to the limited number of listed items in the area. Significant archaeological remains have not been predicted at these locations and therefore impacts are not expected.

8.6.6 Performance outcomes

Identified performance outcomes in relation to non-Aboriginal heritage for operation and construction of the Concept are provided in Table 8-18.

Table 8-18: Non-Aboriginal heritage performance outcomes

Operational performance outcomes	Construction performance outcomes
Design is sympathetic to retained and adjacent heritage items Appropriately qualified and suitably experienced heritage architect and relevant stakeholders are consulted during design The design of stations include non-Aboriginal heritage interpretation.	Direct impacts on World Heritage and National Heritage List items are avoided Impacts on State Heritage Register items are avoided or minimised so that the overall heritage value of the item is maintained Impacts to non-Aboriginal heritage items and archaeology are avoided or minimised where feasible and reasonable Accidental impacts to heritage items are avoided.

8.6.7 Matters to be addressed in staged applications

Non-Aboriginal heritage impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Non-Aboriginal heritage assessments will include, as relevant to the stage:

- Identification of known heritage items or areas of archaeological potential that may be directly or indirectly impacted
- Identification of any requirements for further analysis, such as archival recording or sub-surface investigation
- Assessment of the likely level of impact and/or risk to heritage items and archaeological remains
- Identification of measures required to avoid or mitigate potential impacts to heritage items including significant archaeological remains
- Consultation with the Sydney Metro Heritage Working Group, NSW Heritage Council and local Councils.

An assessment of non-Aboriginal heritage impacts for Stage 1 is provided in Chapter 12 (Non-Aboriginal heritage – Stage 1).

8.7 Aboriginal heritage

8.7.1 Legislative and policy context

The main statutory protection of Aboriginal heritage is provided by the *National Parks and Wildlife Act 1974*. The following guidelines are relevant to the assessment of Aboriginal heritage:

- The Department of Planning, Industry and Environment's Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales 2010 (Department of Environment, Climate Change and Water, 2010a) outlines the requirements for archaeological investigations of Aboriginal objects in NSW
- The Department of Planning, Industry and Environment's Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW (Office of Environment and Heritage, 2011) provides a process for the investigation and assessment of Aboriginal cultural heritage including identifying values of Aboriginal cultural heritage, and the assessment of potential harm of a proposed activity on Aboriginal objects and declared Aboriginal places
- The Department of Planning, Industry and Environment's Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010 (Department of Environment, Climate Change and Water, 2010b) outlines the requirements for proponents to consult with Aboriginal stakeholders during heritage assessment and/or applications for Aboriginal Heritage Impact Permit
- The Burra Charter 2013 (Australia ICOMOS, 2013) provides guidance for the conservation and management of places of cultural significance (cultural heritage places). The Charter sets a standard of practice for those who provide advice, make decisions about, or undertake works to places of cultural significance, including owners, managers and custodians. The Burra Charter provides several significance criteria that attempt to define why a site is important. Such assessment recognises that sites may be important for different reasons to different people, and even at different times.

8.7.2 Assessment approach

The assessment involved:

- Identifying known Aboriginal heritage sites and areas of potential archaeological sensitivity within the Concept corridor that could be encountered during construction and operation of the Concept
- Considering the potential impacts on Aboriginal sites recorded on the Aboriginal Heritage Information Management System (AHIMS) and listed Aboriginal places of significance on the relevant local environment plans
- Consultation with Sydney Metro Heritage Working Group to discuss the approach to the Aboriginal heritage assessment
- Identifying performance outcomes
- Identifying the proposed scope of Aboriginal heritage assessments for future stages.

8.7.3 Existing environment

Aboriginal ethnohistory

Prior to the appropriation of their land by Europeans, Aboriginal people lived in small family or clan groups that were associated with particular territories or places. It seems that territorial boundaries were fairly fluid, although details are not known. The language group spoken across Sydney was known as Darug (Dharruk – alternate spelling). This term was used for the first time in 1900, as before the 1800s language groups or dialects were not discussed in the literature (Matthews and Everitt,1900) (Attenbrow, 2010). The Darug language group is thought to have been spoken in the area south of Port Jackson, north of Botany Bay, and west to Parramatta. Clan groups identified near the Concept corridor included the Cadigal, Wangal and Barramatagal (Attenbrow, 2010).

Aboriginal people were a highly mobile society utilising different landscapes and resource strategies across the Concept corridor. Land use often included complex land management strategies including the use of fire-stick farming to facilitate effective hunting and promote fresh growth across the environment. In addition, different resources may have been available seasonally, necessitating movement or trade across the landscape (Attenbrow, 2010).

The limited historical references to Aboriginal people identify a focus of longer term land use on valley bottoms and along existing shorelines (Attenbrow, 2010). The Parramatta River and its surrounds in particular would have provided access to a number of marine resources including fish, eel and shellfish species. Other aspects of the landscape would have formed travel routes with current roads such as Parramatta Road reportedly following traditional Aboriginal walking tracks.

With the establishment of European settlement at Sydney Cove, Aboriginal people were rapidly alienated from land and resources. A smallpox epidemic which broke out in 1789 had a devastating effect on the Aboriginal population of Sydney which compounded the dislocation and destruction of the lifeways of Aboriginal people.

Archaeological context

The existing archaeological record comprises a variety of features reflecting the diversity of land uses used by Aboriginal people. Some site types such as scarred trees are particularly susceptible to destruction by historic land use, while other sites types are able to withstand degradation and decay. As a result, the most common type of Aboriginal objects remaining in the archaeological record are stone artefacts, followed by bone and shell.

A search of AHIMS sites within and near the Concept corridor identifies a prevalence of sites along foreshore contexts as well as within the Parramatta CBD.

Sites within the Parramatta and Sydney CBD are largely comprised of subsurface artefact sites and areas of archaeological potential (see further discussion below). Additionally, the early colonisation of Parramatta suggests the potential for Aboriginal objects to be associated with European contact.

Sites along the foreshore environments are dominated by shell midden sites reflecting the use of marine resources along the Parramatta River. Areas of pigment art and grinding grooves are also focused around foreshore areas likely associated with less developed portions of the Concept corridor as well as locations of exposed sandstone outcrops and shelters.

Archaeologically sensitive environmental features

Most of the Concept corridor is underlain by a shale geology which is the predominant geological feature of the Cumberland Plain, an area that approximately extends from inner western Sydney to the Nepean River. This landscape is characterised by generally gently undulating terrain incised by freshwater tributaries of the Parramatta River, the Nepean River and the Hawkesbury River. Shale geology is often associated with overlying residual soils which are susceptible to a high degree of impact from construction activities, such as residential and commercial development (Herbert, 1983). Areas within these landscape features which have been subject to previous development are likely to have low archaeological sensitivity.

The foreshore areas of Sydney Harbour and the Parramatta River by comparison are generally characterised by Quaternary period sediments and outcropping Triassic period Hawkesbury Sandstone (Clark and Jones, 1991). Hawkesbury Sandstone outcrops in foreshore areas are associated with elevated and steep terrain bordering the foreshore contexts. Quaternary period sediments underlie tidally influenced flats and the margins of numerous tributaries that flow into Sydney Harbour and Parramatta River. Foreshore areas exhibit archaeological sensitivity associated with presence of Hawkesbury Sandstone outcrops and the presence subsistence resources such shellfish within the intertidal zones.

Foreshore areas within the Concept corridor include Clyde, The Bays and Sydney CBD. In several cases the pre-European foreshore in these areas have been modified through reclamation programs. In these areas, it is considered that archaeologically sensitive foreshore contexts may exist below layers of reclamation fills.

Portions of the Parramatta CBD are underlain by a significant geological feature, the Parramatta Sand Body. The Parramatta Sand Body is an important archaeological resource with evidence of Aboriginal activities dating from the Holocene and Pleistocene epochs. The sand body is also relatively deep, increasing the possibility of portions of the sand body surviving beneath phases of historical development.

The major watercourse associated with the Concept corridor is the Parramatta River. The Parramatta River extends eastwards from North Parramatta to the confluence with Lane Cove River between Balmain and Greenwich. In the Sydney CBD, a major watercourse known as the Tank Stream flowed north from a swampy area between current day Market and Park Street to Sydney Harbour. A number of first and second order watercourses flow into Parramatta River and Sydney Harbour within the Concept corridor. Due to the tidally influenced nature of Parramatta River and Sydney Harbour, the mouth of each watercourse generally consists of tidally influenced flats that were likely to have been extensive areas of mangrove. Many of these watercourses have been modified and the tidal flats in-filled as areas of reclamation. Areas within 200 metres of watercourses are considered to contain archaeological sensitivity (Department of Environment Climate Change and Water, 2010a).

Known Aboriginal sites and areas of archaeological sensitivity

There are 27 recorded AHIMS sites within the Concept corridor. This includes 15 sites within the Parramatta CBD, two within Pyrmont and ten within the Sydney CBD investigation area. Most of the sites within the corridor are areas of potential archaeological deposit and subsurface artefact sites. Five of these sites have been classified as destroyed or 'not a site'. There are around 40 additional AHIMS sites recorded within 500 metres of the Concept.

Several additional sites within the Parramatta CBD are located near the Concept corridor. Further investigation of these sites during future assessment stages may identify that their site extent continues into land covered by the Concept corridor.

Several environmental features have been identified as containing Aboriginal archaeological sensitivity including areas within 200 metres of water sources, foreshore areas, and areas containing outcropping Hawkesbury Sandstone. Portions of the Concept corridor within Clyde, Lilyfield, The Bays and the Sydney CBD contain one or more of these landscape features.

No areas of Aboriginal heritage significance as listed on the relevant local environmental plans were identified within the Concept corridor.

Cultural heritage significance

Areas within the Concept corridor may also contain cultural significance associated with the spiritual, traditional, historic or contemporary associations and attachments the place or area has for Aboriginal people.

Aboriginal cultural knowledge was traditionally passed on through oral traditions from generation to generation. Within Aboriginal communities there was a time of dislocation and upheaval associated with the arrival of colonial settlers. This widespread disruption resulted in much of the detailed knowledge and understanding of many of the elements of the cultural landscape being lost from the Aboriginal community. Nonetheless, many Aboriginal people maintain a strong connection to the land of their ancestors and collectively possess a wealth of knowledge passed down through the generations.

Consultation undertaken with Aboriginal stakeholders during future staged assessments may identify cultural heritage values or areas of cultural heritage significance within or in the immediate vicinity of the Concept corridor.

Predictive model

Based on the existing environment, archaeological context and known features, the following predictive statements have been developed:

- The survivability of Aboriginal objects would be largely dependent on the extent and nature of subsequent phases of historical construction activities
- Sub-surface artefact sites tend to consist of lower density isolated occurrences in areas away from major watercourses such as freshwater, marine and estuarine areas
- More frequent and higher concentrations of sub-surface artefact sites are likely to occur near major watercourses such as freshwater, marine and estuarine areas
- Shell midden sites are more likely to be identified in close proximity to marine and estuarine areas. Due to land reclamation in many areas, former marine and estuarine areas may be set-back from contemporary shoreline areas
- Sandstone shelters suitable for archaeological deposit and outcrops suitable for engravings may be preserved in ridge crest and ridge slope landform contexts
- Surviving portions of deeper soil profiles, such as the Parramatta Sand Body, may provide stratified evidence of occupation.

8.7.4 Potential operational benefits and impacts

Impacts to Aboriginal sites or areas of Aboriginal archaeological potential during operation of the Concept are not expected.

The operation and use of Sydney Metro West provides opportunity to acknowledge and incorporate Aboriginal heritage values through heritage interpretation. The key aim of heritage interpretation would be to connect the contemporary experience of the commuters and staff with the Aboriginal cultural and heritage values associated with the Concept corridor. Heritage interpretation elements may include:

- Engaging Aboriginal artists to develop designs/artworks that could be incorporated into the built form of the stations
- Incorporating local Aboriginal language words into naming conventions
- Incorporating native plant species into landscaping elements
- Providing interpretive information regarding the Aboriginal history of the site(s) developed in consultation with Aboriginal stakeholders.

Heritage interpretation would aim to partially offset any potential impact to Aboriginal heritage that may occur as part of construction. Further detail in relation to Aboriginal cultural design is provided in Chapter 7 (Placemaking).

8.7.5 Potential construction impacts

Development of Sydney Metro West has aimed to avoid and minimise interface with known Aboriginal sites and areas of high Aboriginal archaeological potential. Potential impacts to Aboriginal heritage items and archaeology would be appropriately managed in accordance with the performance outcomes in Section 8.7.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

The Concept would require substantial earthworks, primarily related to demolition and excavation within proposed station and services facilities sites. Likely impacts during construction include:

- Potential for direct impact to registered AHIMS sites and sensitive landforms with the potential to contain Aboriginal objects within the surface construction sites
- Potential impacts to AHIMS listed sites related to vibration and settlement as a result of tunnelling across the alignment, although given average tunnel depth is greater than 50 metres, the risk is expected to be very low
- Potential impacts to areas of cultural significance
- Cumulative impacts on the archaeological record through the continued reduction of intact archaeological contexts which may contain Aboriginal objects.

There is a high likelihood of direct construction impacts to identified AHIMS sites at Parramatta due to the concentration of sites at this location. Interaction with the Parramatta Sand Body is possible, with potential for archaeological deposit(s) with high archaeological significance to be uncovered.

As several AHIMS sites are located in the Sydney CBD investigation area, the Concept may also impact identified AHIMS sites within the Sydney CBD.

Intact landforms or significant geological features at other sites may also be associated with the presence of Aboriginal objects. In particular, there is potential for impacts to areas of archaeological sensitivity associated with foreshore areas within the Concept. Detailed investigations and consultation with Aboriginal stakeholders would be carried out as part of the assessment of each stage.

Following consultation with Aboriginal stakeholders, impacts to areas of cultural heritage significance or cultural heritage values may also be identified.

8.7.6 Performance outcomes

Identified performance outcomes in relation to Aboriginal heritage for operation and construction of the Concept are provided in Table 8-19.

Table 8-19: Aboriginal heritage performance outcomes

Operational performance outcomes	Construction performance outcomes
The design of stations include Aboriginal heritage interpretation in consultation with registered Aboriginal parties.	Impacts on areas of moderate or higher archaeological potential and significance are avoided or minimised, where feasible and reasonable Accidental impacts to heritage items are avoided.

8.7.7 Matters to be addressed in staged application

Aboriginal heritage impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Aboriginal heritage assessments will include, as relevant to the stage:

- Identification of the potential to disturb Aboriginal heritage (sites, objects, remains, values, features or places)
- Determination, in consultation with relevant stakeholders, of the significance of the heritage resources
- Determination of the extent and significance of impacts to those resources
- Identification of the potential for in situ conservation of items and/or areas and the need for further archaeological testing and/or excavations
- Identification of appropriate measures to avoid, minimise and/or mitigate potential impacts
- Consultation with Sydney Metro Heritage Working Group, local Councils and registered Aboriginal parties.

An assessment of Aboriginal heritage impacts for Stage 1 is provided in Chapter 13 (Aboriginal heritage – Stage 1).

8.8 Property and land use

8.8.1 Legislative and policy context

Strategic planning context

Strategic direction for land use planning across the Concept corridor is provided in several plans and strategies. Further discussion of planning strategies relevant to the Concept is provided in Chapter 2 (Strategic need and justification) and Chapter 7 (Placemaking). An overview is provided below.

The Greater Sydney Region Plan: A Metropolis of Three Cities (Greater Sydney Commission, 2018a) sets the 40-year vision and 20-year implementation plan for Sydney to develop as three unique and connected cities. Of these cities, the Concept corridor is located within the Central River City and Eastern Harbour City. The Central City District Plan (Greater Sydney Commission, 2018b) and the Eastern City District Plan (Greater Sydney Commission, 2018c) provide direction for the growth of the Central River City and Eastern Harbour City respectively.

Between Westmead and Sydney Olympic Park, the Concept is located within the Greater Parramatta and the Olympic Peninsula economic corridor. The NSW Department of Planning, Industry and Environment's Greater Parramatta Interim Land Use and Infrastructure Implementation Plan (Department of Planning and Environment, 2017) sets out the future envisaged growth in the Greater Parramatta and the Olympic Peninsula economic corridor.

Land to the east of the existing North Strathfield Station and around Burwood North is also included in the Parramatta Road Corridor Urban Transformation Strategy (2016). This strategy identifies the Parramatta Road urban renewal corridor as a focus for increased housing, economic activity and social infrastructure over a thirty year period.

Local planning context

Local Government Areas within the Concept have local plans and strategies relevant to the local conditions and growth strategies. Details of the plans and strategies relevant to each site are provided in Chapter 7 (Placemaking). The plans and strategies relevant to property and land use include:

- Cumberland 2030: Our Local Strategic Planning Statement (Cumberland City Council, 2019)
- City of Parramatta Local Strategic Planning Statement (City of Parramatta Council, 2020)
- Sydney Olympic Park Master Plan 2030 (Sydney Olympic Park Authority, 2018)
- Canada Bay Local Strategic Planning Statement (City of Canada Bay Council, 2020)
- Draft Burwood 2030 Local Strategic Planning Statement (Burwood Council, 2019)
- Our Place Inner West: Inner West Council Local Strategic Planning Statement (Inner West Council, 2019)
- City Plan 2036 Draft Local Strategic Planning Statement (City of Sydney, 2019).

8.8.2 Assessment approach

This assessment involved:

- Describing the key strategic land use context of the Concept, including identification of the strategic role of each centre based on a review of aerial photography, strategic policy and land use zones specified by applicable local environmental plans
- Reviewing strategic land use policy documentation relevant to the Concept, in order to identify planned future land use priorities and developments
- Identifying potential impacts of the Concept on strategic land use roles at centres along the Concept corridor
- Consultation with the Department of Planning, Industry and Environment and local Councils in regard to local and regional plans and proposed developments
- Identifying performance outcomes
- Identifying the proposed scope of property and land use assessments for future stages.

8.8.3 Existing environment

The Concept traverses through a highly urbanised area connecting a range of existing and future centres with a diverse range of land uses along the Concept corridor. The land use context of the different settings within the Concept corridor are described in Table 8-20, including key land uses.

Table 8-20: Land use context within the Concept

Urban setting	Land use context
CBDs • Parramatta • Sydney	The Parramatta and Sydney CBDs include highly developed commercial cores, with a wide range of commercial, retail, health, government administration and community based uses, and high density residential developments located towards the edge of the CBD areas. A number of key administrative uses are located in or around the Parramatta and Sydney CBDs, including educational facilities, historic structures, law courts, public gathering places and places of worship. Significant areas of open space, such as Parramatta Park, the Botanical Gardens, the Domain and Hyde Park are also located within or near the CBD areas. The Sydney CBD is also the hub of the Sydney's existing public transport network which services the city centre, including the suburban rail network and the under-construction Sydney Metro City & Southwest, as well as light rail, bus and ferry networks.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	The suburban areas feature low scale commercial uses, shops, business premises and restaurants, surrounded by low and medium density residential uses. North Strathfield has an existing railway station with small scale retail and office spaces directly opposite the entrance of the existing North Strathfield Station. There are a number of educational facilities nearby, with low and medium density residential beyond these facilities. The Burwood North locality is located along the Parramatta Road corridor between Burwood and Concord. The Parramatta Road corridor contains a wide range of commercial and urban services facilities, including business premises, shops, and pubs/hotels. Moving away from the Parramatta Road corridor to the north and south, the land use changes to residential, with a mix of densities. Surrounding residential areas are generally of low to medium density, however newer residential development has started to introduce higher densities, especially closer to Parramatta Road. There are also several educational, medical and recreational facilities in the surrounding neighbourhood. Five Dock comprises a range of retail and commercial uses, with some local education and health services, apartments and community facilities. The middle of the town centre is located around Fred Kelly Place on the western side of Great North Road, and a small area of open space located opposite on the eastern side of Great North Road, adjacent to the Post Office. To the west and east of Great North Road are low to medium density residential areas, including a mix of low rise (generally up to two storeys) residential flat buildings, medium density dwelling types and detached dwelling houses. The area between Five Dock and The Bays consists mostly of low density residential neighbourhoods with some retail and commercial uses in Lilyfield and Rozelle. There are also several educational, medical and recreational facilities within and surrounding these neighbourhoods.

Urban setting	Land use context
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	The urban renewal precincts generally contain a mix of uses, including specialised health, education and recreation areas. The Westmead health and education precinct includes over 400,000 square metres of specialised health related developments, which includes four hospitals, three medical research institutes and two university campuses (Health NSW, 2019). Significant education and health facilities in this precinct include Western Sydney University's Westmead campus, Westmead Hospital and The Children's Hospital at Westmead. Westmead has an existing railway station which is surrounded by a range of different business uses including commercial, medical and retail services. South of the railway station is generally low and medium density residential. Sydney Olympic Park comprises a mix of sports and entertainment facilities, with a growing mixed use commercial and residential core immediately to the south and east of the existing Olympic Park Station. Major sporting and entertainment facilities at Sydney Olympic Park include the ANZ Stadium, the Sydney Olympic Park Tennis and Hockey centres, the Sydney Olympic Park Aquatic and Athletic Centres, and the Showgrounds. The precinct also benefits from high quality public open space, located to the north and east, including Brickpit Ring Walk, Wentworth Common and Bicentennial Park. The Bays Precinct currently features a mix of maritime and port related employment uses around White Bay and Glebe Island ports. Key facilities within the White Bay and Glebe Island ports include the White Bay Cruise Terminal and the Glebe Island Silos, which are currently operated partly by Cement Australia and partly by Sugar Australia, as well as the disused White Bay Power Station. White Bay and Glebe Island also contain a number of multi-user berths for general port activities, including the import of bulk materials. North of White Bay are the largely low and medium density residential suburbs of Rozelle and Balmain, however a small industrial precinct is located immediately opposite the port along Robert Street. To the east are Jones and Johnstons Bays, and then the high density residential suburb of Pyrmont. To the south of Glebe Island is the City West Link and Anzac Bridge, and beyond is a maritime precinct along the northern foreshore of Rozelle Bay. To the west are Victoria Road, and the future Westconnex (Stage 3) Rozelle Interchange.
Industrial and urban services areas • Clyde • Silverwater	The industrial centres of Clyde and Silverwater are dominated by a range of industrial and urban services. Clyde is an industrial precinct dominated by major transport infrastructure including the Western Motorway, Parramatta Road, James Ruse Drive, the T1 Western Line, which forms the southern boundary of the precinct, and the now closed T6 Carlingford Line, which forms the western boundary of the precinct. To the north and east is the Rosehill industrial estate, which contains the Viva Energy Parramatta and Clyde Terminals and the Rosehill Gardens racecourse. Silverwater contains warehousing, industrial and urban services uses. The residential area of Silverwater is located to the south and south-east with Newington to the east.

8.8.4 Potential operational benefits and impacts

The Concept would support planned growth and improve transport accessibility between Greater Parramatta and the Sydney CBD, providing services which connects residents, workers and visitors. The broader land use benefits of the Concept have been described in Chapter 2 (Strategic need and justification).

In most cases, the permanent operational footprint of the Concept would be located within the construction sites. However, in some instances there may be residual land at the completion of construction that is not required for operational infrastructure. Opportunities may arise in relation to the use of residual land to support the strategic land use objectives for precincts around new metro stations. Future land use adjustments for the concept are detailed in Chapter 7 (Placemaking) however, would be assessed at a later stage. Strategies to assist in the realisation of strategic land use benefits from the Concept would be further developed in consultation with relevant authorities including the Department of Planning, Industry and Environment, the Greater Sydney Commission, and local councils as well as with local communities.

The Concept corridor is not anticipated to impact on any Commonwealth owned land. However, there may be Commonwealth leased land within the footprint of some sites. This is likely to comprise offices and other facilities for Commonwealth Government departments. These facilities are likely to re-establish in another location nearby and the impact would be negligible.

The potential land use opportunities and impacts within each setting have been identified in Table 8-21. Discussion of how the Concept integrates with relevant local strategic plans and strategies is provided in Chapter 7 (Placemaking).

Table 8-21: Potential operational property land use benefits and impacts

Urban setting	Potential land use benefits and impacts
CBDs • Parramatta • Sydney	The proposed metro stations provide opportunities to create high quality integrated station precincts which are well connected with existing rail and bus networks, and integrated with the surrounding built form. Further detail is provided in Chapter 7 (Placemaking). At CBD sites there would be a change from mixed use (commercial / retail) to transport infrastructure, although this change in land use would be negligible when considering the scale of commercial and retail in the surrounding area.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	The proposed metro stations would provide opportunities to create high quality integrated station precincts that result in improved public domain outcomes, while supporting the delivery of a range of new housing and commercial buildings as transit-oriented development. Further detail is provided in Chapter 7 (Placemaking). At suburban station sites there would be a change from mixed use (commercial / retail) and residential areas to transport infrastructure. It is envisaged that development would retain the current low-medium density residential character of the suburban settings, while enhancing the character of the town centres. The services facility between Five Dock and The Bays may have a minor impact on surrounding land uses by changing a small area of the land use to transport infrastructure. The design of the facility would consider surrounding land use.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	The proposed metro stations and improved accessibility would support the continued growth and development of these areas where revitalisation is underway or planned. There is also opportunity for the Concept to support increased housing supply through transit-oriented development at each location. Further detail is provided in Chapter 7 (Placemaking). At urban renewal settings there would be a change from mixed use (commercial/ retail), residential and/or industrial areas to transport infrastructure.
Industrial and urban services areas • Clyde • Silverwater	There would be minimal change to land use within the industrial and urban services areas as services facilities would be within existing industrial uses. Due to the nature of these facilities there are limited land use integration opportunities. Sydney Metro would liaise with relevant Councils to identify potential opportunities to integrate the facilities with any strategic plans for the area.

8.8.5 Potential construction impacts

Potential property and land use impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.8.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

During construction, the main land use and property impacts would relate to property acquisition. Private properties directly affected by the Concept would be acquired. All property acquisition would be managed in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and the land acquisition reforms announced by the NSW Government which can be viewed online at https://www.propertyacquisition.nsw.gov.au/property-acquisition-process. Sydney Metro has appointed Personal Managers to offer residents and small businesses assistance and support throughout the acquisition process.

The social impacts and business impacts of relocation are discussed in Section 8.11 (Social impacts - Concept) and Section 8.10 (Business impacts - Concept) respectively.

Where a property is over the future tunnel then it is generally only necessary to acquire the underground envelope containing the tunnel and any associated structures. This is referred to as substratum acquisition and is undertaken in accordance with the *Transport Administration Act 1988*. The steps for substratum acquisition are also managed in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*, however compensation is generally not payable except in specific circumstances.

Construction of the Concept would result in a land use change from its current land use (such as residential, commercial or industrial) to a construction site. Impacts would be minimised where possible by developing and planning construction sites to limit the amount of land required for construction outside of the permanent infrastructure footprint. This would also minimise the amount of residual land at the completion of construction.

Potential amenity impacts to surrounding land uses would be appropriately managed through the performance outcomes identified in Section 8.4 (Transport and traffic - Concept), Section 8.5 (Noise and vibration - Concept), 8.9 (Landscape character and visual amenity - Concept), and Section 8.17 (Air quality - Concept). The social and business impacts as a result of these amenity effects are assessed in Section 8.11 (Social impacts - Concept) and Section 8.10 (Business impacts - Concept).

8.8.6 Performance outcomes

Identified performance outcomes in relation to property and land use for operation and construction of the Concept are provided in Table 8-22.

Table 8-22: Property and land use performance outcomes

Operational performance outcomes	Construction performance outcomes
• Future land use opportunities within metro station precincts are developed in cooperation with (as relevant) the Department of Planning, Industry and Environment, the Greater Sydney Commission, and local councils • Transport infrastructure is effectively integrated with land use planning.	• Acquisition of privately owned land is minimised by limiting the extent of construction sites and using existing Government owned land where possible • Residual land at the completion of construction is minimised • The need for partial acquisitions is minimised.

8.8.7 Matters to be addressed in staged applications

Property and land use impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Property and land use assessments will include, as relevant to the stage:

- Description of land use and planning context for each site along the corridor relevant to the stage
- Identification of planning controls analysis for each site along the corridor relevant to the stage
- Identification of the potential acquisition, including processes and procedures for acquisition
- Identification of potential land use impacts and opportunities
- Identification of mitigation measures to address the property and land use impacts
- Further consultation with the Department of Planning, Industry and Environment and local Councils.

A property and land use assessment for Stage 1 is provided in Chapter 14 (Property and land use – Stage 1).

8.9 Landscape character and visual amenity

8.9.1 Legislative and policy context

The following guidelines, policies and standards are applicable to landscape character and visual impact assessment:

- Guidance note EIA-N04 Guidelines for Landscape Character and Visual Impact Assessment, (Transport for NSW, 2018)
- Guidance for Landscape and Visual Impact Assessment (Landscape Institute and Institute of Environmental Management & Assessment, 2013)
- Guidance Note for Landscape and Visual Assessment (Australian Institute of Landscape Architects, 2018).

Chapter 7 (Placemaking) provides detail on the Design Quality Framework, design principles and objectives, and design guidelines that are applicable to Sydney Metro West.

8.9.2 Assessment approach

The assessment involved:

- Describing the existing landscape character and visual sensitivity around the Concept and the potential receivers which could be impacted
- Categorising the different levels of landscape and visual sensitivity that could apply across the corridor
- Assessing the types of potential landscape character and visual amenity impacts of constructing and operating the Concept, by describing the types of changes that may be experienced in typical landscapes and views along the Concept corridor, and their compatibility with the existing setting
- Categorising the potential impact of the Concept as either likely to cause an adverse, negligible or beneficial effect on the landscape character and visual amenity
- Consultation with local Councils in regard to urban design considerations
- Identifying performance outcomes
- Identifying the proposed scope of landscape character and visual amenity assessments for future stages.

Landscape character impact assessment

Landscape sensitivity refers to the value placed on a landscape element or place and the level of service it provides to the community. For the Concept, the degree of sensitivity of each landscape element to change was identified as either neighbourhood, local, regional, State or national and described in Table 8-23.

Table 8-23: Landscape and visual sensitivity levels

Sensitivity	Description
National	• Landscape feature protected under national legislation or international policy • Heavily experienced view to a national icon.
State	• Landscape feature that is heavily used and/or is iconic to the State • Heavily experienced view to a feature or landscape that is iconic to the State.
Regional	• Landscape feature that is heavily used and valued by residents of a major portion of a city or a non-metropolitan region • Heavily experienced view to a feature or landscape that is iconic to a major portion of a city or a non-metropolitan region, or an important view from an area of regional open space.
Local	• Landscape feature valued and experienced by concentrations of residents and/or local recreational users • High quality view experienced by concentrations of residents and/or local recreational users, local commercial areas and/or large numbers of road or rail users.
Neighbourhood	• Landscape feature valued and appreciated primarily by a small number of residents (e.g. street trees in a local street) • Views where visual amenity may be appreciated by a small number of residents or local road users but is not particularly valued by the wider community.

Landscape and visual modification levels

To assess the changes to the landscape, proposed changes are assigned a magnitude of change level. The magnitude of change can result in adverse or beneficial effects and is defined for the Concept in Table 8-24.

Table 8-24: Landscape and visual magnitude of change levels

Landscape magnitude of change	Description
Reduction	• Changes could reduce the quality or quantity of valued landscape features. This may include changes to vegetation cover, the area of open space or public realm area, accessibility, permeability, legibility and wayfinding, comfort and amenity, activation and safety, and diversity of the public realm • Changes could reduce the quality or availability of views. The Concept would contrast with the surrounding landscape.
No-perceived change	• Either the view is unchanged or if it is, the changes would be generally unlikely to be perceived by viewers. The Concept is not likely to contrast with the surrounding landscape • Either the landscape quality is unchanged or if it is, it is largely mitigated by proposed public realm improvements. Would not alter or not noticeably alter the vegetation cover, the area of open space or public realm area, accessibility, permeability, legibility and wayfinding, comfort and amenity, activation and safety, and diversity of the public realm.
Improvement	• Changes could improve the quality or quantity of valued landscape features. This may include changes to vegetation cover, the area of open space or public realm area, accessibility, permeability, legibility and wayfinding, comfort and amenity, activation and safety, and diversity of the public realm • Changes could improve the quality or availability of views.

Landscape and visual impact magnitude

To assess the potential landscape character impact of the Concept, the sensitivity of the landscape and the likely landscape magnitude of change are combined to form likely impact levels (see Table 8-25).

Table 8-25: Landscape and visual impact levels

Modification	Sensitivity				
	National	State	Regional	Local	Neighbourhood
Reduction	Higher adverse effect		Adverse effect		
No change	Negligible				
Improvement	Higher beneficial effect		Beneficial effect		

8.9.3 Existing environment

The landform of the Concept corridor is generally undulating due to being part of the historical large river valley of Parramatta River, and the creeks, coves and bays of Sydney Harbour including Iron Cove and White Bay.

Within the Concept corridor there are a number of different receiver environments, including suburban, urban and industrial. These are described in the context of the existing landscape character and visual environment in Table 8-26.

Table 8-26: Existing landscape character and visual environment

Urban setting	Existing landscape character and visual environment
CBDs • Parramatta • Sydney	The CBD areas form regional focal points for commerce, trade, employment, retail and recreation. They generally consist of medium to high density commercial, retail and residential, with a mix of contemporary urban and historic character built form. Heritage features reflect colonial settlement and historical development; and are important visual features. The CBD areas also contain recreational and open space features which are often of national significance, such as Parramatta Park, Hyde Park and the Royal Botanic Gardens. Landscape elements and views within the CBDs range from local to national level sensitivity.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Suburban areas are characterised by a mix of low to medium rise retail, commercial, light industrial and residential uses, along with recreational and open space uses. These uses are generally the focal point of the local neighbourhood. Views from existing heritage structures and street planting/landscaping may be considered sensitive, along with views from nearby residential receivers. Landscape elements and views within suburban areas generally range from neighbourhood to local sensitivity.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Urban renewal precincts are areas of local redevelopment and/or transformation. They are generally mixed use precincts which are in the process of going through change to be redeveloped into new commercial, residential and recreational land uses. Urban renewal precincts include Westmead, Sydney Olympic Park and The Bays Precinct. Landscape elements and views within urban renewal precincts range from regional to local sensitivity.
Industrial and urban services areas • Clyde • Silverwater	Industrial areas are centres of local industry and employment. They include a mix of general and heavy industrial uses, with industrial built form often including large warehouses, heavy vehicle access roads and loading docks. Clyde is located near Duck Creek and A'Becketts Creek which contain mature stands of native vegetation of visual sensitivity to local workers and passing road users. Land uses with high visual impact include the Sydney Speedway at Clyde and the Sydney Helicopters helipad, both located on Government owned land. Landscape elements and views within industrial areas generally range from neighbourhood to local sensitivity.

8.9.5 Potential operational benefits and impacts

The introduction of new metro stations would provide improved local visual amenity and landscape character through:

- High quality architecture and urban design that reflects the Sydney Metro Design Objectives and the place and design principles
- Upgrades to public realm areas and streetscapes providing and improved pedestrian environment and accessibility
- Integration of the station with future development and reflecting the existing or desired future scale and character of local areas
- Tree plantings and landscaping to ensure no net loss of tree numbers and tree canopy.

The potential landscape character and visual amenity benefits and impacts associated with the operation of the Concept are outlined in Table 8-27.

Table 8-27: Operational landscape character and visual benefits and impacts

Urban setting	Potential operational benefits and impacts	Impact
CBDs • Parramatta • Sydney	The architecture of the new metro station entries would have a civic quality that provides a visual feature improving sense of place.	Beneficial landscape impacts
	Upgrades to adjacent public realm areas and streetscapes would improve pedestrian accessibility and amenity.	Beneficial landscape impacts
	The station entry architecture would be integrated into future development and would have a scale and character which would be in keeping with the surrounding built form.	Beneficial visual impacts
	Refreshed and upgraded public realm areas and streetscapes would improve the amenity of short range views from adjacent heavily used city streets and buildings.	Beneficial visual impacts
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Local amenity would be restored and improved by the public realm design of the new Metro station entries, including improvements to adjacent streetscapes and access to open space where possible	Beneficial landscape impacts
	The architecture of the new stations would provide a sense of place and precinct identity. Reconfigured street layouts and intersection upgrades if required, could improve local precinct accessibility, and provide improved pedestrian connectivity to stations and interchange facilities which would enhance permeability and accessibility for public transport customers.	Beneficial landscape impacts
	The station entry architecture would have a scale and character which would be in keeping with the surrounding built form and have a civic quality that provides a local feature within views.	Beneficial visual impacts
	Public realm areas would be refreshed and upgraded, including new trees, improving the amenity of short-range views from adjacent streets and residential areas.	Beneficial visual impacts
	The built form of the services facility would be architecturally designed considering its setting. The services facility would have a function driven scale and include service vehicle areas.	Adverse visual impacts
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	The architecture of the new metro station entries would have a civic quality that provides a visual feature and improves the sense of place within the emerging future urban form of urban renewal precincts.	Beneficial landscape impacts
	New public realm areas would be created, increasing public accessibility, amenity and passive recreation opportunities. At Sydney Olympic Park these areas would build upon the predominantly leafy character of the avenues.	Beneficial landscape impacts
	The station entry architecture would consider future development and would have a scale and character which would be in keeping with the future character of surrounding built form.	Beneficial visual impacts
	Built form would be designed to respond to the setting of any nearby heritage places and important streetscapes and plaza areas which have higher visual sensitivity.	Beneficial visual impacts
Industrial and urban services areas • Clyde • Silverwater	Views of the stabling and maintenance facility from residential and commercial areas, including the visibility of large structures such as the dive structure, retaining walls and bridge structures would be screened where practicable. Opportunities for the incorporation of vegetation into the services facility and stabling and maintenance facility for screening and amenity would be considered.	Neutral landscape and visual impacts

8.9.4 Potential construction impacts

Potential landscape character and visual amenity impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.9.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

The potential landscape character and visual amenity impacts associated with the construction of the Concept are outlined in Table 8-28.

Table 8-28: Potential construction landscape character and visual amenity impacts

Urban setting	Potential construction impacts	Magnitude
CBDs • Parramatta • Sydney	Removal of street trees reducing the amenity of streetscapes.	Adverse landscape impacts
	Temporary alterations to footpaths and diversion of inter-block pedestrian connections reducing local accessibility or legibility.	Adverse landscape impacts
	Potential impacts on the higher sensitivity public domain and parks within the Sydney CBD which are typically used intensively by the community during events, and the high density population share access to these recreational resources.	Higher adverse landscape impacts
	Temporary introduction of construction works and temporary site structures into a dense commercial precinct.	Adverse visual impacts
	Potential impact on the visual setting of heritage buildings.	Adverse visual impacts
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Removal of vegetation within the proposed construction site (if present) and on adjacent streets if required, reducing the temporary amenity of streetscapes.	Adverse landscape impacts
	Temporary alterations to footpaths and street reconfigurations reducing local accessibility or legibility.	Adverse landscape impacts
	Temporarily altered pedestrian movements and precinct arrangements during construction near existing stations, particularly North Strathfield Station which could reduce wayfinding and legibility.	Adverse landscape impacts
	Potentially direct impacts on recreational areas and parks if construction sites are located nearby.	Adverse landscape impacts
	Temporary introduction of construction works, and temporary site structures to residential, commercial or recreational areas which would contrast in scale and character.	Adverse visual impacts
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Potential impacts on the public domain of Sydney Olympic Park as these spaces are typically used intensively by the community during events.	Higher adverse landscape impacts
	Removal of vegetation within the construction sites and on adjacent streets (where required) reducing the amenity of streetscapes.	Adverse landscape impacts
	Temporary introduction of construction works, and temporary site structures into a dense urban setting with heritage places, residential and commercial uses.	Adverse visual impacts
Industrial and urban services areas • Clyde • Silverwater	Removal of vegetation within the proposed construction site and on adjacent streets reducing the amenity of streetscapes.	Adverse landscape impacts
	Potential visual amenity impacts associated with the construction of the stabling and maintenance facility as seen from surrounding roads, residential and commercial areas.	Adverse visual impact
	Potential changed landscape character as a result of bulk earthworks and the construction of structures such as retaining walls and bridges.	Adverse visual impact

8.9.6 Performance outcomes

Identified performance outcomes in relation to landscape character and visual amenity for operation and construction of the Concept are:

- The design reflects the Sydney Metro Design Objectives and the place and design principles
- The Sydney Metro Design Quality Framework is implemented
- Metro stations contribute positively to the surrounding urban environment and provide a sense of place
- No net loss of tree numbers and tree canopy.

8.9.7 Matters to be addressed in staged applications

Landscape character and visual amenity impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Landscape character and visual amenity assessments will include, as relevant to the stage:

- Description of the existing landscape character and visual sensitivity and the receivers which could be impacted
- Assessment of the landscape character impacts (including all ancillary infrastructure) on:
  - Key sites and buildings
  - Areas of open space and impacts on trees impacts
  - Streetscapes
  - Vegetation within the construction footprints.
- Assessment of the visual amenity impacts (including all ancillary infrastructure) on:
  - Key views and vistas
  - Streetscapes, recreation and open space areas
  - Heritage items including Aboriginal places and environmental heritage
  - The local community.
  - Identification of mitigation measures to address the landscape character and visual amenity impacts
  - Further Consultation with local Councils.

An assessment of landscape character and visual amenity impacts for Stage 1 is provided in Chapter 15 (Landscape character and visual amenity – Stage 1).

8.10 Business impacts

8.10.1 Legislative and policy context

The *Environmental Planning and Assessment Act 1979 establish*es the framework for social and economic impacts to be considered and assessed as part of the environmental planning assessment process.

Business impacts would be assessed using the significance categories and likelihood ratings established in the Australian Transport Assessment and Planning Guidelines (Australian Transport Council, 2016).

8.10.2 Assessment approach

This assessment involved:

- Describing the existing business environment within the Concept corridor
- Identifying the types of business impacts that could occur during construction or operation of the Concept
- Consultation with local Councils, business and industry groups
- Identifying performance outcomes
- Identifying the proposed scope of business impact assessments for future stages.

8.10.3 Existing environment

The existing regional business context across the Concept corridor is described in Table 8-29.

Table 8-29: Business context within the Concept

Urban setting	Business context
CBDs • Parramatta • Sydney CBD	Parramatta CBD is an established business district, recognised as Sydney's second CBD, with a substantial number and range of businesses. Businesses include commercial, retail, government administration, education, entertainment and events and other population serving businesses. The Sydney CBD is Sydney's primary business district, with important commercial, financial, retail and government centres. Businesses range from domestic to large international companies. There are a wide range of businesses in the Sydney CBD including retail, commercial, entertainment and events, education, cafes and restaurants.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Commercial and retail locations of varying size exist throughout the Concept corridor within suburban settings, from local village types to slightly larger suburban town centres. These locations provide easy access to goods and services, with some businesses having developed their own unique identity which reflects the local cultural diversity and needs of the community. North Strathfield is a small but growing suburban centre, which has three distinct business precincts: along Concord Road, along Queen Street and the Bakehouse Quarter and associated businesses along George Street. Businesses range from commercial, retail, education, cafes and restaurants which serve commercial customers and local communities in the suburb and from adjoining localities. Burwood North has a range of established businesses which serve the local population. Many of the businesses are located along main transport corridors such as the Parramatta Road corridor and Burwood Road. Businesses within the area include commercial, retail, educational and health uses. Businesses located within the Parramatta Road corridor are mainly focussed on the auto services industry (including car washes, repairs and maintenance and sales showrooms) but also include retail, commercial and local services. Businesses such as small retail shops and cafes, are generally located along the shopping strip of Burwood Road. Five Dock is an established local centre with a wide range of businesses serving the local population. The local centre also provides a key destination for the local community to connect and engage with others while accessing local goods and services. Businesses within the area include a wide range of retail, restaurants and cafes, commercial services, educational and health services. Between Five Dock and The Bays, there are local retail, commercial and services , mostly centred around Balmain Road/Darling Street in Lilyfield and Victoria Road in Rozelle.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Westmead is a growing town centre located adjacent to the Westmead health and education precinct. Businesses include those serving local populations such as local retail, services and cafes, as well as businesses that service or contribute to the health, education and research activities in the broader area. Sydney Olympic Park is Sydney's premier entertainment, sports and recreation precinct, attracting 10 million visitors a year. Businesses within the area range from commercial, education, short term accommodation, retail, cafes and restaurants. Some of these businesses are reliant on events within the area to attract customers. The Bays is a former industrial precinct adjoining Sydney Harbour. Significant urban renewal is planned for the area over the next 20-30 years, including new retail, commercial and residential areas. Existing businesses operating near The Bays are mainly industrial with heavy presence of automotive related or related to the operation of the White Bay Cruise Terminal. Businesses in the nearby suburbs of Balmain and Rozelle include retail and commercial.
Industrial and urban services areas • Clyde • Silverwater	Clyde is a heavy industrial precinct, as well as home to Rosehill Gardens racecourse. Businesses within Clyde range from commercial, industrial, manufacturing, warehousing and logistics. Silverwater is an industrial and urban services precinct with a large number of businesses specialising in manufacturing, urban services, and other industrial uses.

8.10.4 Potential operational benefits and impacts

The broader economic benefits of Sydney Metro West are detailed in Chapter 2 (Strategic need and justification).

The types of potential benefits and impacts to businesses during the operation of Sydney Metro West include:

- Improved accessibility and connectivity of business precincts around the Concept to the rest of Sydney. The benefits include increasing business access to local and regional labour markets and increasing customer access to businesses
- Increased visual amenity through placemaking initiatives at new metro stations – refer to Chapter 7 (Placemaking)
- Increased urban renewal and development around new metro stations adding to local placemaking – refer to Chapter 7 (Placemaking)
- Increase in passing trade for some existing businesses near new metro stations, depending on the type of business and their location. For example, retail businesses that serve customers such as convenience stores or cafes could experience an increase in trade from pedestrian flows to and from the metro station
- Potential adverse impacts associated with operational noise and vibration although these are likely to be negligible and mitigated through appropriate design of elements such as track form, mechanical and ventilation systems.

Potential local business impacts and benefits for different settings are described in Table 8-30.

Table 8-30: Potential business benefits and impacts

Urban setting	Potential operational benefits and impacts
CBDs • Parramatta • Sydney CBD	New metro stations in the Parramatta and Sydney CBDs would improve connectivity between Sydney's two core business districts further enhancing and reinforcing their regional and national importance. Sydney Metro West would effectively double rail capacity from Parramatta to the Sydney CBD. The Concept would also improve travel time between the Parramatta CBD and Sydney CBD to a target of about 20 minutes. It is expected these two metro stations would support further business investment and growth within the Parramatta and Sydney CBDs by providing greater connections between businesses, labour markets, customers and clients located within and near to the Concept corridor.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Sydney Metro West would increase the reach and use of Sydney's public transport network by providing new stations at Burwood North and Five Dock, which are not serviced by the existing suburban rail network. Locating metro stations in suburban centres would improve access to major employment centres and education facilities within the Concept corridor. At North Strathfield, a metro station would provide additional interchange capability and reduce crowding on existing rail services. This would provide greater access to employment and education opportunities for local workers, customers and communities. It is expected business investment would be attracted to suburban centres serviced by metro because they would become more accessible, improving access to labour markets and customers. As identified in Chapter 2 (Strategic need and justification), public transport accessibility and amenity are critical to supporting employment and supporting economic growth. There are not expected to be operational business impacts from the services facility proposed to be located between Five Dock and The Bays as it would only require periodic access for maintenance purposes.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	New metro stations in urban renewal areas would support opportunities for business investment, along with improving access and connectivity to labour markets, customers and visitors. The metro station at Westmead would contribute to and support the health, education and research precinct by increasing its accessibility for patients, customers and employees supporting the precinct in expanding its role, function and ability to serve the community. A new metro station at Sydney Olympic Park is expected to further enhance the area's role as Sydney's premier entertainment, sports and recreation precinct by providing direct connections from both the Parramatta and Sydney CBDs and other catchments within the Concept corridor. The presence of a metro station would provide more public transport options for members of the public travelling to events utilising supporting businesses and services. A new metro station at The Bays is a vital component of The Bays Precinct Masterplan and would provide access to an area not currently serviced by the existing suburban rail network. Increased accessibility would support revitalisation of the area and encourage further business investment which otherwise may not be realised. It would also improve connectivity to existing commercial centres, such as Parramatta CBD and Sydney CBD, providing greater opportunities for employment and economic growth within the precinct and across the corridor due to increased public transport access for workers and customers to the area.
Industrial and urban services areas • Clyde • Silverwater	A stabling and maintenance facility at Clyde is expected to provide a limited range of positive business impacts. Local retail, cafes and restaurants are expected to benefit most from the presence of the operational workforce. The services facility at Silverwater would have only minor impacts as it would be in keeping with surrounding industrial land uses.

8.10.5 Potential construction impacts

Potential business impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.10.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

Some businesses around construction sites could experience an increase in passing trade due to nearby construction workers. Construction impacts are expected to vary depending on a number of factors, including the type of business, its location relative to a construction site and the potential type of business impact. The main types of potential impacts that could affect businesses during the construction phase include:

- Direct impacts to businesses where they are located within the properties being acquired. This process is managed in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and Sydney Metro assists businesses through this process
- Potential temporary changes to employee and customer access if traffic congestion due to vehicle movements from the construction site leading to increased travel times
- Potential loss of parking near construction areas which could affect access to businesses for both employees and customers
- Potential temporary reduced local amenity (due to noise, vibration dust and visual impacts) which could affect certain types of businesses (e.g. cafés)
- Potential for temporary reduction in passing customers due to changes in access or business visibility.

Potential local business impacts for different settings are described in Table 8-31.

Table 8-31: Potential construction business impacts

Urban setting	Potential construction impacts
CBDs • Parramatta • Sydney CBD	Construction activities at the Parramatta and Sydney CBDs that reduce local amenity (from visual impacts, increased noise or dust levels) could temporarily impact businesses such as cafes and restaurants, which are more susceptible to these impacts. Impacts are expected to be slightly greater in CBD areas compared to other areas due to the comparatively larger number of businesses within Parramatta and Sydney CBDs. However, these areas are diverse and dynamic, with a high capacity to absorb and adapt to construction impacts.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Visual impacts, increased noise levels, dust and construction traffic could temporarily impact certain local businesses. Businesses that are located on busier roads like Parramatta Road and Burwood Road may be less susceptible to amenity impacts due to the existing lower amenity from high traffic volumes compared to quieter local roads. If traffic congestion occurs due to truck movements from the construction sites, or parking losses are significant, this could temporarily affect the attractiveness for customers to visit certain suburban centres to access products and services from local businesses.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Construction activities in or around urban renewal precincts could temporarily impact on local business through amenity related issues (e.g. visual, or increased noise and dust levels) and construction traffic from vehicle movements to and from construction sites. A large number of businesses within these precincts form the main attraction to the area and are expected to be less susceptible to amenity related impacts. This includes businesses associated with the health, education and research activities at Westmead and sporting and entertainment venues in Sydney Olympic Park. Businesses which occupy commercial offices may also be less susceptible to amenity impacts but may be impacted by traffic congestion caused by construction traffic. Businesses within The Bays Precinct are less likely to experience amenity related impacts owing to the existing industrial nature of the area. However, the area is highly car dependent and businesses are relatively more sensitive to temporary disruptions or congestion on the local road network.
Industrial and urban services areas • Clyde • Silverwater	Businesses within industrial areas may be less susceptible to amenity related impacts. The areas are highly car dependent and businesses are relatively more sensitive to temporary disruptions to the local road network.

8.10.6 Performance outcomes

Identified performance outcomes in relation to business impacts for operation and construction of the Concept are provided in Table 8-32.

Table 8-32: Business performance outcomes

Operational performance outcomes	Construction performance outcomes
• Potential impacts to businesses are minimised • Connectivity is improved to, from and between businesses in Greater Parramatta, the Sydney CBD and other centres.	• Potential impacts to businesses are minimised • Affected businesses are communicated with in a clear and timely manner to reduce disruption and address concerns • Access to businesses for employees and customers is maintained • Assistance is provided to businesses that are adversely impacted.

8.10.7 Matters to be addressed in staged applications

Business impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Business impact assessments will include, as relevant to the stage:

- Identification of businesses that may be directly or indirectly impacted
- Assessment of the potential impacts on local businesses
- Identification of measures to avoid or mitigate the potential impacts
- Further consultation with local government, business and industry groups.

An assessment of business impacts for Stage 1 is provided in Chapter 16 (Business impacts – Stage 1).

8.11 Social impacts

8.11.1 Policy and legislative setting

The *Environmental Planning and Assessment Act 1979* establishes the framework for assessing all types of development in New South Wales. In particular, the objects of the *Environmental Planning and Assessment Act 1979* include the need to promote the social and economic welfare of the community and to include social considerations in decision-making about environmental planning and assessment.

Guidelines relevant to the assessment of social impacts include:

- International Principles for Social Impact Assessment (Vanclay, 2003)
- Social impact assessment: NSW Department of Planning, Industry and Environment's Draft guidelines for State significant mining, petroleum production and extractive industry development (Department of Planning and Environment, 2017).

8.11.2 Assessment approach

This assessment involved:

- Describing the existing social environment where surface sites for construction and/or operation could be located along the Concept corridor
- Assessing the potential social impacts of operating and constructing the Concept
- Consultation with local Councils, the potentially impacted and broader community
- Identifying performance outcomes
- Identifying the proposed scope of social impact assessments for future stages.

8.11.3 Existing environment

Community profile

For Census purposes, the Australian Bureau of Statistics breaks regions down into statistical areas. Statistical Area Level 2 is the second smallest unit, often based on officially gazetted State suburbs and localities (Australian Bureau of Statistics, 2013). There are 15 Statistical Area Level 2 units relevant to the Concept corridor. As at the 2016 Census, the combined population within these areas was 306,563. Other demographic trends include:

- The largest overall household type is 'couple households with children', which tended to be higher in the western extent of the Concept. Lone person households tended to be higher in the eastern extent. There were also larger household sizes in the western areas
- The level of household income across the Concept was comparable to Greater Sydney. Households with higher incomes tend to be concentrated in the east, whereas the level of income tends to decline further west, particularly between Westmead and Clyde
- There are high levels of cultural and linguistic diversity including:
  - Large numbers of residents identifying as Indian in the western extent of the Concept
  - Large numbers of residents identifying as Chinese in the areas around Sydney Olympic Park to Burwood
  - A noticeable grouping of residents identifying as Italian around the Burwood to Lilyfield area
- The proportion of English-speaking households was higher in the east but tended to be lower along the western extent. Newly arrived migrants tended to live in the western part of the Concept corridor
- Areas in the west have a relatively higher level of disadvantage across all 'socio-economic indexes for areas', whereas areas to the east, and around Sydney Olympic Park, have relatively higher levels of advantage

- Within the Concept corridor, most jobs are within the Sydney CBD followed by Parramatta CBD. The share of jobs across the other station catchments is quite low, with most of these jobs being 'population serving' jobs that services the local population
- Most of the station catchments within the Concept corridor support a large number of dwellings and are important population centres - the exception being Sydney Olympic Park. The low share of dwellings in this area is due to its historic role and function being an entertainment centre rather than a population centre.

Social infrastructure

The Concept corridor contains a wide range of regional, district and local social infrastructure serving a broad catchment across greater Sydney.

There are a number of significant regional social infrastructure assets within the Concept, including hospitals, regional open space and recreation facilities, heritage assets and cultural and creative facilities.

Local and district social infrastructure within the Concept includes schools, childcare centres, open spaces, medical facilities, aged care facilities, community facilities, creative and cultural facilities and recreation facilities.

Within predominantly industrial and commercial settings, such as Silverwater and Clyde, there tends to be very limited social infrastructure given the lack of residential population in these areas. Similarly, Sydney Olympic Park is a mainly recreation and entertainment destination with limited other social infrastructure.

Community values

Key community values within the Concept include:

- Economic activity and regional infrastructure is concentrated within key centres (including Parramatta CBD and Sydney CBD). Residents are seeking opportunities to reduce travel times and congestion and to be able to access social infrastructure, employment opportunities and housing close to where they live
  - Concentrations of employment, educational opportunities and high-value knowledge sector jobs occur within and around the CBDs, particularly the Sydney CBD. This contributes to a Greater Sydney that is divided by economic opportunity, health and social outcomes
  - Increasing pressures and community concerns related to housing affordability near places of employment, local shopping centres and leisure precincts
  - A number of neighbourhoods have maintained a low scale, walkable, neighbourhood character that is valued by the local community. Other neighbourhoods have higher densities, more employment opportunities and activation opportunities throughout the day and night, such as Parramatta and Sydney CBD
- Many of the residential precincts are tightly formed residential neighbourhoods, reliant on local social infrastructure, community facilities and services for their day-to-day community health and wellbeing
  - A wide range of infrastructure and urban renewal projects within and near the Concept are transforming communities and potentially affecting connection to place, which has resulted in community concern in relation to some projects.

An overview of the community profile and social infrastructure of the different settings within the Concept are described in Table 8-33.

Table 8-33: Social context within the Concept

Urban setting	Social context
CBDs • Parramatta • Sydney	**Community profile(s)** There are increasing residential populations within the Parramatta and Sydney CBDs, where residents tend to be relatively young and culturally and linguistically diverse. There are large housing development areas within 30 minutes of the Parramatta CBD, which is increasing demand for jobs and services away from the traditional Sydney CBD centre. Within the Concept, more than 70 per cent of jobs are based in either the Parramatta or Sydney CBDs, with more than 50 per cent of jobs based in the Sydney CBD. **Social infrastructure** The CBD areas contain numerous items of key social infrastructure, often the focus of large regional events, recreation and tourism. They include Parramatta Park, Hyde Park and the Domain and Western Sydney Stadium.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	**Community profile(s)** The suburban areas are made up of mostly residential areas, with a mix of low to medium density housing. There are a smaller number of jobs located within the suburban areas compared to other settings within the Concept, which are generally limited to jobs that service the local population. **Social infrastructure** Social infrastructure within the suburban setting tends to cater for local community events and recreation, including sporting grounds such as Concord Oval, along with local parks and community facilities.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	**Community profile(s)** Community profiles vary between the urban renewal precincts. Sydney Olympic Park contains relatively few residents, compared to Westmead and The Bays areas that are surrounded by large residential neighbourhoods. Job opportunities within the urban renewal precincts tend to be focused around specialty areas such as medical, education, sporting and industrial, reflecting the existing infrastructure within each of the precincts. **Social infrastructure** The Westmead and Sydney Olympic Park areas in particular contain a number of items of key social infrastructure, including Westmead Hospital, Westmead Children's Hospital, Western Sydney University (Westmead Campus), Parramatta Park, ANZ Stadium and Sydney Olympic Park Aquatic Centre.
Industrial and urban services areas • Clyde • Silverwater	**Community profile(s)** The Clyde and Silverwater areas are dominated by heavy industry, with some residential areas nearby. Job opportunities are linked to the existing industrial operations and support services. **Social infrastructure** Key social infrastructure within the industrial and urban services areas include Sydney Speedway (located on government owned land and currently leased from the government).

8.11.4 Potential operational benefits and impacts

The Concept has the potential to provide opportunities and impacts on a number of social factors including way of life, community composition and character, access to infrastructure, services and facilities, culture, health and wellbeing.

Potential social opportunities may include:

- Increased economic development opportunities due to greater access to public transport and urban renewal
- Improvements to accessibility due to new public transport opportunities in areas which are currently disconnected from high speed and high capacity public transport
- Increased use of public transport due to increased connections and faster travel times compared to existing transport options
- Improved equity, particularly for groups that currently experience transport or mobility difficulties such as older people, youth, people experiencing disability, non-drivers or people without access to a private vehicle
- Increased opportunities for healthy active lifestyles and reduced car trips as users walk and cycle to stations on improved pedestrian and cycle facilities
- Increased access to jobs, universities, and social infrastructure across the Concept and greater Sydney, which helps to improve social cohesion and reduce social health related issues.

Potential social impacts may result from the following:

- Changes to community character and composition due to loss of established businesses, changes to streetscape and urban fabric
- Changes in access to community facilities, businesses or services due to relocation
- Reduced visual amenity associated with new structures or impaired view to heritage items or familiar local landmarks
- New facilities may conflict with existing community values and character for some members of the community.

Additional potential social benefits and impacts within each setting associated with operation of the Concept are identified in Table 8-34. Cumulative impacts are discussed in Section 8.21.

Table 8-34: Potential operational social benefits and impacts

Urban setting	Potential operational benefits and impacts
CBDs • Parramatta • Sydney	**Benefits** Improved accessibility to employment precincts in the Parramatta CBD and Sydney CBD. **Impacts** Changes to sense of place associated with potential impacts to heritage items, loss of established businesses, changes to streetscape and urban fabric Changes to how the community functions, through changes to accessibility of services, recreation facilities and open space.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	**Benefits** Increased community pride associated with renewal and activation of areas surrounding the metro stations Increased employment opportunities associated with new business growth close to the proposed metro stations and increased productivity of local businesses due to increased foot traffic from customers accessing the metro Potential for increased property values for housing and commercial premises within walking distance to public transport opportunities Positive changes to localised community character and sense of place associated with placemaking opportunities, potential for activation and viability of local centres. **Impacts** Perceived and potential safety impacts associated with increased numbers of people using metro stations, resulting in an influx of unfamiliar visitors to some areas, including low density neighbourhoods Perception of changes to community values and connections due to potential shifts in community composition, associated with potential new development and changes in employment distribution Changes to how the community functions, through changes to accessibility of services, loss of community meeting spaces, recreation facilities and open space.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	**Benefits** • Increased economic development opportunities as a result of precinct development and improved accessibility to employment precincts in Sydney Olympic Park and Westmead • Increased community pride and excitement associated with renewal and activation of areas surrounding proposed metro stations • Increased employment opportunities associated with new business growth close to metro stations and increased productivity of local businesses due to increased foot traffic from customers accessing the metro • Potential for increased property values for housing and commercial premises within walking distance to public transport opportunities • Positive changes to localised community character and sense of place associated with placemaking opportunities, potential for activation and viability of local centres.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	**Impacts** • Changes to community character and values due to urban renewal and development • Perceived and potential safety impacts associated with increased numbers of people using metro stations, resulting in an influx of unfamiliar visitors to some areas, including low density neighbourhoods • Perception of changes to how the community functions, through changes to accessibility of services, loss of community meeting spaces, recreation facilities and open space.
Industrial and urban services areas • Clyde • Silverwater	**Benefits** • Increased economic development opportunities within the industrial and urban services areas as a result of new maintenance and service facilities. **Impacts** • Changes to the composition of employment opportunities.

8.11.5 Potential construction impacts

Potential social impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.11.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage. Mitigation measures and performance outcomes associated with amenity related issues (such as noise, traffic, visual and air quality) would also manage potential special impacts.

Within the Concept as a whole, potential social impacts during construction may include:

- Potential for temporary noise and vibration impacts to communities above tunnelling activities between construction sites, with associated impacts relating to concerns about property damage
- Potential to temporarily impact traffic conditions for road users on existing road networks, potentially affecting people's daily routines and access to services
- Potential for temporary reductions in amenity due to construction noise and vibration particularly near construction sites
- Potential for temporary changes to working and living environments for residents, workers and visitors in around construction precincts
- Potential for temporary impacts to health and wellbeing associated with construction noise and vibration (e.g. sleep disturbance and stress). These impacts would affect communities near construction sites, along with those living or working above the tunnels
- Potential impacts to wellbeing associated with compulsory property acquisition, and uncertainty for affected businesses and residents
- Potential for cumulative negative wellbeing impacts, such as fatigue, frustration and stress, associated with ongoing construction associated with major infrastructure projects of a long duration, including Westconnex, Parramatta Light Rail and Sydney CBD and South East Light Rail.

Potential construction social impacts associated with each setting are described inTable 8-35. Cumulative impacts are discussed in Section 8.21.

Table 8-35: Potential social impacts within each Concept setting during construction

Urban setting	Potential construction impacts
CBDs • Parramatta • Sydney	• Temporary disruption to pedestrian and vehicle movements, changes to road and public transport routes and access patterns, resulting in potential disruption to daily routines • Temporary changes to access to local retail and community facilities and recreation facilities.

Urban setting	Potential construction impacts
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	• Temporary disruption to pedestrian and vehicle movements, changes to road and public transport routes and access patterns, changed wayfinding and pedestrian accessibility, resulting in potential disruption to daily routines. Changes are likely to be more challenging for people living with disabilities, older people and children and their carers • Perceived safety impacts associated with changed sightlines, changes to wayfinding, and the reduced (or increased) activation of construction precincts at night, which may affect residents' decisions to access particular community facilities or localities • Reduced car parking available to communities, resulting in increased inconvenience and disruption • Temporary changes to access to local retail and community facilities and recreation facilities • Perceived changes to sense of community associated with acquisition and introduction of construction sites, particularly within the Five Dock town centre • Perceived safety impacts associated with the influx of unfamiliar construction workers to neighbourhoods, particularly when construction sites are located close to sensitive receivers (e.g. schools, childcare centres, nursing homes).
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	• Temporary changes to community connections to place and local place narratives associated with the transformation of the area, e.g. the transition of areas from industrial or suburban residential contexts to more activated, mixed-use precincts • Temporary disruption to pedestrian and vehicle movements, changes to road and public transport routes and access patterns, changed wayfinding and pedestrian accessibility • Perceived safety impacts associated with changed sightlines, changes to wayfinding, and the reduced (or increased) activation of construction precincts at night, which may affect residents' decisions to access particular community facilities or localities • Reduced car parking available to communities, resulting in increased inconvenience and disruption • Temporary changes to access to local retail and community facilities and recreation facilities • Perceived safety impacts associated with the influx of unfamiliar construction workers to neighbourhoods, particularly when construction sites are located close to sensitive receivers (e.g. schools, childcare centres, nursing homes).
Industrial and urban services areas • Clyde • Silverwater	• Temporary disruption to vehicle movements, changes to road and public transport routes and access patterns.

8.11.6 Performance outcomes

Identified performance outcomes in relation to social impacts for operation and construction of the Concept are provided in Table 8-36.

Table 8-36: Social performance outcomes

Operational performance outcomes	Construction performance outcomes
• Negative impacts on customers and the community (including transport services, amenity, noise and vibration, water management and air quality) are minimised • Impacts on the availability and quality of public open space and social infrastructure are avoided • Access to local facilities, services and destinations is improved, supporting opportunities for community interaction and improving social connections and connection to place • Placemaking at stations provides a focal point for the community improving social cohesion • Legacy projects are delivered to benefit local communities.	• Negative impacts on customers and the community (including transport services, amenity, noise and vibration, water management and air quality) are minimised • Affected communities are communicated with in a clear and timely manner to enhance community benefits, reduce disruption and address community concerns.

8.11.7 Matters to be addressed in staged applications

Social impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Social impact assessments will include, as relevant to the stage:

- Identification of the existing social environment and any impacts to social conditions, communities and community values
- Review of community characteristics, including identification of significant community infrastructure
- Assessment of the social impact on the directly affected community and its facilities and/or services
- Identification of any community facilities that would be lost, and if alternative facilities are available or if the facilities can be replaced in the local area
- Identification of community facilities adjacent to construction sites that may be impacted by reduced amenity or access
- Identification of mitigation and management measures for the potential impacts
- Further consultation with the impacted and broader community.

An assessment of social impacts for Stage 1 is provided in Chapter 17 (Social impacts – Stage 1).

8.12 Groundwater and ground movement

8.12.1 Legislative and policy context

The policy context for the assessment of potential groundwater impacts includes:

- National Water Quality Management Strategy which is the adopted national approach to protecting and improving water quality in Australia. The strategy includes the Guidelines for Groundwater Quality Protection in Australia (Australian Government, 2013), which sets out a high-level risk-based approach to protecting or improving groundwater quality for a range of groundwater beneficial uses (called 'environmental values')
- The NSW Department of Planning, Industry and Environment's NSW Aquifer Interference Policy (NSW Office of Water, 2012) which defines the regime for protecting and managing impacts of aquifer interference activities on NSW water resources. The policy requires that an aquifer interference activity (such as excavation which intercepts the aquifer) meets defined minimal impact considerations and that any change in groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity
- The NSW Department of Planning, Industry and Environment's NSW State Groundwater Dependent Ecosystems Policy (Department of Land and Water Conservation, 2002) provides guidance on the protection and management of Groundwater Dependent Ecosystems.

Under the *Water Management Act 2000*, water sharing plans provide the basis for equitable sharing of surface water and groundwater between water users, including the environment. For groundwater, Stage 1 lies within the area covered by the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011. The Water Sharing Plan contains provisions for allocation of water to construction projects through a volume of 'unassigned water' or through the ability to purchase an entitlement where groundwater is available under the long-term average annual extraction limit.

8.12.2 Assessment approach

This assessment involved both a desktop review of the existing groundwater data for areas near the Concept, and a review of data obtained from field investigations for Sydney Metro West. The assessment included:

- Reviewing relevant legislation, guidelines and policies
- Reviewing data from relevant databases, including the WaterNSW groundwater bore database, the Water Register and the Bureau of Meteorology Groundwater Dependent Ecosystems Atlas
- Identifying the primary groundwater risks during construction and operation
- Assessing the potential groundwater impacts based on the risks and level of sensitivity identified
- Identifying performance outcomes
- Identifying the proposed scope of groundwater and ground movement assessments for future stages.

8.12.3 Existing environment

Geology

The geology of the Concept corridor is dominated by Triassic-Age Ashfield Shale of the Wianamatta Group. The alignment is crossed by Triassic-Age Hawkesbury Sandstone of the Wianamatta Group; Quaternary Age alluvial/fluvial sediments comprising sand, silt and clay; and fill.

Information obtained as part of site investigations, and desktop review of the NSW Government's 1:100,000 Geological Sheet 9030 for Parramatta (Herbert and Smith, 1991) and the 1:100,000 Geological Sheet 9130 for Sydney (Herbert, 1983), indicate the geological units in the region of the Concept include, in order of shallowest to deepest:

- Fill – typically comprising waste, emplaced material and engineered fill. Reclaimed land areas are generally located next to the harbour and include parkland, residential, industrial, and open space areas
- Quaternary deposits – alluvial and marine sediments associated with gullies, valleys, and former drainage channels
- Ashfield Shale – comprising claystone, mudstone, siltstone, laminites, and fine-grained lithic sandstone of four variably thick sub-units
- Mittagong Formation – comprising interbedded dark siltstone and fine-grained sandstone beds and laminae of varying thickness
- Hawkesbury Sandstone – typically medium- to coarse-grained quartz sandstone. It generally has a shallow weathering profile, but possesses increased defects in zones of faulting, shear and valley stress relief.

A number of structural features, including faults, dykes and joint swarms, have also been identified and inferred. The regional geological context within the Concept is shown in Figure 8-3.

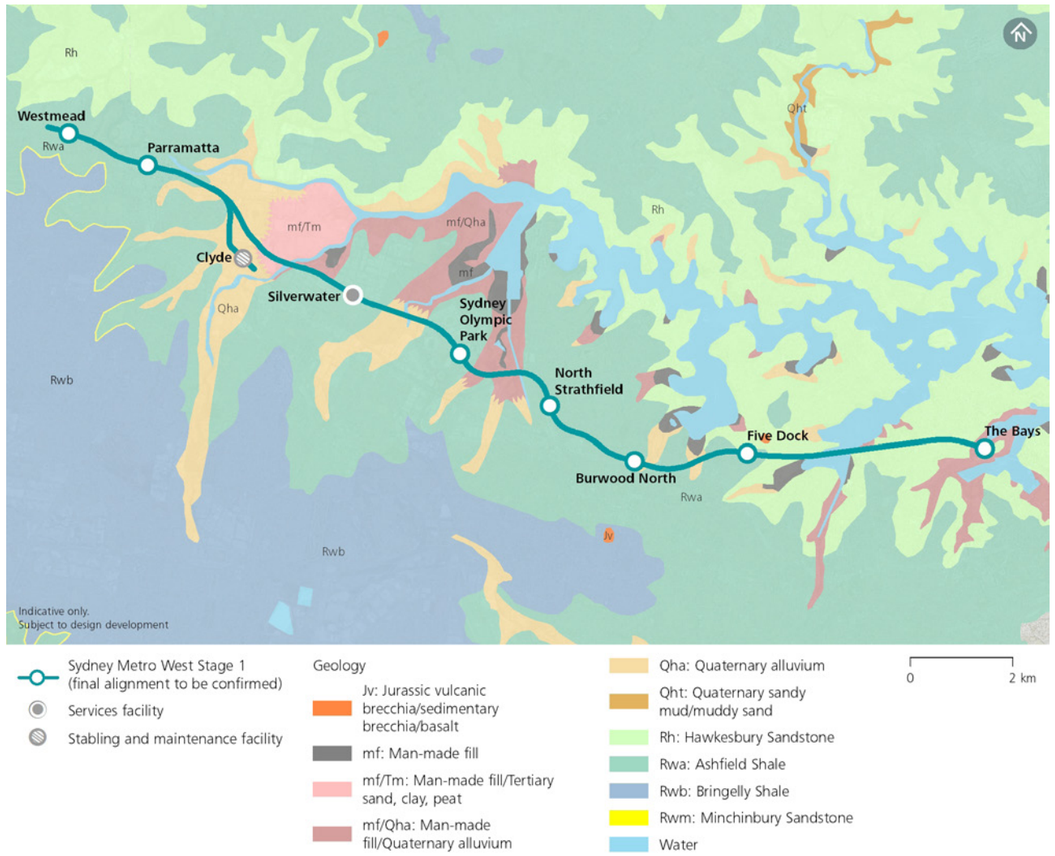

Figure 8-3: Regional geological context

Aquifers

Aquifers are permeable rocks or soil that transmit groundwater and are related to the geological units. Aquifers near the Concept corridor include porous and fractured rock aquifers. Porous aquifers in alluvial soils are continuous (unconfined) over an area. Porous aquifers in the residual soils are often ephemeral and result from water building on bed rock, where there is perched groundwater and are localised and discontinuous and are reflective of water moving down the soil profile into the underlying bedrock.

Fractured rock aquifers occur where groundwater is transmitted through fractures or joints and bedding planes, such as in the shales and Hawkesbury Sandstone.

The permeability of the shale, siltstone and sandstone is generally low to very low, with most of the groundwater flow transmitted through joints and fractures. The alluvial/residual soils are of variable permeability but generally expected to be relatively low.

Groundwater levels

The groundwater level along most of the Concept corridor is between five and 30 metres below ground level. Local shallow groundwater within residual soils is anticipated to be between two and five metres below ground level.

Groundwater data from along the Concept corridor indicates that there is generally hydraulic connection between the soil and rock aquifers. At some locations a perched water table may be present within the soils.

Soils are recharged by rainfall, localised irrigation and incidental runoff from impervious surfaces. Recharge to the rock groundwater systems is by downward filtration through soils. Where rock is exposed at the surface, it is anticipated that there is direct recharge of the rock groundwater system. Groundwater discharge is expected to occur to drainage lines and water bodies.

Groundwater quality

Groundwater quality is influenced by both the underlying geology and potential contaminants that may leach into the groundwater system. Groundwater quality is typically fresh to brackish, with near-neutral pH and shows concentrations of numerous heavy metals above the Australian and New Zealand Environment and Conservation Council (ANZECC) trigger levels for protection of aquatic ecosystems (ANZECC, 2019). This is not uncommon for groundwater encountered in the Sydney basin.

The expected groundwater quality based on key geological units within the Concept corridor is shown in Table 8-37.

Table 8-37: Expected groundwater quality in key geological units

Geological unit	Expected salinity	Expected pH	Other expected characteristics
Quaternary deposits	Fresh to saline 300 milligrams per litre to 20,000 milligrams per litre	Neutral to slightly acidic (4-8)	Nil
Ashfield Shale	Brackish to saline 2,000 milligrams per litre to 20,000 milligrams per litre	Neutral to slightly acidic (4-8)	Nil
Hawkesbury Sandstone	Fresh to brackish 300 milligrams per litre to 1,400 milligrams per litre	Neutral to slightly acidic (4.5 to 8)	Elevated iron Elevated manganese
Mittagong Formation	Fresh to brackish 250 milligrams per litre to 350 milligrams per litre	Neutral to slightly acidic (4.5 to 8)	Elevated iron Elevated manganese

There is potential for contaminants to have leached into the groundwater due to the highly disturbed nature of much of the Concept corridor and former industrial uses at locations such as Clyde, Sydney Olympic Park and The Bays. These contaminants may include heavy metals, total recoverable hydrocarbons, benzene, toluene, ethyl benzene and xylene, polycyclic aromatic hydrocarbons, nutrients, hexavalent chromium, total and speciated phenols, per- and polyfluoroalkyl substances, volatile organic compounds, organochlorine and organophosphate pesticides, and tributyltins. Areas of fill or reclaimed land may have a higher potential risk of groundwater contaminants, these risks are discussed further in Section 8.14 (Contamination – Concept).

Groundwater users

A review of the WaterNSW Groundwater Bore Database (WaterNSW, 2019) and the Register of Water Approvals (WaterNSW, 2019) identified 333 registered groundwater bores within about one kilometre of the Concept corridor. Of the 333 registered bores, five are supply bores, one is for dewatering and one is for commercial/industrial purposes. All others are recorded as monitoring bores or for unknown/exploration purposes.

Of the five supply bores, three bores are listed as functional (GW108611 – located near Westmead; GW024667 – located near Parramatta; GW106471 - located near the Sydney CBD). The status of the other two supply bores is unknown (GW305646 - located near Burwood North; GW200690 – located near the Sydney CBD). The status of the bore for commercial/industrial purposes (GW108378 - located near Westmead) is also unknown.

The NSW Water Register provides information on water licencing. Based on this, only one bore of those listed above (GW106471, located near the Sydney CBD) is listed as active. This suggests that only this bore is licenced to actually extract groundwater. The status of groundwater licences would be investigated further during assessment of each stage.

Groundwater dependent ecosystems

A search of relevant online tools and review of the biodiversity assessment for the Concept identified groundwater dependent ecosystems within 500 metres of the Concept corridor near the Westmead metro station and Clyde stabling and maintenance facility (refer to Section 8.16 Biodiversity - Concept).

Protected wetlands

The Bicentennial Park Wetlands and the Newington Wetlands, both at Sydney Olympic Park, are listed as Nationally Important Wetlands. Online search tools did not identify any Ramsar Wetlands near the Concept corridor.

8.12.4 Potential operational benefits and impacts

To limit potential groundwater inflows and groundwater drawdown, the metro tunnels would be tanked (designed to prevent the inflow of groundwater, typically using concrete lining and waterproofing membrane). Similarly, the cross passages and some of the station caverns would be tanked. As a result, limited change is expected to groundwater levels.

When operational, Sydney Metro West could cause interaction between groundwater and surface water along the alignment which would likely be limited to:

- Likely surface water infiltration that percolates through the soil and/or rock and contributes to groundwater
- Discharge from groundwater to surface watercourses and waterbodies
- Leakage from surface watercourses to groundwater.

The main impacts from operation could occur where untanked stations are proposed (i.e. groundwater could flow into the station excavation across both soil and rock) and could include:

- Ongoing groundwater drawdown, that is, lowering of the water table due to station excavations, until a steady state is reached
- Impacts on groundwater users (if present) due to reduced groundwater yields in existing bores as a result of groundwater drawdown
- Potential for ground settlement at sites where alluvial/fluvial soils are present below the groundwater table in the vicinity of drained structures.

8.12.5 Potential construction impacts

Potential groundwater and ground movement impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.12.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

For the running tunnels, the tunnel boring machines would install a pre-cast segmental tunnel lining as excavation progresses. Therefore, the tunnels would be tanked almost immediately following the tunnel boring, preventing groundwater from entering the tunnels. As such, tunnel construction is anticipated to possibly cause only short-term disruption to groundwater levels.

Some of the station excavations would similarly be tanked (sealed), which would prevent groundwater from the surrounding rock and soil flowing into the excavation. Other excavations for stations or services facilities would be untanked.

Tunnelling activities and underground excavations have the potential to impact on groundwater and ground movement during and immediately following construction. Potential impacts include:

- Where excavations are untanked and occur below the water table, groundwater would flow into the excavation through the aquifers (porous aquifers or the fractures and joints). This groundwater inflow would be pumped out of the excavation (dewatering) which could result in lowering the water table near the excavation, causing groundwater drawdown
- Groundwater drawdown may reduce existing groundwater baseflow and modify local groundwater flow regimes. This has the potential to impact on groundwater dependent ecosystems – refer to Section 8.16 (Biodiversity – Concept)
- Possible reduction of surface water baseflow in surface water bodies (such as creeks and wetlands) if the underlying groundwater contributes to stream baseflow and is impacted by groundwater drawdown
- Potential mobilisation of groundwater contaminants (where present) due to groundwater drawdown
- Potential ground movement and settlement due to the removal of soil and/or rock through tunnelling or excavation activities and from the possible effects of groundwater drawdown
- Potential impacts on groundwater users due to reduced groundwater yields, reduced groundwater quality and/or direct impacts and damage to existing groundwater bores. Potential to reduce available groundwater supply at one bore located near Sydney CBD (GW106471) has been identified
- Potential reduction in infiltration of rainfall or surface water into the groundwater system due to the structures extending below the groundwater table (such as piled walls) and the increase in impervious areas.

There is also the potential to temporarily impact on surface water quality due to the discharge of treated groundwater (from construction activities) into the stormwater system. Temporary water treatment plants would treat collected groundwater so that the discharge requirements meet any relevant environment protection licence or the requirements of the *Protection of the Environment Operations Act 1997*.

Where station excavations are not tanked, the potential groundwater drawdown during construction would depend on site-specific conditions, and the interaction of recharge sources and drainage measures. The generally low hydraulic conductivity of the Mittagong Formation, Hawkesbury Sandstone and Ashfield Shale geological units indicates the extent of groundwater drawdown may be limited by relatively low discharge rates compared to recharge sources. Rock near water-bearing geological features such as faults, dykes and joint swarms does have the potential for relatively high hydraulic conductivity, potentially increasing the pathways of groundwater flow to those excavations.

8.12.6 Performance outcomes

Identified performance outcomes in relation to groundwater and ground movement for operation and construction of the Concept are:

- Groundwater supply for licenced groundwater users is not significantly affected by groundwater drawdown
- The groundwater accessible to groundwater dependent ecosystems is not significantly reduced
- Structural damage to buildings from ground movement associated with excavation, tunnelling or groundwater drawdown is avoided.

8.12.7 Matters to be addressed in staged applications

Groundwater and ground movement impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Groundwater and ground movement assessments will include, as relevant to the stage:

- Characterisation of the existing environment including climate, topography, geology, groundwater occurrence, quality and use, existing groundwater users and groundwater dependent ecosystems which would include desktop studies and site investigations
- Modelling of groundwater flow to assess the potential groundwater inflows to proposed excavations and associated groundwater drawdown during construction and to untanked structures/elements during operation

- Assessment of potential groundwater-related impacts due to estimated groundwater level drawdown associated with construction, operation and cumulative impacts, based on modelling results. Consideration of potential impacts including those related to groundwater dependent ecosystems, acid sulfate soils, groundwater contamination, groundwater quality and ground settlement (including associated potential damage to infrastructure/sensitive assets)
- Assessment of the requirements for treatment of collected groundwater at each excavation during construction and drained structures/elements during operation
- Identification of mitigation measures for the potential impacts.

An assessment of groundwater and ground movement impacts for Stage 1 is provided in Chapter 18 (Groundwater and ground movement – Stage 1).

8.13 Soils and surface water quality

8.13.1 Legislative and policy context

The Australian Government Department of Agriculture's National Water Quality Management Strategy (Australian Department of Agriculture and Water Resources, 2018) is the adopted national approach to protecting and improving water quality in Australia. The National Water Quality Management Strategy contains guidelines for setting water quality objectives to sustain current or likely future environmental values for water resources.

Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) have developed water quality guidelines to provide a set of tools for assessing and managing ambient water quality in natural and semi-natural water resources. The ANZECC/ARMCANZ Water Quality Guidelines, 2000 (ANZECC/ARMCANZ (2000) guidelines) provide a framework for conserving ambient water quality in rivers, lakes, estuaries and marine waters and list a range of environmental values assigned to that waterbody. The guidelines provide recommended trigger values which have been considered when describing the existing water quality and key indicators of concern.

The NSW Government has developed NSW Water Quality and River Flow Objectives (Department of Environment, Climate Change and Water, 2006) that are consistent with the National Water Quality Management Strategy (Australian Department of Agriculture and Water Resources, 2018). The water quality objectives are the agreed environmental values and long-term goals for NSW surface water. The water quality objectives provide environmental values for NSW waters and the ANZECC/ARMCANZ (2000) guidelines provide technical guidance to assess the water quality needed to protect these values.

8.13.2 Assessment approach

This assessment involved:

- Reviewing desktop information to describe the existing soil types, catchments and sensitive receiving environments within the Concept
- Identifying the types of potential soil and surface water quality impacts which may occur during construction and operation of the Concept
- Consultation with the NSW Environment Protection Authority to discuss assessment approach
- Identifying performance outcomes
- Identifying the proposed scope of soils and surface water quality assessments for future stages.

8.13.3 Existing environment

Soil types

The geology of the Concept corridor is dominated by Quaternary Age alluvial/fluvial sediments and fill, along with Wianamatta Group Ashfield Shale and Hawkesbury Sandstone, as discussed in Section 8.12 (Groundwater and ground movement – Concept). The Soil Landscapes of Sydney 1:100,000 Sheet (Tille et al., 2009) and Penrith 1:100,000 Sheet (Hazelton et al., 2010) identify a number of soil types within the Concept corridor derived from the underlying geological units. The soil units and their characteristics are described in Table 8-38 and shown in Figure 8-4.

Table 8-38: Soil units underlying the Concept

Soil unit	Description
Birrong	• Landscape: found on level to gently undulating alluvial floodplain draining Wianamatta Group shale, with slopes less than three per cent. Broad valley flats and extensively cleared tall open forest and woodland • Soils: deep soils (less than 250 centimetres) on older alluvial terraces and current floodplain • Limitations: localised flooding, high soil erosion hazard, saline subsoils, seasonal waterlogging, and very low soil fertility.
Blacktown	• Landscape: found on gently undulating rises on Wianamatta Group shales, with slopes of less than five per cent and local reliefs of up to 30 metres • Soils: strongly acidic and hard setting soils • Limitations: low fertility, high aluminium toxicity, localised salinity and sodicity, low wet strength, low permeability, and low available water holding capacity.
Disturbed terrain	• Landscape: found on a variety of landscapes ranging from level plain to hummocky terrain that has been extensively disturbed by human activity. Slopes are typically less than five per cent and local reliefs of less than 10 metres • Soils: the original soil has been completely disturbed, removed or buried. Landfill may include soil, rock, building and waste material with a cap of sandy loam. Soil may by strongly acidic to strongly alkaline • Limitations: low fertility, low wet strength, low availability water capability, high permeability, localised toxicity/acidity and/or alkalinity, potential mass movement hazard.
Glenorie	• Landscape: found on undulating to rolling low hills on Wianamatta Group shales, with slopes typically between five per cent and 20 per cent • Soils: shallow to moderately deep on crests (less than 100 centimetres) moderately deep on upper slopes (70 to 150 centimetres) and deep on lower slopes (greater than 200 centimetres) • Limitations: high soil erosion hazard, localised impermeable soil and moderate soil reactivity.
Gymea	• Landscape: found on undulating to rolling rises and low hills on Hawkesbury Sandstone, with slopes between 10 per cent and 25 per cent and local relief up to 80 metres • Soils: shallow to moderately deep (30 to 100 centimetres) • Limitations: localised steep slopes, high soil erosion hazards, shallow highly permeable soil and very low soil fertility.
Lucas Heights	• Landscape: found on gently undulating crests and ridges on plateau surfaces of the Mittagong Formation, with local reliefs up to 30 metres and slopes less than 10 per cent • Soils: moderately deep (50 to 150 centimetres) soils on the outer edges of crests • Limitations: stony soil, low soil fertility, and low waterholding capacity.
Hawkesbury	• Landscape: found on rugged, rolling to very steep hills on Hawkesbury Sandstone, with slopes greater than 25 per cent and local reliefs up to 200 metres • Soils: Shallow (less than 50 centimetres) discontinuous lithosols/siliceous sands associated with rock outcrops, with earthy sands and some yellow podzolic soils on the inside of benches and along rock joints and fractures • Limitations: extreme soil erosion hazard, mass movement hazard, steep slopes, high permeability soil and low soil fertility.

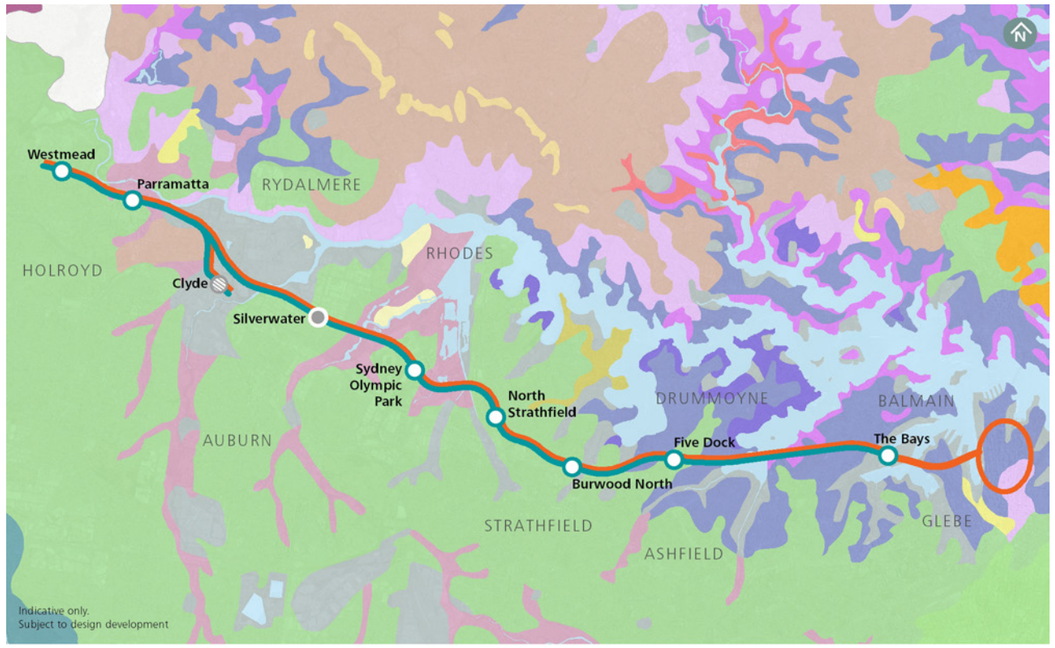

Figure 8-4: Soil landscapes within the Concept

Soil salinity

Soil salinity refers to the movement and concentration of salt in soils as a result of weathering rock materials, historic inland seas and deposition of salt from the ocean onto land by wind or rain. Saline soils can degrade ecosystems and habitats and reduce the productive agricultural capacity of land (Agriculture Victoria, 2017). The NSW Soil and Land Information System and the Salinity Hazard Report for Catchment Action Plan upgrade – Sydney Metropolitan Catchment Management Authority (Winkler et al, 2012) were reviewed to identify the probability for saline soils to be present within the Concept.

Based on this information, there would be a high probability for saline soils to be present within the Concept between Westmead and Parramatta, and a very high probability between Parramatta and Burwood North. There would be a high to very high probability of saline soils between Burwood North and the Sydney CBD in elevated areas, and a very low probability in areas of low elevation.

Acid sulfate soils

Acid sulfate soils are the common name given to naturally occurring sediments and soils containing iron sulfides. Excavation, drainage or groundwater drawdown of this soil type can result in exposure of the sulfides within these soils to oxygen which can generate sulphuric acid.

Acid sulfate soil risk maps were reviewed to assess the probability of acid sulfate soils being present across the Concept. Most of the Concept passes through areas having 'no known occurrence' of acid sulfate soils (NSW Office of Environment and Heritage, 2019). These areas are typically on elevated ground at distance from shorelines and drainage lines. Areas around the Parramatta River, Rosehill, Silverwater, Sydney Olympic Park, Lilyfield/Rozelle, White Bay, Pyrmont Bay/Darling Harbour and Sydney CBD are identified as 'disturbed terrain'. These areas are often located on reclaimed land or land subject to dredging or mining, with the potential presence of acid sulfate soils. These areas are associated with fill and/or alluvium that extends from harbour shores up local drainage lines.

Catchments and watercourses

The Concept is located within the Sydney Metropolitan catchment (Port Jackson) which includes the Parramatta River and Sydney Harbour. The catchment is highly urbanised and altered from its natural state, with pockets of open spaces and parkland. Many of the watercourses within the catchment have been extensively modified, with creek systems channelised or edged with concrete. Most of the catchment is estuarine, up to the tidal limit of Parramatta River at Charles Street weir in Parramatta. Freshwater watercourses occur in the upper catchments of the tributaries of Parramatta River. The catchment lies over the Cumberland Plain and is relatively flat, with elevation ranging from 140 metres Australian Height Datum in the north-west of the catchment to sea level in the east.

Water quality

The NSW Department of Planning, Industry and Environment's Water Quality and River Flow Objectives (Department of Environment, Climate Change and Water, 2006) provide a number of environmental values for the Sydney Harbour and Parramatta River regional catchment:

- Aquatic ecosystems and visual amenity which applies to all waterways within the Concept
- Secondary contact recreation applies to the estuarine waterways
- Primary contact recreation applies to the Parramatta River and The Bays area.

While commercial fishing has been banned in the harbour, some recreational fishing occurs along the foreshore where consumption of fish is likely.

The water quality of watercourses relevant to the Concept is influenced by several factors including:

- Current and historical polluting land uses within the catchments
- Stormwater and sewage overflows and leachate from contaminated and/or reclaimed land
- Urbanisation of the catchments and subsequent reduction in permeable area, increasing run-off and pollutant loads entering watercourses
- Illegal dumping.

A review of available existing water quality data indicates that the watercourses relevant to the Concept are generally in poor condition and are representative of a heavily urbanised system.

Water quality objectives that provide guideline levels to help manage water quality have been developed for each catchment in NSW (Department of Environment and Conservation, 2006). These objectives include community-based values, long term goals, and their associated national criteria drawn from ANZECC/ ARMCANZ (2000) guidelines. The objectives aim to improve poor water quality and maintain existing good water quality (Department of Environment and Conservation, 2006). The water quality objectives, trigger values and/or criteria for the Sydney Harbour and Parramatta River catchments are shown in Table 8-39. The applicability of the criteria in Table 8-39 would be determined during assessments of relevant future stages.

Table 8-39: Water quality objectives for catchments within the Concept

Water quality objective	Indicators	Associated trigger values or criteria
Aquatic ecosystems		
Maintain or improve the ecological condition of waterbodies and their riparian zones over the long term.	**Total phosphorus**	• Upland rivers: 20 µg/L • Lowland rivers: 25 µg/L for rivers flowing to the coast • Lakes and reservoirs: 10 µg/L • Estuaries: 30 µg/L
	Total nitrogen	• Upland rivers: 250 µg/L • Lowland rivers: 350 µg/L for rivers flowing to the coast • Lakes and reservoirs: 350 µg/L • Estuaries: 300 µg/L
	Chlorophyll-a	• Upland rivers: not applicable • Lowland rivers: 5 µg/L • Lakes and reservoirs: 5 µg/L • Estuaries: 4 µg/L
	Turbidity	• Upland rivers: 2–25 NTU • Lowland rivers: 6–50 NTU • Lakes and reservoirs: 1–20 NTU • Estuaries: 0.5–10 NTU
	Salinity (electrical conductivity)	• Upland rivers: 30–350 µS/cm • Lowland rivers: 125–2200 µS/cm
	Dissolved oxygen	• Upland rivers: 90–110% • Lowland rivers: 85–110% • Freshwater lakes and reservoirs: 90–110% • Estuaries: 80–110%
	pH	• Upland rivers: 6.5–8.0 • Lowland rivers: 6.5–8.5 • Freshwater lakes and reservoirs: 6.5–8.0 • Estuaries: 7.0–8.5
Visual amenity		
Maintain the aesthetic qualities of waterways.	**Visual clarity and colour**	Natural visual clarity should not be reduced by more than 20%. Natural hue of the water should not be changed by more than 10 points on the Munsell Scale. The natural reflectance of the water should not be changed by more than 50%.
	Surface films and debris	Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and litter.
	Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts.
Secondary contact recreation		
Maintain or improve water quality for activities such as boating and wading, where there is a low probability of water being swallowed.	**Faecal coliforms**	Median bacterial content in fresh and marine waters of < 1000 faecal coliforms per 100 mL, with 4 out of 5 samples < 4000/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month).
	Enterococci	Median bacterial content in fresh and marine waters of < 230 enterococci per 100 mL (maximum number in any one sample: 450-700 organisms/100 mL).
	Algae & bluegreen algae	< 15 000 cells/mL
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreation.

Water quality objective	Indicators	Associated trigger values or criteria
Primary contact recreation		
Maintain or improve water quality for activities such as swimming, where there is a high probability of water being swallowed.	**Turbidity**	A 200 mm diameter black disc should be able to be sighted horizontally from a distance of more than 1.6 m (approximately 6 NTU).
	Faecal coliforms	Beachwatch considers waters are unsuitable for swimming if: • The median faecal coliform density exceeds 150 colony forming units per 100 millilitres (cfu/100mL) for five samples taken at regular intervals not exceeding one month, or • The second highest sample contains equal to or greater than 600 cfu/100mL (faecal coliforms) for five samples taken at regular intervals not exceeding one month. ANZECC 2000 Guidelines recommend: • Median over bathing season of < 150 faecal coliforms per 100 mL, with 4 out of 5 samples < 600/100 ML (minimum of 5 samples taken at regular intervals not exceeding one month).
	Enterococci	Beachwatch considers waters are unsuitable for swimming if: • The median enterococci density exceeds 35 cfu/100mL for five samples taken at regular intervals not exceeding one month, or • The second highest sample contains equal to or greater than 100 cfu/100mL (enterococci) for five samples taken at regular intervals not exceeding one month. ANZECC 2000 Guidelines recommend: • Median over bathing season of < 35 enterococci per 100 mL (maximum number in any one sample: 60-100 organisms/100 mL).
	Protozoans	Pathogenic free-living protozoans should be absent from bodies of fresh water. (Note: it is not necessary to analyse water for these pathogens unless temperature is greater than 24 degrees Celsius).
	Algae & bluegreen algae	< 15 000 cells/mL
	Nuisance organisms	Use visual amenity guidelines. Large numbers of midges and aquatic worms are undesirable.
	pH	5.0-9.0
	Temperature	15°-35°C for prolonged exposure
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucus membranes are unsuitable for recreation.
Aquatic foods		
Protect water quality so it is suitable for the production of aquatic foods for human consumption and aquaculture activities.	**Algae & bluegreen algae**	No guideline is directly applicable, but toxins present in blue-green algae may accumulate in other aquatic organisms.
	Faecal coliforms	Guideline in water for shellfish: The median faecal coliform concentration should not exceed 14 MPN/100mL; with no more than 10% of the samples exceeding 43 MPN/100 mL. Standard in edible tissue: Fish destined for human consumption should not exceed a limit of 2.3 MPN E Coli/g of flesh with a standard plate count of 100,000 organisms/g.
	Toxicants (as applied to aquaculture activities)	Metals: • Copper: less than 5 µgm/L • Mercury: less than 1 µgm/L • Zinc: less than 5 µgm/L Organochlorin==es: • Chlordane: less than 0.004 µgm/L (saltwater production) • PCB's: less than 2 µgm/L
	Physicochemical indicators (as applied to aquaculture activities)	• Suspended solids: less than 40 micrograms per litre (freshwater) • Temperature: less than 2 degrees Celsius change over one hour

Sensitive receiving environments

A number of watercourses relevant to the Concept have been identified as sensitive receiving environments due to their proximity to State Environmental Planning Policy Coastal Wetlands and their mapping as Key Fish Habitat (Department of Primary Industry, 2019). These watercourses have a high conservation or community value or supports ecosystems or human uses of water that are particularly sensitive to pollution or degradation of water quality. These watercourses are shown in Figure 8-5 and include:

- Parramatta River/Sydney Harbour
- Duck River
- Duck Creek
- Haslams Creek
- Powells Creek
- Dobroyd Canal/Iron Cove Creek.

Figure 8-5: Key watercourses crossing the Concept

8.13.4 Potential operational benefits and impacts

Potential impacts to soils and water quality during operation of the Concept are anticipated to be limited and mainly associated with activities at the stabling and maintenance facility at Clyde.

Soils

The presence of acid sulfate soils near drained structures and facilities has the potential to impact on groundwater quality and therefore surface water quality during operation. The highest potential risk of this is at Clyde, Silverwater, Burwood North and near Lilyfield. Where required, any captured groundwater would be appropriately treated prior to discharge to the surface water systems to avoid impacts to the receiving environment.

Water quality

The Concept would be designed to achieve a maximum water discharge quality equivalent to the 90 per cent protection level specified for freshwater ecosystems in accordance with ANZECC/ARMCANZ (2000) guidelines. The discharge water quality level would be determined in consultation with the NSW Environment Protection Authority, taking into consideration the current water quality of the receiving watercourses. It is unlikely that the sensitive receiving environments identified in Section 8.13.3 would be impacted by discharge from the water treatment plant during operation.

There would be a minor increase in hard standing areas which would result in increased runoff and therefore generation of additional pollutants and litter being transported to downstream watercourses via local stormwater systems. The operation of a stabling and maintenance facility at Clyde has the potential to result in sediments, fuels/oil and other pollutants entering the surrounding stormwater system.

Operation of the Concept would require the ongoing capture and management of surface water runoff into the tunnels and groundwater inflows into any drained station structures or ancillary facilities. Groundwater inflows and surface water runoff have the potential to be contaminated with sediments, fuel/oils and/or other pollutants (such as litter), which could have the potential to enter the surrounding stormwater system. Water would be captured and pumped to the operational wastewater treatment plant located at Clyde. Treated water would either be reused or discharged into the local stormwater system which in turn discharges to A'Becketts Creek and Duck Creek.

8.13.5 Potential construction impacts

Potential soils and water quality impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.13.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

Soils

A summary of potential impacts to soils during construction of the Concept is provided in Table 8-40.

Table 8-40: Summary of potential construction impacts on soils

Type of impact	Description of impact
Soil erosion	Potential temporary increase in soil erosion from the temporary exposure of soil to water runoff and wind through the removal of vegetation, overlying structures (such as buildings and footpaths) and excavation of construction footprints for stations, structures and foundations. This would be adequately managed with the implementation of standard erosion and sediment controls.
Disturbance of saline soils	Construction of the tunnel and station excavations may cause salinity impacts where there is disturbance of saline soils, often associated with changes to the groundwater system. Salinity impacts may include locally severe salt scalding across landscape elements, damage to buildings and infrastructure, fluvial and sheet erosion, high in-stream salinity, localised waterlogging, flood hazard, and a potential decline in water quality. Any potential salinity impacts would be managed in accordance with Book 4 Dryland Salinity: Productive Use of Saline Land and Water (NSW DECC 2008).
Disturbance of acid sulfate soils	The exposure of acid sulfate soils during excavation could result in the release of acid sulfates, which could pollute downstream watercourses. Any potential acid sulfate soil impacts would be managed in accordance with the Acid Sulfate Soil Manual (ASSMAC, 1998)

Water quality

Performance outcomes relating to meeting discharge water quality requirements and implementing erosion and sediment controls would adequately manage potential water quality impacts during construction of the Concept. A summary of potential impacts to water quality during construction of the Concept is provided in Table 8-41.

Table 8-41: Summary of potential construction impacts on surface water quality

Construction activities	Potential impacts
Surface activities	
Demolition works	Demolition works, including the removal of existing buildings and structures, have the potential to disturb and/or spread sources of pollutants that could affect water quality. These pollutants, once mobilised, could have the potential to enter stormwater runoff and be distributed downstream receiving watercourses via the drainage network.
Earthworks	Exposure of soils during earthworks could potentially result in temporary soil erosion and off-site movement of eroded sediments by wind and/or stormwater into receiving watercourses. If sediments were to enter watercourses, they could impact the aquatic environment by increasing turbidity, reducing dissolved oxygen levels, and increasing the concentration of nutrients and heavy metals.
Removal of vegetation	The removal of vegetation for construction has the potential to temporarily increase the risk of erosion and sedimentation. This could result in the mobilisation of soils into stormwater runoff and nearby watercourses.
Accidental spills from the operation of construction plant and equipment	Accidental spills or leaks could potentially occur from the maintenance or re-fuelling of construction plant and equipment machinery at construction sites, or from vehicle/truck incidents travelling to and from construction sites. This could result in contaminants being transported downstream to receiving waters via drainage infrastructure.
Disturbance of contaminated land	Disturbance of contaminated land, groundwater, or acid sulfate soils construction could potentially result in the mobilisation of contamination or acid sulfate soils by stormwater runoff and subsequent transportation to downstream watercourses, potentially increasing contaminant concentrations in the receiving environment.
Tunnelling and underground excavation activities	
Generation and discharge of wastewater from tunnelling and underground excavation works	Tunnelling and underground excavation works would result in large volumes of wastewater being generated from the following sources: • Groundwater ingress • Rainfall runoff into tunnel portals • Machinery wash down runoff • Dust suppression water. Captured water would be appropriately treated to meet discharge water quality requirements and avoid potential impacts on the water quality of downstream watercourses and the nominated environmental values.

8.13.6 Performance outcomes

Identified performance outcomes in relation to soil and water quality impacts for operation and construction of the Concept are provided in Table 8-42.

Table 8-42: Soil and water quality performance outcomes

Operational performance outcomes	Construction performance outcomes
The water quality criteria for water discharge, determined in consultation with NSW Environment Protection Authority, is met.	• The discharge water quality requirements outlined in applicable environment protection licence(s) are met • Existing water quality of receiving surface watercourses is maintained • Impacts on aquatic environments from the disturbance of acid sulfate soils are avoided • Pollution of surface water is minimised through the implementation of appropriate erosion and sediment controls.

8.13.7 Matters to be addressed in staged applications

Soil and surface water quality impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Soil and surface water quality assessments will include, as relevant to the stage:

- Consideration of the relevant regulatory framework and guidelines, and publicly available data
- Identification of the existing soil landscapes, surface catchments and watercourses
- Identification of the potential environmental impacts to soils and surface water quality including acid sulfate soils, erosion and sedimentation, and an indicative water balance
- Identification of mitigation measures to address the potential impacts
- Further consultation with the NSW Environment Protection Authority.

A soils and surface water quality assessment for Stage 1 is provided in Chapter 19 (Soils and surface water quality – Stage 1).

8.14 Contamination

8.14.1 Legislative and policy context

The *Contaminated Land Management Act 1997* provides the statutory framework for managing contaminated land in NSW.

The following guidelines are applicable to the assessment of contamination for the Concept:

- The NSW Department of Planning, Industry and Environment's Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land (Department of Urban Affairs and Planning and Environment Protection Authority, 1998)
- The NSW Environment Protection Authority's Guidelines for Consultants Reporting on Contaminated Sites (Office of Environment and Heritage, 2000)
- National Environment Protection (Assessment of Site Contamination) Measure 1999 (as revised 2013).

8.14.2 Assessment approach

The assessment involved:

- Desktop review of relevant information sources and site observations of the Concept corridor to understand the existing environment and potential risk for contamination
- Identification of areas of contamination potential
- Assessment of the potential for contamination to be exposed during construction and the management of existing/residual contamination during operation
- Consultation with the NSW Environment Protection Authority to discuss the approach to contamination assessment
- Identifying performance outcomes
- Identifying the proposed scope of contamination assessments for future stages.

8.14.3 Existing environment

The existing contamination potential for each setting within the Concept is described in Table 8-43.

Table 8-43: Potential sources of contamination

Urban setting	Potential sources of contamination
CBDs **Parramatta** **Sydney**	Historical activities undertaken within the proposed corridor include maritime and industrial land uses (including former gasworks) and commercial land use (potential underground storage tanks). There is the possibility of leaks from underground storage tanks related to commercial or industrial buildings and the possible inappropriate management (during demolition) and/or degradation of hazardous building materials within current and former on-site structures. There is potential for contamination from existing and former railway activities within both the Parramatta and Sydney CBDs.

Urban setting	Potential sources of contamination
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	Current and historical activities undertaken in the area include possible leaks/spills from underground petroleum storage infrastructure, automotive repair/maintenance, possible inappropriate management (during demolition) and/or degradation of hazardous building materials within current and former on-site structures. Between Five Dock and The Bays current and historical activities include industrial land use and historical land reclamation adjacent to waterways. There is also potential contamination from existing railway activities at North Strathfield.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	Current and historical activities undertaken in the locality include adjacent industrial land uses, historical land reclamation adjacent to waterways, mechanical workshop activities (including associated leaks/spills from underground petroleum storage infrastructure), dumping of construction wastes and the possible inappropriate management (during demolition) and/or degradation of hazardous building materials within current and former on-site structures. There is potential for contamination from existing railway activities at Westmead and Sydney Olympic Park, and former railway activities in the vicinity of The Bays. There is also a risk at Sydney Olympic Park associated with historical landfilling with areas of waste and groundwater contamination, and degradation of organics within former waste landfills.
Industrial and urban services • Clyde • Silverwater	Current and historical activities undertaken on the site in the area include industrial land uses, industrial land uses on adjoining sites, vehicle maintenance, historical land reclamation around on-site waterways, known soil and groundwater contamination (James Hardie and former Clyde Refinery). There is also asbestos waste remaining at the former James Hardie site.

8.14.4 Potential operational benefits and impacts

As the tunnels would be lined and most stations would be tanked, the potential for contamination groundwater, vapour and gas ingress is low. However, there could be an ongoing requirement to ensure that where existing contamination may pose risks, whether in soil, groundwater or vapour, it is appropriately managed to protect human and ecological receivers during the life of the Concept.

Operation of the Concept would also require maintenance activities to be undertaken which could give rise to the potential for soils and/or groundwater contamination to occur due to spills and leaks of fuel, oils and other hazardous materials from trains, maintenance vehicles and other infrastructure.

8.14.5 Potential construction impacts

Potential contamination impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.14.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

During construction, contamination is likely to be encountered at several locations in the Concept corridor due to current and historical activities. A desktop review of available data and previous reports identified potential contaminants that could be encountered during excavation, other ground disturbing activities or associated with groundwater ingress are described in Table 8-44.

Table 8-44 Potential contaminants that may be encountered during construction

Urban setting	Potential contaminants of concern
CBDs • Parramatta • Sydney	• Hydrocarbons, heavy metals and metalloids, solvents, phenolics, per- and polyfluoroalkyl substances, pesticides, and asbestos in soil associated with former and current industrial land uses • Hydrocarbons and heavy metals associated with leaks and spills from fuel storage infrastructure • Metals, hydrocarbons, pesticides, nutrients, phenols, carbamates, pesticides, herbicides and asbestos in soils associated with existing railways.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	• Hydrocarbons and heavy metals associated with leaks and spills from fuel storage infrastructure • Hydrocarbons, heavy metals and metalloids, solvents, phenolics, per- and polyfluoroalkyl substances, pesticides, and asbestos in soil associated with former and current industrial land uses • Metals, hydrocarbons, pesticides, nutrients, phenols, carbamates, pesticides, herbicides and asbestos in soils associated with existing railway activities at North Strathfield.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	• Hydrocarbons and heavy metals associated with leaks and spills from fuel storage infrastructure • Hydrocarbons, heavy metals and metalloids, solvents, phenolics, per- and polyfluoroalkyl substances, pesticides, and asbestos in soil associated with former and current industrial land uses • Metals, hydrocarbons, pesticides, nutrients, phenols, carbamates, pesticides, herbicides and asbestos in soils associated with existing railways • Landfill leachate and/or hazardous ground gases including methane, hydrogen sulphide, and carbon monoxide associated with former landfill sites.
Industrial and urban services • Clyde • Silverwater	• Hydrocarbons, heavy metals and metalloids, solvents, phenolics, per- and polyfluoroalkyl substances, pesticides, and asbestos in soil associated with former and current industrial land uses • Contaminated groundwater associated with the above soil contamination.

8.14.6 Performance outcomes

Identified performance outcomes in relation to contamination impacts for operation and construction of the Concept are provided in Table 8-45.

Table 8-45: Contamination performance outcomes

Operational performance outcomes	Construction performance outcomes
• Residual contamination does not pose a risk to Sydney Metro customers or staff.	• Contamination risks to human health and ecological receivers are minimised through effective management of existing contaminated land • Contaminated land is remediated to be suitable for the intended future land use.

8.14.7 Matters to be addressed in staged applications

Contamination impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Contamination assessments will include, as relevant to the stage:

- Desktop review of relevant information sources and observations from site inspections to gain an understanding of the existing environment and potential risk for contamination
- Identification of the potential contamination risk based on the potential for contamination to be present, the potential for works to interface with contamination and the potential for pathways to human or ecological receivers
- Identification of mitigation measures and management strategies to address the potential impacts
- Identification of any further investigations that are required to better inform management or remediation in accordance with current guidelines
- Further consultation with the NSW Environment Protection Authority.

An assessment of contamination impacts for Stage 1 is provided in Chapter 20 (Contamination – Stage 1).

8.15 Hydrology and flooding

8.15.1 Legislative and policy context

The Department of Planning, Industry and Environment's Floodplain Development Manual (Department of Infrastructure, Planning and Natural Resources, 2005) guides the assessment of potential hydrology and flooding impacts in New South Wales. The Floodplain Development Manual incorporates the NSW Government's Flood Prone Land Policy. The key objectives of this policy are to identify potential hazards and risks associated with flooding, reduce the impact of flooding and flood liability on owners and occupiers of flood prone property, and to reduce public and private losses resulting from floods. This policy also recognises the benefits of the use, occupation and development of flood prone land.

8.15.2 This assessment involved:

- Describing the existing flood behaviours within the Concept footprint
- Identifying the types of potential hydrology and flooding impacts which may occur during construction and operation of the Concept
- Consultation with Department of Planning, Industry and Environment (Environment, Energy and Science Group) to discuss the approach to hydrology and flooding assessment
- Identifying performance outcomes
- Identifying the proposed scope of hydrology and flooding assessments for future stages.

8.15.3 Existing environment

Surface hydrology and drainage infrastructure

The Concept corridor is within the Parramatta River and Sydney Harbour catchment, with Parramatta River being one of the main tributaries of Sydney Harbour. Surface water within the Concept corridor west of The Bays drains towards watercourses which are sub-catchments of the Parramatta River. Surface water near The Bays and Sydney CBD drains directly to Sydney Harbour. Many of the watercourses within the Concept corridor have been greatly modified, with creek systems extensively made into channels or hard-edged with concrete.

Drainage catchments across the Concept corridor are highly urbanised, with large impervious surfaces created by roads, footpaths and buildings. These impervious surfaces are interspersed with pervious surfaces within parkland areas and other unsealed surfaces (such as vacant land and landscaped areas). Surface water is generally collected by developed stormwater networks, which consist of road kerb and guttering, lined and unlined drainage channels, and sub-surface pit and pipe networks.

Flooding

Due to the highly urbanised and modified environment, the Concept corridor is mainly affected by local runoff and overland flooding. These impacts may be caused by intense rainfall events resulting in a rapid rise in flood flows. When local catchment runoff exceeds the capacity of existing drainage systems, excess flows are conveyed in overland flow paths and can cause ponding at low points.

There are a limited number of locations where the Concept corridor is affected by mainstream, or riverine, flooding. Mainstream flooding may be caused by prolonged heavy rainfall providing some warning time for rising floodwaters, particularly for the large catchment of the Parramatta River.

Mainstream flooding occurs within the Parramatta River and its major tributaries, including Duck River, Duck Creek and A'becketts Creek. Parramatta River has a catchment area of 108 square kilometres upstream of Charles Street weir at Parramatta. Duck River, Duck Creek and A'becketts Creek have a combined catchment area of about 28 square kilometres.

Low-lying areas within the Concept corridor are also subject to coastal inundation. Elevated ocean levels caused by storm surges or high tides raise water levels within the Parramatta River and tributaries, affecting low-lying areas. Coastal inundation events can also coincide with catchment and mainstream flooding, making impacts worse by raising flood levels in and around the waterways.

8.15.4 Potential operational benefits and impacts

Surface hydrology and drainage infrastructure

Aboveground infrastructure within the Concept corridor would be generally located in areas of existing development and is expected to have a negligible impact on the existing surface hydrology. At most sites, the runoff volume and flow rate would likely be similar to existing conditions with minimal impact to the capacity of the existing downstream stormwater infrastructure.

The Concept has the potential to alter localised stormwater catchment flows and the operation of existing stormwater drainage networks due to:

- The introduction of additional drainage infrastructure or rerouting of existing drainage infrastructure (drainage infrastructure may need to be relocated and/or augmented to accommodate elements of the project such as station infrastructure)
- Increases to local drainage catchment areas
- Interruption to existing surface flows due to new or modified infrastructure
- Increases to impervious surface areas.

There are existing large areas of mostly unpaved surfaces near Clyde. The siting of surface infrastructure would likely require paving of at least part of these areas. An increase in impervious surface areas brings the potential for increased runoff volumes, flow rates and resultant increases in downstream flooding without the implementation of appropriate mitigation measures. New drainage infrastructure would be constructed as part of both aboveground facilities and tunnel dive structures and connected to existing stormwater systems.

Flooding

Aboveground stations and ancillary infrastructure are expected have a negligible impact on existing flood behaviour because the infrastructure would be generally located within the footprint of existing structures. Infrastructure would be designed to be compatible with the existing flood hazard and hydraulic function of the sites and to have minimal impact to the community and emergency management response requirements.

Based on known flooding patterns within Parramatta River and its tributaries, areas around Parramatta, Clyde, Silverwater and The Bays are at risk of flooding during operation. Flooding risk would be taken into account during design development so that station entries and aboveground rail system facilities sit above the Probable Maximum Flood level and at least 0.5 metres above the one per cent annual exceedance probability flood level, where feasible and reasonable. Where it is not feasible and reasonable to meet these design criteria, design would consider the need for sumps and pumps to manage any potential inflows. Design development for the stabling and maintenance facility at Clyde would include quantitative flood modelling which would take into account a climate change scenario for future projected sea level rise.

Low-lying sites including The Bays may be exposed to coastal inundation, as a result of high tides combined with storm surge. Their exposure may increase due to future climate change and resulting sea level rise.

The construction of filled embankments has the potential for flooding impacts due to loss of floodplain storage and obstruction of flood flow routes, particularly for sites with a higher flood risk and flood affectation.

8.15.5 Potential construction impacts

Potential hydrology and flooding impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.15.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

Construction of the Concept has the potential to impact existing flooding behaviour through disruption of existing conditions (such as drainage systems and/or overland flow paths). In addition, flooding events during construction could impact areas within and near construction sites, including the potential inundation of construction sites.

Potential flood-related impacts during construction may include:

- Temporary interruption of overland flow paths by installation of temporary construction site infrastructure (i.e. noise barriers, temporary structures, retaining walls) and/or modifications to landforms (i.e. placement of fill materials, stockpiles)
- Loss of floodplain storage resulting from construction of permanent filled embankments
- An increase in runoff volumes following rainfall events due to an increase in impervious surfaces at construction sites
- Temporary interruption or diversion of existing flood routes away from the location of bunding or spoil within construction sites, resulting in a re-distribution of flood flows and an increased flood risk to adjacent areas
- Temporary blocking of drainage networks through increased sedimentation of receiving waters
- Flow of water into station excavations, services facility shafts and tunnel portals.

Key risk areas for potential flooding during construction include Parramatta, Clyde, Silverwater and The Bays. Construction flooding risk is expected to be minor to negligible at all other locations within the Concept corridor. Flooding risk at each construction site, along with potential risk mitigation measures, would be considered as part of assessment and construction planning in future stages.

8.15.6 Performance outcomes

Identified performance outcomes in relation to hydrology and flooding impacts for operation and construction of the Concept are provided in Table 8-46.

Table 8-46: Hydrology and flooding performance outcomes

Operational performance outcomes	Construction performance outcomes
• Increases in flood levels are minimised, particularly within private properties, during events up to and including the one per cent annual exceedance probability • No additional private properties are affected by flood events up to and including the 1% annual exceedance probability • The potential for soil erosion and scouring is minimised for events up to and including a 1% annual exceedance probability event • Dedicated evacuation routes are not impacted in flood events up to and including the probable maximum flood • The performance of the downstream drainage network is maintained • Metro tunnels and other critical infrastructure would be protected from the probable maximum flood, or be 0.5 metres above the one per cent Annual Exceedance Probability flood level (whichever is greater).	• Dedicated evacuation routes are not impacted in flood events up to and including the probable maximum flood.

8.15.7 Matters to be addressed in staged applications

Hydrology and flooding impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Hydrology and flooding assessments will include, as relevant to the stage:

- Consideration of the relevant regulatory framework and guidelines, and publicly available data
- Identification of the existing hydrology and flooding conditions
- Identification of the potential environmental impacts to hydrology and flooding, including qualitative and quantitative assessment as required
- Identification of mitigation measures to address the potential impacts
- Further consultation with Department of Planning, Industry and Environment (Environment, Energy and Science Group).

A hydrology and flooding assessment for Stage 1 is provided in Chapter 21 (Hydrology and flooding – Stage 1).

8.16 Biodiversity

8.16.1 Legislative and policy context

The following key biodiversity legislation and policy is applicable to the Concept:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* provides a framework for protection of the Australian environment, including its biodiversity and its natural and culturally significant places
- *Biodiversity Conservation Act 2016* and the Biodiversity Conservation Regulation 2017 sets out the framework for assessing and reporting on biodiversity impacts from development and requires proponents to avoid, minimise and offset biodiversity impacts from development through the Biodiversity Offset Scheme
- *Biosecurity Act 2015* provides a framework for the prevention, elimination, minimisation and management of biosecurity risks
- *Fisheries Management Act 1994* identifies threatened fish and marine vegetation in NSW along with providing a framework for their protection
- NSW Biodiversity Assessment Method (Office of Environment and Heritage, 2017).

8.16.2 Assessment approach

The assessment involved:

- Reviewing existing databases, reports, and mapping for the area within 10 kilometres of the Concept corridor (referred to as the search area) and a more comprehensive review of the existing environment within a 500 metre buffer area from the centreline of the Concept corridor (referred to as the biodiversity study area). The review considered mapping of vegetation, geology and soils, wetlands, groundwater dependent ecosystems and key fish habitat
- Conducting a Protected Matters Search using the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* tool
- Preparing a list of potential plant community types
- Preparing a list of threatened animal species, populations and communities
- Identifying important habitats for migratory species with a likelihood of occurrence in the survey area and Concept
- Identifying any areas of outstanding biodiversity value
- Reviewing the preliminary and provisional determinations to list species and ecological communities as threatened under the *Biodiversity Conservation Act 2016* and the annual Final Priority Assessment List of nominated species and ecological communities that have been approved for assessment by the Minister responsible for the *Environment Protection and Biodiversity Conservation Act 1999* (Australian Government Department of the Environment and Energy 2019)
- Assessing potential impacts to biodiversity including native vegetation, threatened ecological communities, habitat, threatened species, ground dependent ecosystems and key threatening processes
- Consultation with Department of Planning, Industry and Environment (Environment, Energy and Science Group) to discuss the approach to biodiversity assessment
- Identifying performance outcomes
- Identifying the proposed scope of biodiversity assessments for future stages.

8.16.3 Existing environment

A summary of the existing biodiversity environment is provided in Table 8-47 and shown on Figure 8-6, Figure 8-7 and Figure 8-8.

Table 8-47: Existing biodiversity environment

Aspect	Existing biodiversity environment
Bioregion	Sydney Basin Bioregion, Cumberland subregion and Pittwater subregion.
Landscape	Sydney Metro catchment (Port Jackson) within the Ashfield Plains and the Port Jackson Basin landscape.
Rivers, streams, estuaries	The tunnel alignment would pass at depth beneath Domain Creek, Clay Cliff Creek, Duck River, Haslams Creek, Saleyards Creek, Powells Creek and Iron Cove. Other waterways near the Concept include Coopers Creek, Toongabbie Creek, Finlaysons Creek, Darling Mills Creek, Hunts Creek, A'Becketts Creek, Duck Creek, Vineyard Creek, Subiaco Creek, Saltwater Creek, Iron Cove Creek, Hawthorne Canal, Whites Creek, Johnstons Creek and a number of unnamed tributaries and canals. The Concept is also located in proximity to the upper reaches of the Parramatta River estuary, Homebush Bay, Exile Bay, Canada Bay, Kings Bay, Iron Cove and White Bay.
Wetlands	The biodiversity study area contains several wetlands, some of which are known to be regularly used by migratory bird species and threatened species. Of these wetlands, Mason Park wetlands adjacent to Powells Creek, Bicentennial Park wetlands, Newington Nature Reserve wetlands, the Brickpit at Sydney Olympic Park, Haslams Creek, and wetlands associated with Duck River including the Clyde Wetland are the most important. Mapped areas of wetland listed under State Environmental Planning Policy (Coastal Management) 2018 are present and include vegetation along the Parramatta River, Duck River, Haslams Creek, Bicentennial Park, Powells Creek, and Mason Park wetlands.

Aspect	Existing biodiversity environment
Key fish habitat	Within the biodiversity study area Key Fish Habitat is mapped in the following areas (NSW Government Department of Primary Industries 2019): • Parramatta River • Toongabbie Creek • Darling Mills Creek • Subiaco Creek • Duck River • Duck Creek • Pond on Rosehill Racecourse • Haslams Creek • Lake Belvedere in Bicentennial Park • Powells Creek • Kings Bay • Iron Cove Creek • Hawthorne Canal • Sydney Harbour including Iron Cove, Rozelle Bay, White Bay, Johnstons Bay, Blackwattle Bay Cockle Bay, Elizabeth Macarthur Bay, Pyrmont Bay, Darling Harbour.
Habitat connectivity	The habitats within the biodiversity study area have a low degree of connectivity due to the impacts of urbanisation. Habitat within the biodiversity study area is generally present as small isolated fragments within an urban land use context of residential, commercial and industrial development. There are discontinuous corridors of habitat along riparian areas specifically the Parramatta River, Duck River, Haslams Creek, and Powells Creek. Remnant patches of vegetation in Parramatta Park, Five Dock and Concord are connected by planted trees and gardens which provide some functional connectivity for mobile species such as the Grey-headed Flying-fox and birds that can use the resources available in urban areas.
Areas of outstanding biodiversity values	The Concept would not impact any areas of outstanding biodiversity value.
Native vegetation	The biodiversity study area contains native vegetation from the following plant community types as identified in the BioNet Vegetation Classification database and mapped in The Native Vegetation of the Sydney Metropolitan Area – Version 3.1 (State Government of NSW and Office of Environment and Heritage 2016): • Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (Plant Community Type 835) • Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (Plant Community Type 849) • Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion (Plant Community Type 920) • Saltmarsh in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion (Plant Community Type 1126) • Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion (Plant Community Type 1234) • Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion (Plant Community Type 1281) • Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley (Plant Community Type 1800) • Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline (Plant Community Type 1808) • Seagrass meadows of the estuaries and lagoons of the New South Wales coast (Plant Community Type 1913).
Marine vegetation	Mangroves, saltmarsh and seagrass are classed as marine vegetation protected under the *Fisheries Management Act 1994* (FM Act). Marine vegetation is present in the biodiversity study area along Parramatta River, Duck River, Duck Creek, A'Becketts Creek, Haslams Creek, Bicentennial Park Wetlands, Powells Creek, Mason Park Wetlands, Iron Cove, Blackwattle Bay and Johnstons Bay.

Aspect	Existing biodiversity environment
Threatened ecological communities (*Biodiversity Conservation Act*)	The following threatened ecological communities listed under the *Biodiversity Conservation Act, 2016* are found within the biodiversity study area: • Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions • Cumberland Plain Woodland in the Sydney Basin Bioregion • River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions • Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions • Sydney Turpentine-Ironbark Forest.
Threatened ecological communities (*Environment Protection and Biodiversity Conservation Act*)	The following threatened ecological communities listed under the *Environment Protection and Biodiversity Conservation Act, 1999* are found within the biodiversity study area: • Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest • Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion • Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community • Coastal Upland Swamps in the Sydney Basin Bioregion • Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion • Shale Sandstone Transition Forest of the Sydney Basin Bioregion • Subtropical and Temperate Coastal Saltmarsh • Western Sydney Dry Rainforest and Moist Woodland on Shale.
Groundwater dependent ecosystems	There are no aquatic groundwater dependent ecosystems mapped within the biodiversity study area (Bureau of Meteorology 2017). However, there are several terrestrial ecosystems that could be high to moderate potential groundwater dependent ecosystems including: • Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (Plant Community Type 849) in Parramatta Park • Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (Plant Community Type 835) along Domain Creek in Parramatta Park and the Parramatta River • Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley (Plant Community Type 1800) along Parramatta River • Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion (Plant Community Type 920) along the Parramatta River, Duck River, Duck Creek, A'Becketts Creek, Haslams Creek, Powells Creek, Mason Park Wetlands, Iron Cove, Blackwattle Bay and Johnstons Bay • Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion PCT (PCT 781) along the Duck River at Auburn • Saltmarsh in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion (Plant Community Type 1126) along Duck River, Haslams Creek, Bicentennial Park wetlands, and the Mason Park Wetlands • Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion (Plant Community Type 1234) along Parramatta River, Duck River, Duck Creek, Bicentennial Park wetlands, Powells Creek and Mason Park Wetlands • Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion (Plant Community Type 1281) in Queen Elizabeth Park and Five Dock Park • Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline (Plant Community Type 1808) in Bicentennial Park.

Aspect	Existing biodiversity environment
Threatened species	The BioNet database searches (NSW Government Department of Planning, Industry and Environment 2019) returned 37,219 individual threatened plant records and 63,240 individual threatened animal records. There are 111 threatened plant species, 81 threatened bird species, 30 threatened mammal species, eight threatened frog species, eight threatened reptile species, three threatened invertebrate species, three threatened fish species, and two threatened elasmobranchs (sharks and rays) known from the search area. Nineteen endangered populations listed under the *Biodiversity Conservation Act 2016* are known from the search area. The Protected Matters Search Tool (Australian Government Department of the Environment and Energy 2019) returned 78 *Environment Protection and Biodiversity Conservation Act 1999* listed threatened species from the search area. This includes 17 threatened plants and 61 threatened animals.
Migratory species	The Protected Matters Search Tool (Australian Government Department of the Environment and Energy 2019) returned 69 *Environment Protection and Biodiversity Conservation Act 1999* listed migratory species from the search area. While some migratory species of bird are likely to use the biodiversity study area, there are no habitats that may be impacted by the Concept that would be classed as an 'important habitat' (Department of Environment 2013; Department of the Environment 2015). The habitats of the biodiversity study area are not large enough or of high enough quality to support a nationally significant proportion of the population of any migratory species.
Threatened fish and marine species	The desktop searches returned 16 species including two threatened fish, five elasmobranchs (sharks and rays), four marine mammals, and five marine reptiles that may be found within the biodiversity study area.

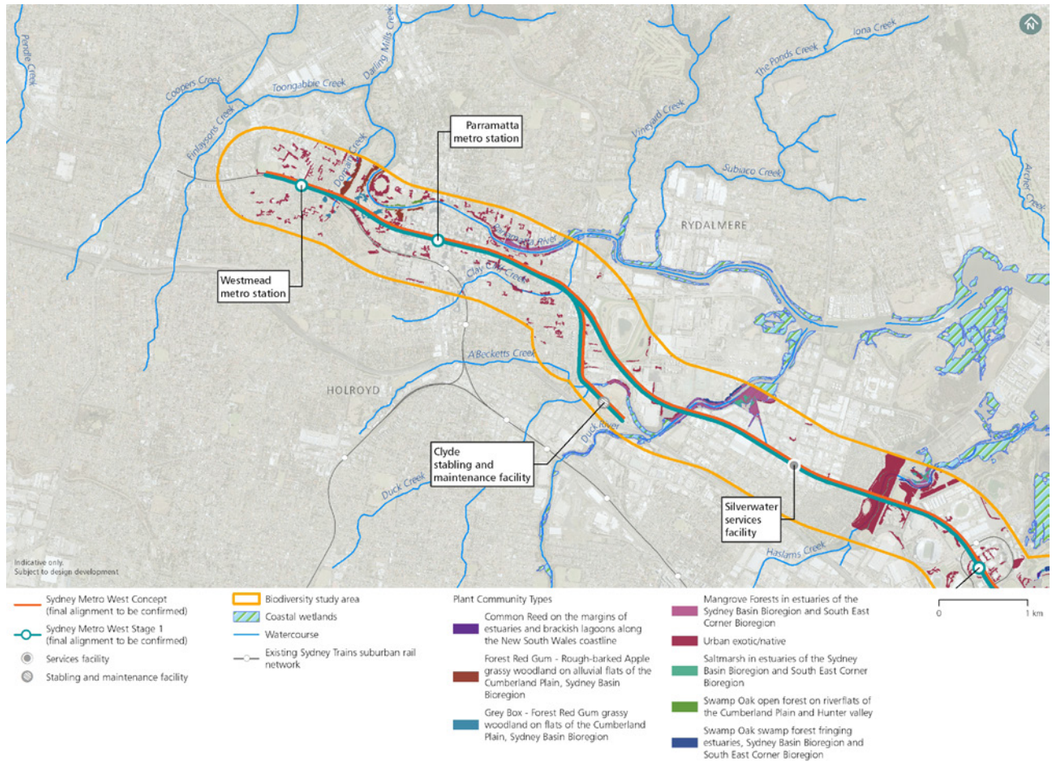

Figure 8-6: Biodiversity environment for the Concept – Map 1

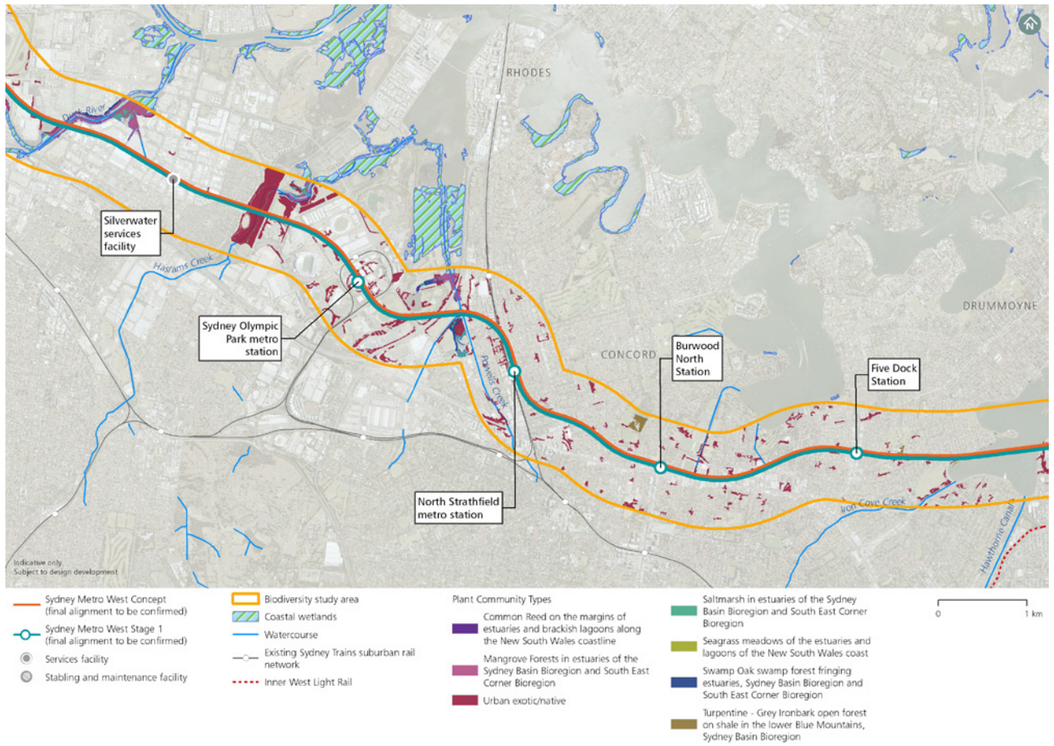

Figure 8-7: Biodiversity environment for the Concept – Map 2

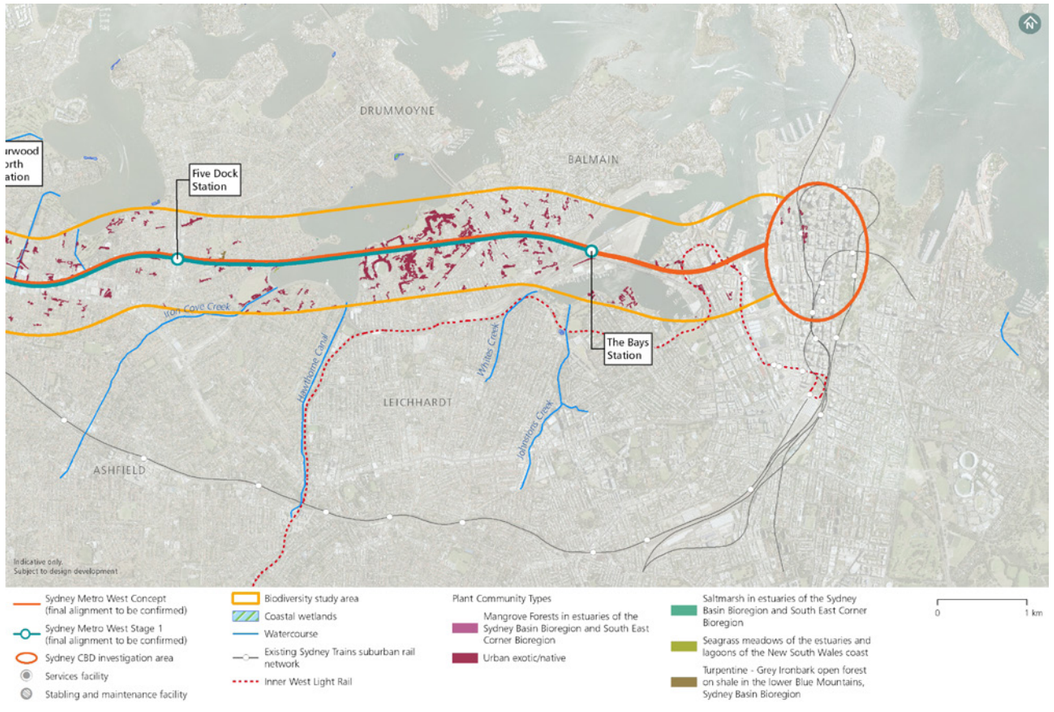

Figure 8-8: Biodiversity environment for the Concept – Map 3

8.16.4 Potential operational benefits and impacts

The potential operational impacts of the Concept on biodiversity are expected to be negligible considering the highly urbanised landscape where the Concept is situated and given that most of the Concept is underground. However, in areas where aboveground disturbance would occur such as at the Clyde stabling and maintenance facility construction site there are likely to be some potential ongoing biodiversity impacts during operation including weed invasion, runoff and sedimentation, and the introduction and spread of pathogens. The implementation of standard mitigation measures is expected to control potential weed invasion, runoff and sedimentation and the introduction and spread of pathogens.

The vegetation adjacent to the Clyde stabling and maintenance facility construction site is a thin band of vegetation along Duck Creek and is currently heavily impacted by edge effects, so further loss of vegetation integrity is not expected in the adjacent vegetation during operation.

8.16.5 Potential construction impacts

Potential biodiversity impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.16.6. This would include offsetting any residual impacts in accordance with the *Biodiversity Conservation Act 2016*. Specific mitigation measures and offset requirements would be developed as part of assessment of each subsequent stage.

The Concept is mainly located in built up areas and has substantially avoided or minimised direct biodiversity impacts. Most of the biodiversity impacts associated with the Concept would occur during construction due to vegetation and habitat removal.

Impacts to native vegetation

As most works would be underground and surface disturbance limited to discreet areas in built up urban and industrial sites, there is likely to be minimal disturbance to native vegetation and threatened ecological communities. There may however be some limited impact to small unmapped areas of threatened ecological communities.

The biodiversity study area contains a mix of plant community types including threatened ecological communities, planted native vegetation (street trees, gardens) and weed growth typical of the Sydney area. Vegetation clearing may occur, but the magnitude of this impact is likely to be low given the majority of works would be underground and surface disturbance is limited to discreet areas in built up urban and industrial sites. The Concept is located within a highly urbanised area that does not possess large expanses of intact native vegetation. Where vegetation removal and disturbance cannot be avoided, the vegetation is likely to be of poor to moderate quality and/or to provide limited habitat for threatened species.

Plant community types within the biodiversity study area are generally in poor to moderate condition due to human disturbance and weed invasion. The integrity of existing vegetation, including composition, structure and function, is likely to be low. Therefore, minimal impacts are expected.

Impacts to habitat

The Concept is located in a highly urbanised and industrialised part of Sydney and the natural habitats have largely been cleared or have been extensively modified. The habitat suitability for most threatened species in large parts of the study area is marginal.

The habitats that do remain in the biodiversity study area are fragmented and isolated. Vegetated riparian zones (e.g. the Parramatta River, Duck River, Haslams Creek and Powells Creek) provide the most obvious semi-intact movement corridors that may be impacted. Additionally, the isolated vegetation remnants, planted urban vegetation, and to a lesser extent, weed growth within the biodiversity study area also play a less obvious role in facilitating the movement of threatened species across the landscape.

Functional connectivity still exists for many species, particularly birds and bats and, to a more limited extent, amphibians, mammals and reptiles. Flying animals such as birds and bats use the airspace to move between habitats and may use fragmented vegetation as cover to escape from predators. The biodiversity study area is likely to be used as a foraging or perching resource by flying animals as part of daily movements. For example, a portion of the Grey-headed Flying-fox population leaves the nationally important Parramatta camp of an evening and likely passes through the biodiversity study area as the bats fly to foraging grounds. The threatened Swift Parrot is likely to pass through the biodiversity study area during seasonal movements. Threatened species known from the Concept corridor including the Grey-headed Flying-fox, Swift Parrot and threatened micro bats are powerful flyers capable of covering large distances between habitat patches. The landscape of the Concept corridor in its current form is accessible to these species. Habitat connectivity for these species, and threatened species movement, is unlikely to be detrimentally affected and the bioregional persistence of these species would not be influenced by the Concept.

There are no karst, caves, crevices, cliffs and other geological features of significance that are likely to be impacted by the Concept. There are no areas likely to be impacted that contain significant rock features that may be used by threatened species as habitat. Human made structures, notably buildings, would be impacted by the Concept.

Impacts on threatened species

Potential impacts to threatened species habitat would be avoided where possible through detailed design and siting of the Concept components on land already disturbed from current or previous urban development.

Direct impacts to threatened species within the biodiversity study area are unlikely. There is, however, potential for impacts to threatened species habitat, although this is likely to be minimal given the small area of habitat that would require removal. Based on the threatened species returned from the database searches, the following threatened species may have habitat impacted by the Concept:

- Plants including *Acacia pubescens*, *Cynanchum elegans*, *Dillwynia tenuifolia*, *Grevillea juniperina subsp. juniperina*, *Haloragis exalata subsp. exalata*, *Marsdenia viridiflora* endangered population, *Pultenaea pedunculata*, and *Wilsonia backhousei*
- Birds including Dusky Woodswallow, Australasian Bittern, Curlew Sandpiper (foraging habitat only), Little Lorikeet, White-bellied Sea-Eagle (foraging habitat only), Swift Parrot (foraging habitat only), Broad-billed Sandpiper (foraging habitat only), Black-tailed Godwit (foraging habitat only), Eastern Osprey (foraging habitat only), Red Knot (foraging habitat only), Great Knot (foraging habitat only), Lesser Sand-plover (foraging habitat only), and Eastern Curlew (foraging habitat only)
- Bats including Little Bentwing-bat (foraging habitat only), Eastern Bentwing-bat (foraging habitat only), Eastern Freetail-bat, Southern Myotis, and Grey-headed Flying-fox (foraging)
- Green and Golden Bell Frog.

The high number of threatened species records returned from the searches reflects the intense biodiversity survey effort that has occurred in the Sydney area.

The tunnel alignment potentially passes beneath Domain Creek, Duck River, Haslams Creek and Powells Creek. These areas contain threatened ecological communities listed under the *Biodiversity Conservation Act 2016* that are at least somewhat dependent on groundwater, surface water flows, and/or tidal flushing. While there is a risk that groundwater drawdown could detrimentally impact these areas and associated ecosystems and species, tunnel construction is anticipated to cause only short-term disruption to groundwater levels as tunnels would be lined almost immediately after excavation to prevent significant volumes of groundwater inflow. Therefore, the risk to threatened species and groundwater dependent ecosystems from groundwater drawdown during tunnelling is expected to be minimal.

These areas also contain habitat for the Green and Golden Bell Frog and threatened and migratory bird species listed under the *Biodiversity Conservation Act 2016* and *Environment Protection and Biodiversity Conservation Act 1999*. There is potential to disturb habitat for these listed species during excavation at construction sites located within the vicinity of the above waterways.

The risk of increased vehicle strike from construction of the Concept is low and would generally be limited to vehicle movements to and from construction sites, which would typically be on existing busy roads. Vehicle strike is considered unlikely to detrimentally affect any threatened species of animals or animals that are part of a threatened ecological community.

There would be no components of the Concept that would affect species movement or interfere with the current flight paths of any protected species. The movement of migratory, nomadic or local species is likely to continue unaltered as no new obstacles would be placed in the flight path of any species. Importantly, no important habitats along the flight path of any species (e.g. wetlands) are likely to be directly affected and the Concept is unlikely to result in an increased collision risk to flying species.

Impacts to aquatic ecosystems and groundwater dependent ecosystems

Construction and operation of permanent waterway crossings (such as bridges and culverts) is unlikely to impact fish species given the existing quality of the habitat and the implementation of mitigation measures to prevent detrimental changes to water quality. Construction activity around watercourses has the potential to result in temporary changes to flow and loss of aquatic habitat associated with the removal of woody snags, changes to instream substrate and loss of aquatic plants (macrophytes). Tunnels would likely pass at depth beneath Domain Creek, Duck River, Haslams Creek, Saleyards Creek, Powells Creek and Iron Cove. Work may be required within Duck Creek and A'Becketts Creek as part of works at the Clyde stabling and maintenance facility. These creeks are mapped as key fish habitat and mitigation measures would be implemented so that fish passage is not blocked in these areas as much as practicable.

The only threatened fish that may be impacted is the Black Rockcod, but the likelihood of an impact to this species is considered low given no direct impacts to the habitat are likely to occur.

As stated above, tunnel construction is anticipated to cause only short-term disruption to groundwater levels. Therefore, risk to threatened species groundwater dependent ecosystems from groundwater drawdown during tunnelling is expected to be minimal.

There are no aquatic groundwater dependent ecosystems mapped within the biodiversity study area. The following threatened ecological communities within the biodiversity study area are considered likely to be terrestrial groundwater dependent ecosystems:

- Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Cumberland Plain Woodland in the Sydney Basin Bioregion
- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Sydney Turpentine-Ironbark Forest.

Most of the threatened ecological communities listed above are not obligate groundwater dependent ecosystems (i.e. they are not entirely dependent on groundwater). Cumberland Plain Woodland in the Sydney Basin Bioregion, River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions, and Sydney Turpentine-Grey Ironbark Forest are not restricted to locations of groundwater discharge and are not located within aquifers. These three threatened ecological communities are likely to be opportunistic facultative groundwater dependent ecosystems that depend on the subsurface presence of groundwater (often accessed via the capillary fringe – subsurface water just above the water table) in some locations but not in others, particularly where an alternative source of water (i.e. rainfall) cannot be continuously accessed to maintain ecological function. The plants within these threatened ecological communities would mainly use shallow soil water but would also make use of deeper soil water or groundwater where available. The trees may rely on groundwater from the capillary fringe during dry years or in extended drought.

Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions and Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions are tidal wetland threatened ecological communities which may depend on groundwater or a combination of surface and groundwater. Mangroves and seagrass beds also fall into this category.

Contribution to Key Threatening Processes

A key threatening process is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. The Concept may directly or indirectly contribute to the following key threatening processes:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
- Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams
- Clearing of native vegetation and land clearance
- Infection of frogs by amphibian chytrid causing the disease chytridiomycosis and infection of amphibians with chytrid fungus resulting in chytridiomycosis
- Infection of native plants by *Phytophthora cinnamomi* and dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)
- Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae
- Invasion and establishment of exotic vines and scramblers
- Invasion of native plant communities by African Olive *Olea europaea* subsp. *cuspidata* (Wall. ex G. Don) Cif.
- Invasion of native plant communities by *Chrysanthemoides monilifera*
- Invasion of native plant communities by exotic perennial grasses
- Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat)
- Degradation of native riparian vegetation along New South Wales water courses.

8.16.6 Performance outcomes

Identified performance outcomes in relation to biodiversity are:

- Impacts on biodiversity are avoided (where possible) and minimised, including the clearing of native vegetation
- Significant impacts to flow regimes in receiving waterways are avoided
- Design of waterway modifications and crossings incorporates best practice principles
- The Concept does not contribute to key threatening processes associated with weeds and pathogens
- Biodiversity impacts are offset in accordance with the *Biodiversity Conservation Act 2016.*

8.16.7 Matters to be addressed in staged applications

Biodiversity assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Biodiversity assessments will include, as relevant to the stage:

- Identification and description of flora and fauna species, habitat, populations and ecological communities that occur, or are considered likely to occur
- Assessment of potential impacts in accordance with the Biodiversity Conservation Act and the Biodiversity Assessment Method
- Identification of mitigation measures using the principles of 'avoid, minimise, mitigate'
- Consideration and assessment of required biodiversity offsets in line with the Biodiversity Offsets Scheme
- Further consultation with Department of Planning, Industry and Environment (Environment, Energy and Science Group).

A biodiversity assessment for Stage 1 is provided in Chapter 22 (Biodiversity – Stage 1).

8.17 Air quality

8.17.1 Legislative and policy context

The *Protection of the Environment Operations Act 1997* provides the statutory framework for managing pollution in NSW. It includes procedures to regulate the potential for pollution, including the issue of environment protection licences for activities identified in Schedule 1 of the Act. Air quality requirements (including criteria) are typically included in environment protection licences.

Air quality impact assessment is guided by the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (Environment Protection Authority, 2016). The Approved Methods generally apply to stationary sources of air pollution but include air quality impact assessment criteria.

The National Environment Protection (Ambient Air Quality) Measure sets national air quality standards for particulate matter with an aerodynamic diameter of less than 10 microns (PM_{10}), and for particulate matter with an aerodynamic diameter of less than 2.5 microns ($PM_{2.5}$).

8.17.2 Assessment approach

Potential air quality impacts were assessed qualitatively by:

- Identifying potential environmental sensitivity around the Concept corridor considering existing land uses and sources of emissions to air, climate and meteorological conditions, and background air quality information
- Identifying the primary potential air quality risks during construction and operation
- Determining the potential air quality impacts based on the risks and level of sensitivity
- Consultation with the NSW Environment Protection Authority to discuss the approach to air quality assessment
- Identifying performance outcomes
- Identifying the proposed scope of air quality assessments for future stages.

8.17.3 Existing environment

Climate and meteorology

Climate and meteorological conditions are important for determining the direction and rate at which emissions from a source will disperse. Typical climate conditions for different locations across the Concept corridor were determined by reviewing long-term climate records from automatic weather stations operated by the Bureau of Meteorology. These included Parramatta North (Station number 066124) which was used to characterise prevailing conditions at areas towards the western end of the Concept and Sydney Observatory Hill (Station number 066062) for eastern areas of the Concept.

The data measured at the Parramatta North weather station indicates the area around this location generally experiences warm, wet summers, with average maximum temperatures of around 28 degrees Celsius. Months through winter are generally the coldest, with average mean daily maximum temperatures of around 18 degrees Celsius. Months through winter were also measured to be the driest, with the lowest average monthly rainfall recorded in July (45 millimetres).

At Sydney Observatory Hill, data indicates that average maximum summer temperatures are around two degrees Celsius lower (26 degrees Celsius). Summers are also wet, although June has the highest average mean rainfall (133 millimetres) of all months. July is the coldest month and September has the lowest mean monthly rainfall (68 millimetres).

At both stations, unfavourable weather conditions most associated with dust dispersion (i.e. above average temperature conditions and average or below average rainfall) were measured in spring.

Long-term records of wind speed and direction measurements from Parramatta North and Sydney Observatory Hill automatic weather stations were reviewed to understand prevailing meteorological conditions. In the mornings (9am), winds blowing from the north-west and west are most common at Parramatta North, and winds from the east and south-east are prevalent at Sydney Observatory Hill. In the afternoons (3pm), winds from the west are most common at Parramatta North, with easterly winds blowing most frequently at Sydney Observatory Hill.

Existing emissions sources

The air quality in the Greater Sydney region is influenced by a variety of different man-made and natural sources. The Air Emissions Inventory for the Greater Metropolitan Region in New South Wales (Environment Protection Authority, 2012) recorded the relative contribution of air pollutants in the Sydney region from different human sources. These included on-road mobile (i.e. road traffic), off-road mobile (e.g. boats and construction plant), domestic, commercial and industrial sources. The following key pollutants were reported:

- Fine particulate matter, comprising PM_{10} and $PM_{2.5}$
- Oxides of nitrogen
- Carbon monoxide
- Volatile organic compounds.

Air quality criteria

Air quality impact assessment criteria are provided in the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (Environment Protection Authority, 2016), and are summarised in Table 8-48 for key pollutants. The air quality impact assessment criteria reflect the environmental outcomes adopted by the Environment Protection Authority for the cumulative ground level concentration of air pollutants as a result of all emissions sources and are not individual emissions source criteria.

Table 8-48: Air quality impact assessment criteria for key pollutants

Pollutant	Units	Averaging period	Criteria
PM_{10}	$\mu g/m^3$	24-hour	**50**
		Annual	**30**
$PM_{2.5}$	$\mu g/m^3$	24-hour	**25**
		Annual	**8**
Carbon monoxide	mg/m^3	1-hour	**30**
Nitrogen dioxide	$\mu g/m^3$	1-hour	**246**
		Annual	**62**
Sulfur dioxide	$\mu g/m^3$	1-hour	**570**
		Annual	**60**

Background air quality

Potential pollutants generated during construction and operations may include dust (including PM_{10} and $PM_{2.5}$), carbon monoxide, sulfur dioxide, oxides of nitrogen and volatile organic compounds. Measurements at the Prospect, Parramatta North, Rozelle and Randwick (former) Office of Environment and Heritage air quality monitoring stations during the 2014 to 2018 reporting periods indicate that:

- Maximum 24-hour averaged PM_{10} concentrations occasionally exceeded the 50 $\mu g/m^3$ criterion, however the 95th percentile values were in the order of 72 per cent of the criterion or less. Natural events such as large-scale hazard reduction burning, bushfires and dust storms are often the cause of elevated short-term particulate matter concentrations in the Sydney Greater Metropolitan Region (Environment Protection Authority, 2013). Exceptional events of this nature are excluded from the calculation of maximum daily and annual average concentrations for PM_{10} and $PM_{2.5}$ under Clause 18 of the National Environment Protection (Ambient Air Quality) Measure
- Annually averaged PM_{10} concentrations were found to vary between the stations considered, with the highest value of 22 $\mu g/m^3$ recorded at the Parramatta North and Prospect stations in 2018 against the 25 $\mu g/m^3$ impact assessment criterion
- The maximum 24-hour averaged $PM_{2.5}$ concentrations exhibited the same trend as for PM_{10} with the 25 $\mu g/m^3$ assessment criterion occasionally being exceeded, and the 95th percentile values below this criterion
- Annually averaged $PM_{2.5}$ concentrations varied across stations and between years, ranging from 7.2 to 9.2 $\mu g/m^3$, exceeding the 8 $\mu g/m^3$ assessment criterion in some years
- Measured results for nitrogen dioxide, carbon monoxide, and sulfur dioxide were well below the respective impact assessment criteria at all of the monitoring stations reviewed.

Surrounding land uses

The Concept would pass through a well-established urban environment comprising a range of different land uses. Table 8-49 summarises the land use and types of receivers associated with each setting within the Concept corridor.

Table 8-49: Summary of land uses and types of air quality sensitive receivers

Urban setting	Land uses and types of air quality sensitive sensitive receivers
CBDs • Parramatta • Sydney	There are a variety of land uses in the Parramatta and Sydney CBDs including commercial, retail, mixed-use and residential. Significant open and recreation spaces include Hyde Park and the Domain, and Parramatta Park. These, along with numerous other open space focal points, attract millions of visitors each year. Potential sensitive receivers include a number of educational facilities located within the CBD areas, including schools, childcare centres, university campuses and other tertiary institutions. Other sensitive receivers include medical facilities, places of worship and community facilities.
Suburban • North Strathfield • Burwood North • Five Dock • Services facility between Five Dock and The Bays	The suburban settings include predominantly residential land use, with small centres of commercial, retail and mixed-use. Potential sensitive receivers include educational facilities such as schools and childcare centres, along with places of worship and public open spaces. Other sensitive receivers include medical facilities, recreational areas and community facilities.
Urban renewal precincts • Westmead • Sydney Olympic Park • The Bays	The current dominant land uses within these areas tend to be specialised – Westmead by health, research and medical uses; Sydney Olympic Park by open-air sporting venues and recreation facilities; and The Bays by former industrial uses. All areas have medium to high density residential land use within or near the precincts. There are also existing train stations at Westmead and Sydney Olympic Park. Other sensitive receivers within the urban renewal precincts include educational facilities, places of worship, commercial and retail.
Industrial and urban services • Clyde • Silverwater	Land use is mainly industrial and commercial. Residential receivers are located nearby.

8.17.4 Potential operational benefits and impacts

When operational, depending on the mode shift from road to rail, the Concept could benefit local air quality by delivering an attractive alternative mode of public transport. This has the potential to reduce air pollution emissions from road transport and congestion within the corridor (when compared to the emissions that would otherwise occur if the Concept was not delivered).

Overall potential air quality impacts would present a low level of risk, would occur infrequently and would be manageable with negligible impacts on air quality.

The Concept would include fresh air ventilation systems to circulate fresh air through the tunnels and underground stations and to prevent the build-up of heat. Fresh air would be drawn into the tunnels and air would be extracted and discharged from the tunnels by mechanical ventilation at the stations and services facilities. The stations would also provide separate fresh air ventilation systems to draw fresh air in and extract air from the station environment. Air discharged from the tunnels and stations would be well diluted and dispersed into the outdoor air environment.

Negligible amounts of particulate matter (PM_{10} and $PM_{2.5}$) emissions would be generated in underground tunnels, mainly due to train brake pad wear, vaporisation of metals due to sparking, wear of steel due to friction between wheels and rail, and recirculation of particulates from tunnel walls. Most of these emissions would be vented through the fresh air ventilation system in very low concentrations.

Vented air is also likely to include minor concentrations of carbon dioxide, volatile organic compounds, oxides of nitrogen and ash and soot particulates generated during maintenance. Given the low concentrations of particulates, the Concept is very unlikely to have air quality impacts on the surrounding environment.

Contaminated soils and groundwater with the potential to cause vapour ingress into stations and tunnels have been identified at a number of locations within the Concept. As set out in Section 8.11 (Contamination - Concept), contamination would be managed during construction so that vapour causing contamination is either removed or appropriately managed to avoid operational air quality impacts.

The fresh air ventilation system would also respond to emergency conditions such as fire incidents, where smoke would be discharged through the emergency ventilation system to prevent smoke from entering stations or recirculating through fresh air ventilation shafts. The design and location of the fresh air ventilation shafts at stations and service facilities would minimise impacts on sensitive receivers and suitable emergency plans would be in place for these circumstances.

Activities with the potential to impact air quality during operation include:

- Trains operating in underground tunnels (i.e. from brake wear, metal vaporisation resulting from sparking, wearing of steel componentry and re-entrainment) – potential release of particulate matter from fresh air ventilation shafts in very low concentrations
- Routine maintenance activities – potential release of exhaust emissions from fresh air ventilation shafts in very low concentrations
- Emergency conditions (e.g. in-tunnel fire) – potential release of smoke (i.e. particulate matter) via emergency ventilation systems.

At Parramatta, Clyde, Silverwater, Sydney Olympic Park and Sydney CBD there is also potential for exposure of contamination sources which may affect air quality, although this risk would be managed through further detailed assessments at later stages.

8.17.5 Potential construction impacts

Potential air quality impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.17.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

With the implementation of effective controls, it is expected that potential air quality risks during constriction would be able to be mitigated or otherwise effectively managed within acceptable levels.

Dust generated during site clearing and demolition, excavation, materials handling, stockpiling and compaction activities has the potential for air quality-related risk during construction. Dust is a general term used to describe particulate matter in the form of total suspended solids or particulate matter with a smaller aerodynamic diameter (PM_{10} and $PM_{2.5}$). If not properly managed, elevated airborne dust levels have the potential to cause adverse human health or nuisance impacts. These types of impacts can include:

- Potential human health issues
- Nuisance impacts including dust soiling (i.e. the unwanted settling of dust on property surfaces)
- Reduced visibility
- Physical and chemical impacts to vegetation (Farmer, 1993; Doley, 2006).

Exhaust emissions from the combustion of fossil fuels in operating construction plant and equipment represent another potential air quality risk during construction. Key pollutants associated with these emissions include:

- Fine particulate matter (i.e. PM_{10} and $PM_{2.5}$)
- Oxides of nitrogen including nitrogen dioxide
- Carbon monoxide
- Sulfur dioxide
- Volatile organic compounds such as benzene.

Considering existing sources of these pollutants in areas around the Concept, the additional air quality risk is considered minor to negligible.

Odours arising from uncovered contaminated and/or hazardous materials and airborne hazardous materials represent other air quality related risks during construction although the risk is likely to be low.

The potential for these impacts to occur at different areas across the Concept corridor would depend on several factors, including:

- The intensity of construction activities and where they take place (i.e. at or above ground level, below ground, or within deep excavations)
- The proximity, density and sensitivity of surrounding land uses
- Prevailing meteorological conditions
- Mitigation and management measures that are applied.

8.17.6 Performance outcomes

The identified performance outcome in relation to air quality is to minimise air quality impacts during construction and operation.

8.17.7 Matters to be addressed in staged applications

Air quality impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Air quality assessments will include, as relevant to the stage:

- Consideration of the relevant regulatory framework and guidelines
- Desktop review and identification of the types of activities that may generate potential air quality related impacts during construction and operation
- Estimation of the potential for dust-related impacts during construction using the risk-based assessment approach presented in Guidance on the assessment of dust from demolition and construction Version 1.1 (United Kingdom Institute of Air Quality Management, 2014). Other impacts during construction and operation would also be qualitatively assessed
- Identification of mitigation measures to address air quality impacts and risks
- Further consultation with the NSW Environment Protection Authority.

An air quality assessment for Stage 1 is provided in Chapter 23 (Air quality – Stage 1).

8.18 Spoil, waste management and resource use

8.18.1 Legislative and policy context

Waste management and recycling is regulated in NSW by the NSW Environment Protection Authority through the *Protection of the Environment Operations Act 1997*, the Protection of the Environment Operations (Waste) Regulation 2014 (including the requirement to track certain types of waste) and the *Waste Avoidance and Resource Recovery Act 2001*.

The *Protection of the Environment Operations Act 1997* defines waste as any substance that is discharged, emitted or deposited in the environment in such a manner as to alter the environment. This broad definition includes substances that are processed, recycled, re-used or recovered.

The *Waste Avoidance and Resource Recovery Act 2001* aims to promote waste avoidance and resource recovery through (amongst other things) the establishment of the following waste hierarchy:

- Avoidance of waste – the first priority in waste management includes actions to reduce the amount of waste generated
- Resource recovery – the second priority in waste management involves opportunities for reuse (without further processing), recycling (processing waste materials to make the same or different products), reprocessing and energy recovery
- Disposal – the least desirable option in the waste management hierarchy involves the disposal of waste in an appropriate manner so as to minimise the potential adverse environmental impacts associated with its disposal.

By minimising consumption and encouraging the efficient use of resources, the *Waste Avoidance and Resource Recovery Act 2001* aims to reduce the generation and impacts of waste.

The NSW Department of Planning, Industry and Environment's NSW Government Resource Efficiency Policy (Office of Environment and Heritage, 2019) aims to drive resource efficiency by NSW Government agencies and reduce harmful air emissions from government operations. As a government agency, Sydney Metro has a responsibility under this policy to incorporate resource-efficiency considerations in all major decisions to address rising costs for energy, water, clean air and waste management.

The *NSW Waste Avoidance and Resource Recovery Strategy 2014–21* (Environment Protection Authority, 2014a) supports the avoidance and minimisation of waste and provides a framework and targets for waste management and recycling in NSW until 2021–2022. Targets include:

- Avoiding and reducing waste generation
- Increasing recycling and diverting waste from landfill
- Improving the management of 'problem wastes' (such as toxic and hazardous products)
- Reducing litter and illegal dumping.

Sydney Metro, as a NSW Government agency, supports these targets by:

- Implementing complementary policies and programs, including sustainable procurement policies
- Incorporating resource recovery and waste reduction objectives into its operations
- Complying with relevant regulations.

A number of policies and strategic documents are relevant to waste management and resource use for the Concept. The NSW Environment Protection Authority Waste Classification Guidelines (NSW Environment Protection Authority, 2014b) assists waste generators to classify the wastes they produce. The guidelines classify waste into groups that pose similar risks to the environment and human health in order to facilitate their management and appropriate disposal. Correct classification is required in order to comply with applicable laws and safeguard the protection of the environment and human health.

The Department of Planning, Industry and Environment (which includes the NSW Environment Protection Authority) is leading the development of a 20-year Waste Strategy for NSW. The Strategy will address key priorities for waste and resource recovery for NSW and an issues paper about the strategy is expected to be released prior to a draft strategy in 2020.

8.18.2 Assessment approach

This assessment involved:

- Identifying the likely resources required for the construction and operation of the Concept
- Identifying the likely waste generating activities and waste types for the construction and operation of the Concept
- Identifying the potential environmental impacts associated with resource use and the generation (and subsequent disposal) of waste materials
- Consultation with the NSW Environment Protection Authority to discuss the approach to assessment of spoil, waste management and resource use
- Identifying performance outcomes
- Identifying the proposed scope of spoil, waste management and resource use assessments for future stages.

8.18.3 Potential operational benefits and impacts

Spoil

There would be no operational impacts associated with spoil. Potential impacts would be confined to the construction phase.

Waste management

It is anticipated that waste would be adequately managed through the application of standard mitigation measures and the waste hierarchy outlined in the *Waste Avoidance and Resource Recovery Act 2001*.

The indicative operational waste streams are outlined in Table 8-50, along with the likely waste classification under the Waste Classification Guidelines (NSW Environment Protection Authority, 2014b). The types, classifications and quantities of wastes generated during the operation of the Concept would be confirmed following further design work and considered in future stages.

Table 8-50: Indicative types of waste generated during the operation of the Concept

Waste stream	Likely waste classification
Wastes from train and systems maintenance activities	• General solid waste (non-putrescible) • Hazardous waste and/or special waste.
General wastes from the operation and maintenance of metro stations	• General solid waste (non-putrescible).
Wastewater from tunnels and metro stations (toilets and station-cleaning activities)	• Liquid waste.

A summary of potential impacts to waste management during the operation of the Concept is provided in Table 8-51.

Table 8-51: Summary of potential operational impacts on waste management

Type of impact	Description of impact
Inadequate collection, classification and disposal of waste	Waste from metro stations and maintenance activities being unnecessarily directed to landfill, potentially increasing the demand for landfill capacity within the Sydney region.
Inadequate management of bins at stations	Waste (such as litter) from station buildings being blown into the surrounding environment.
Incorrect storage, handling and disposal of putrescible waste at metro stations	Potential increase in vermin in the vicinity of metro stations.
Inadequate management of wastewater from metro stations (toilets and station-cleaning activities) and tunnels	Potential contamination of soil, surface and/or groundwater.
Excessive amounts of maintenance materials being ordered	Potentially a large amount of left-over, unused resources.

Resource use

The resources that would be required to operate the Concept include:

- Electricity
- Water
- Materials for ongoing maintenance activities.

The resource requirements for the operation of the Concept are likely to be typical for an infrastructure project of this scale and similar to other operational rail lines including the Metro North West Line. Opportunities to minimise resource consumption and maximise resource efficiency would be considered during further design development. This includes offsetting 100 per cent of operational electricity requirements through new renewable energy capacity. Although operational requirements for water use would be relatively minor, potable water use would be minimised where possible, including avoiding the use of potable water where non-potable water is available. Current best-practice water-efficient features, equipment and appliances at stations, stabling facility and construction sites would be implemented. Further commitments for minimising water use are outlined in Section 8.20 (Sustainability and Climate Change – Concept).

8.18.4 Potential construction impacts

Potential spoil, waste management and resource use impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.18.5. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

Spoil

Spoil generated during the construction of the Concept would be classified in accordance with NSW Waste Classification Guidelines. Spoil that is not classified as hazardous, or special wastes, would be reused following the hierarchy of options presented in Table 8-52. As a performance outcome, Sydney Metro would target beneficial reuse of 100 per cent of the usable spoil generated during construction. The geology of the spoil material as well as its consistency and quality would determine the reuse options.

Sampling and testing of soils in areas of potential contamination concern would be conducted to determine the appropriate waste classification in accordance with the Waste Classification Guidelines. The suitability of soils for beneficial reuse would also be determined in accordance with the National Environment Protection (Assessment of Site Contamination) Measure (National Environment Protection Council, 1999) and the NSW Environment Protection Authority resource recovery framework.

Table 8-52: Spoil management hierarchy for the Concept

Priority	Re-use options
1	Within the Stage 1 construction footprint
2	Environmental projects
3	Other development projects (including other Sydney Metro projects)
4	Land restoration
5	Landfill management

Waste management

The types, classifications and quantities of construction waste generated during the construction of the Concept would be confirmed following further design work and considered in future stages. However, the volumes of construction wastes are expected to be comparable to other similar infrastructure projects including Sydney Metro Northwest (which opened in May 2019) and the Chatswood to Sydenham component of Sydney Metro City & Southwest (currently under construction).

Waste generated by the construction of the Concept would be managed in accordance with the Sydney Metro Construction Environmental Management Framework. It is anticipated that waste would be adequately managed through the application of standard mitigation measures and the waste hierarchy outlined in the *Waste Avoidance and Resource Recovery Act 2001*. General construction and demolition wastes, and wastes from site offices, would be collected for off-site recycling wherever practicable. Wastes that contain hazardous, special or otherwise contaminated, materials would be treated and disposed off-site at a licensed facility in accordance with the relevant guidelines.

The indicative construction waste streams are outlined in Table 8-53, along with the likely waste classification under the Waste Classification Guidelines (NSW Environment Protection Authority, 2014b).

Table 8-53: Indicative types of waste generated during construction of the Concept

Waste stream	Likely waste classification
Demolition waste	• General solid waste (non-putrescible) • Hazardous waste • Special waste.
Vegetation waste	• General solid waste (non-putrescible).
Spoil from tunnel excavation, station excavation and general earthworks (including contaminated soils and acid sulfate soils)	• General solid waste (non-putrescible) • General solid waste (putrescible) • Hazardous and/or special waste • Liquid waste.
Wastewater from dust suppression, wash down of plant and equipment, and staff amenities at construction sites (such as toilets)	• Liquid waste.
General construction waste	• General solid waste (non-putrescible).
Waste from the operation and maintenance of construction plant and equipment	• Hazardous waste and/or special waste.
General waste from site offices	• General solid waste (non-putrescible).

A summary of potential impacts associated with waste management during construction of the Concept is provided in Table 8-54.

Table 8-54: Summary of potential construction impacts associated with waste management

Type of potential impact	Description of potential impact
Inadequate collection, classification and disposal of waste	Waste unnecessarily being directed to landfill, potentially increasing the demand for landfill capacity within the Sydney region.
Inappropriate storage, transport and disposal of liquid and solid wastes	Potential contamination of soil, surface water and/or groundwater.
Incorrect storage, handling and disposal of putrescible waste from construction sites	Potential increase in vermin in the vicinity of construction sites.
Incorrect storage, handling and disposal of hazardous materials	Potential contamination of soil, surface water and/or groundwater and the local air shed.
Inadequate management of spoil stockpiles	Potential runoff, sedimentation and leachate of surface water and/or groundwater.
Excessive amounts of materials being ordered	Potentially z large amount of left-over, unused resources.
Lack of identification of feasible options for recycling or reuse of resources	Waste unnecessarily being directed to landfill, which would potentially increase the demand for landfill capacity within the Sydney region.

Resource use

A variety of resources would be needed to construct the Concept, including but not limited to:

- Electricity
- Fuel
- Concrete, including for tunnel lining segments
- Steel
- Water.

The resource requirements for the construction of the Concept are likely to be typical for an infrastructure project of this scale. While the resource requirements do have the potential to impact resource availability within the Sydney metropolitan region over the construction period, the concurrent construction of recent major infrastructure projects has demonstrated that the market is able to meet the resource requirements of these projects given sufficient opportunity to forward plan.

Consistent with the resource management hierarchy of the *Waste Avoidance and Resource Recovery Act 2001*, resource consumption would be further minimised during construction through reuse, where possible.

8.18.5 Performance outcomes

Identified performance outcomes in relation to spoil, waste management and resource use for operation and construction of the Concept are provided in Table 8-55.

Table 8-55: Spoil, waste management and resource use performance outcomes

Operational performance outcomes	Construction performance outcomes
• The use of potable water for non-potable purposes is avoided if non-potable water is available • The reuse of water is maximised, either on site or off site.	• 100 per cent of useable spoil is reused in accordance with the spoil reuse hierarchy • A minimum 95 per cent recycling target is achieved for construction and demolition waste • Products made from recycled content are prioritised • The use of potable water for non-potable purposes is avoided if non-potable water is available • The reuse of water is maximised, either on site or off site.

8.18.6 Matters to be addressed in staged applications

Spoil, waste management and resource use assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Spoil, waste management and resource use assessments will include, as relevant to the stage:

- Desktop review of the likely construction resources, including construction materials, water and power
- Identification of likely waste generating activities and possible waste streams in accordance with relevant legislation and guidelines
- Identification of the environmental impacts associated with resource use and the generation (and subsequent disposal) of waste materials
- Identification of mitigation measures and management strategies to address the potential impacts
- Further consultation with the NSW Environment Protection Authority.

A spoil, waste management and resource use assessment for Stage 1 is provided in Chapter 24 (Spoil, waste management and resource use – Stage 1).

8.19 Hazards

8.19.1 Legislative and policy context

The following legislation and guidelines apply to assessing and managing potential hazards:

- The Department of Planning, Industry and Environment's Hazardous and Offensive Development Application Guidelines: Applying SEPP 33 (Department of Planning, 2011)
- *Dangerous Goods (Road and Rail Transport) Regulation, 2009*
- Australian Code for the Transport of Dangerous Goods by Road and Rail (edition 7.6) (National Transport Commission, 2018)
- Storage and Handling of Dangerous Goods Code of Practice (WorkCover, 2005)
- SEPP33 - Hazardous and Offensive Development.

8.19.2 Assessment approach

This assessment involved:

- Identifying the types of hazards which could potentially occur during operation and construction of the Concept
- Assessing the potential environmental impacts and/or risks associated with the types of hazards identified
- Identifying performance outcomes
- Identifying the proposed scope of hazards assessments for future stages.

8.19.3 Existing environment

There are several elements within the Concept corridor that have the potential to become hazardous and pose a risk to the environment and/or human health under adverse conditions if activities are not properly managed. These include:

- Utilities – existing utilities within the Concept corridor include high pressure petroleum pipelines, electrical, gas, sewer, water mains and telecommunications
- Major hazard facilities – there are several classified and regulated major hazard facilities within the Concept corridor

Contaminated sites – there are several known contaminated sites within the Concept corridor, and other risk areas due to current or historical land uses and/or activities. For further discussion refer to Section 8.14 (Contamination – Concept)

Building basements and ground support structures – the highly urbanised nature of land within the Concept corridor means that building basements and ground support structures may be at risk of damage due to ground movement. Further discussion is provided in Section 8.12 (Groundwater and ground movement – Concept)

Bushfire prone land – A search of bushfire prone land mapping developed and published by the relevant local councils found the Concept is not within bushfire prone land. As such, bushfire risk is considered to be negligible and has not been considered further.

8.19.4 Potential operational benefits and impacts

Potential hazards and associated risks during operation of the Concept would be low and manageable using standard measures. The potential types of hazards and associated risks that may be encountered during operation of the Concept, and associated impacts and benefits, are shown in Table 8-56.

Table 8-56: Potential hazards and risks during operation of the Concept

Type of hazard	Potential impacts and/or risk associated with hazard
On-site storage, use and transport of dangerous goods and hazardous substances	**Environmental contamination in the event of a spill.** The volumes of dangerous goods stored on site would be low. Regulatory requirements and best practice regarding the on-site storage, use and transport of dangerous goods and hazardous substances would be complied with to minimise risks.
Potential for hazards to customer and public safety and security	**Security and public safety risks.** A key metro characteristic is to provide a system that is inherently safe for customers on trains, at stations, and at the interface with the public domain. As described in Chapter 6 (Concept description) and Chapter 7 (Placemaking), the safety of passengers and the general public has been, and will continue to be, a key consideration during the design process. The Concept would incorporate measures to eliminate security and public safety risks as much as practicable, including implementation of the principles from Crime Prevention Through Environmental Design. Key safety characteristics that would be incorporated into the Concept are described in Chapter 6 (Concept description) and include CCTV cameras, emergency help points and passenger information signage.
Unauthorised access to the rail corridor	**Risk of injury or fatality.** The risk would be minimised by measures such as the installation of platform screen doors, security fencing, and a trackside intruder detection system, including closed circuit television.
Emergency situation – derailment, fire or deliberate sabotage	**Risk of injury or fatality; risks to property or infrastructure.** While the risk of an emergency situation is very low, Sydney Metro emergency response procedures would be implemented as required.
General worker health and safety issues for drivers and maintenance staff	**Risks undertaking regular maintenance and operational tasks.** Maintenance activities and other works within the rail corridor would be undertaken in accordance with Sydney Metro standard operating procedures, reducing the potential for impacts to the health and safety of workers, visitors, and customers.

8.19.5 Potential construction impacts

Potential hazards during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.19.6. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

The potential types of hazards that may be encountered during construction of the Concept, and the associated impacts, are shown in Table 8-57.

Table 8-57: Potential hazards during construction of the Concept

Type of potential hazard	Potential associated impact and/or risk	Discussion
On-site storage, use and transport of dangerous goods and hazardous substances	Environmental contamination in the event of a spill.	Typically, low volumes of potentially hazardous materials would be stored on site. Construction sites would be planned so that hazardous materials are stored appropriately and at a suitable distance from sensitive receivers. Environmental hazards associated with the on-site storage, use and transport of chemicals, fuels and materials would be managed through standard mitigation measures.
On-site handling and transport of contaminated soil and hazardous wastes	Community risk or environmental contamination in the event of a spill.	The handling and transport of contaminated soil and hazardous wastes would comply with regulatory requirements and standard mitigation measures.
Ground movement	Risk of damage to existing building basements and ground support structures Tunnelling challenges.	The tunnels and many elements of the Concept are designed as tanked structures and therefore long-term settlement effects associated with groundwater drawdown is not anticipated at most locations. The potential risks to buildings and structures would be assessed with reference to construction methodologies and geotechnical conditions in each relevant stage, including measures to mitigate potential impacts.
Impacts to utilities	Release of untreated sewage and/or gas from a sewer main Release of natural gas from a gas main Release of large electrical currents through the ground surface from an underground electricity cable (known as earth potential rise) Release of high pressure petroleum or gas products from petroleum, gas or oil pipelines Explosion or fire from ruptured underground pipelines.	The risk associated with utility related hazards would be mitigated by carrying out utility checks and consulting with the relevant utility providers. Construction methodologies for construction works near utilities would be developed to comply with relevant standards in consultation with utility providers to minimise environmental hazards. Measures to manage potential risks to utilities would be developed for each future stage as part of the assessment process.
Interaction with major hazard facilities	Major hazard event if construction works result in an uncontrolled interaction with a major hazard facility.	Appropriate construction methodologies would be developed for works (if proposed) near major hazard facilities. Risks associated with major hazard facilities would be assessed in the assessment of each relevant stage.

8.19.6 Performance outcomes

The identified performance outcome in relation to hazards is that dangerous goods are to be transported, stored and used so as to not cause a hazardous event.

8.19.7 Matters to be addressed in staged applications

Hazards assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Hazards assessments will include, as relevant to the stage:

- Desktop review of the relevant regulatory framework and guidelines
- Identification of the types of activities that may generate potential hazards
- Identification of the potential environmental impacts associated with the potential hazards
- Identification of mitigation measures to address the potential hazards.

An assessment of potential hazards for Stage 1 is provided in Chapter 25 (Hazards – Stage 1).

8.20 Sustainability and climate change

8.20.1 Sustainability overview

The NSW Government has defined sustainability in the NSW public sector as 'addressing the needs of current and future generations through the integration of social justice, economic prosperity and environmental protection in ways that are transparent, accountable and fiscally responsible' (NSW Government, 2006).

Four principles of Ecologically Sustainable Development are defined in the Environmental Planning and Assessment Regulation 2000 as:

- The precautionary principle – if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation
- Inter-generational equality – the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the future generations
- Conservation of biological diversity and ecological integrity – conservation of biological diversity and ecological integrity should be a fundamental consideration
- Improved valuation and pricing of environmental resources – environmental factors should be included in the valuation of assets and services, including the principle of polluter pays, consideration of full life cycle costs and incentive structure to enable those best placed to maximise benefits or minimise costs.

Chapter 27 (Synthesis of the Environmental Impact Statement) details how the Concept addresses these four principles.

8.20.2 Legislative and policy context

Sustainability considerations (particularly for the NSW public sector agencies) have been incorporated into various legislative and policy mechanisms. These mainly relate to efficient use of resources, including waste and energy.

The key legislative and policy mechanisms are:

- NSW Climate Change Policy Framework (NSW Government, 2016) aims to maximise the economic, social and environmental wellbeing of NSW in the context of a changing climate and current and emerging international and national policy settings and actions to address climate change. It includes an aspirational long-term objective to achieve net-zero emissions by 2050
- NSW Government Resource Efficiency Policy (NSW Government, 2019) aims to reduce the NSW Government's operating costs and increase the efficiency of its resource use
- Transport for NSW Corporate Plan – Connecting NSW (Transport for NSW, 2016) identifies the delivery of sustainable and innovative solutions to transport needs in NSW
- Future Transport Strategy 2056 (NSW Government, 2018) identifies sustainability as one of six key outcomes of the vision of the plan
- Transport for NSW Environment and Sustainability Policy (Transport for NSW, 2020) reflects the Transport for NSW duty to undertake activities in the interest of the greater good, moving beyond compliance, and being a genuine leader in environment and sustainability performance
- Transport Environment and Sustainability Policy Framework (Transport for NSW, 2013) is a collective and coordinated approach to deliver the NSW Government's environmental and sustainability agenda across the transport sector
- *National Greenhouse and Energy Reporting Act 2007* is the national framework for reporting and disseminating information on greenhouse gas emissions, energy use and energy production associated with the activities of Australian corporations
- Commonwealth Renewable Energy Target currently commits Australia to generating 33,000 GWh per year of electricity from 'low emission' sources by 2020 in order to achieve the goal of a 23.5 per cent share of renewable energy in Australia's electricity supply by 2020
- Greater Sydney Commission - A Metropolis of Three Cities (Greater Sydney Commission, 2018a) – promotes integrated approaches to deliver sustainable outcomes, such as planning and delivering green infrastructure.

Other relevant legislation and policy includes:

- *Waste Avoidance and Resource Recovery Act 2001*
- National Strategy for Ecologically Sustainable Development (Ecologically Sustainable Development Steering Committee, 1992)
- Sustainable Procurement Guide (Australian Government, 2018).

An Environment and Sustainability Policy has been developed to articulate Sydney Metro's commitment to sustainable outcomes. This policy has been reproduced below in Table 8-58, and captures the social and environmental sustainability objectives of Sydney Metro.

Table 8-58: Sydney Metro Environment and Sustainability Policy

Sydney Metro Environment and Sustainability Policy
This policy reflects a commitment in the delivery of the Sydney Metro program to: • Align with, and support, Transport for NSW Environment and Sustainability Policy • Optimise sustainability outcomes, transport service quality, and cost effectiveness • Develop effective and appropriate responses to the challenges of climate change, carbon management, resource and waste management, land use integration, customer and community expectation, and heritage and biodiversity conservation • Be environmentally responsible, by avoiding pollution, enhancing the natural environment and reducing the project ecological footprint, while complying with all applicable environmental laws, regulations and statutory obligations • Be socially responsible by delivering a workforce legacy which benefits individuals, communities, the project and industry, and is achieved through collaboration and partnerships. • To deliver on these commitments, the Sydney Metro team will: **Industry leadership** • Implement coordinated and transparent decision making, by engaging with stakeholders and suppliers, encouraging innovation and demonstrating sustainability leadership • Explore new benchmarks for the transport infrastructure sector by requiring high standards from our designers, contractors and suppliers, building on experience gained through development of Sydney Metro Northwest. **Community and customer** • Provide accessible, safe, pleasurable, and convenient access and transport service for all customers • Establish positive relationships with community and stakeholders to maximise opportunities to add value to local communities. **Land use integration and place making** • Create desirable places, promote liveability and cultural heritage, and optimise both community and economic benefit • Balance transit oriented development opportunities with stakeholder expectations. **Embedding environmental and social sustainability** • Establish robust sustainability objectives and targets • Maintain an environmental management system that is integrated into all our project activities • Ensure thorough and open environmental assessment processes are developed and maintained • Develop and maintain an environmental management framework to embed best practice pollution management and sustainable outcomes during construction • Apply effective assurance processes to monitor performance against the project environment and sustainability objectives and identify appropriate reward or corrective action, as required • Apply environment and sustainability specific processes to the procurement of delivery activities. **Accountability** • Undertake public sustainability reporting • Hold employees and contractors accountable for proactively meeting their environmental and social sustainability responsibilities • Provide appropriate training and resources necessary to meet our responsibilities.

8.20.3 Sydney Metro West Sustainability Plan

A Sydney Metro West Sustainability Plan is being developed to set out the sustainability principles, objectives and initiatives including performance targets and outcomes which will be adopted from planning, procurement, design, construction and operations to end-of-life. This encompasses all three aspects of sustainability – environmental, social and economic.

Sydney Metro West (including Stage 1) would also achieve an equivalent or improved level of sustainability performance compared to previous metro projects. This would include achieving a minimum Infrastructure Sustainability Council of Australia (ISCA) IS rating of 75 – Version 1.2 (or equivalent) and a 5-Star Green Star rating.

Sustainability principles, initiatives and targets for Sydney Metro West identified as part of the development of the Sydney Metro West Sustainability Plan are discussed in Section 8.20.3. Where relevant, social sustainability has been addressed in Section 8.11 (Social impacts - Concept), and economic sustainability has been addressed in Section 8.10 (Business impacts - Concept).

8.20.4 Sustainability principles, initiatives and targets

Six principles have been developed to govern environmental and socio-economic outcomes and performance for Sydney Metro West. The principles are designed to deliver on the Sydney Metro Environment and Sustainability Policy commitments and are set out in Figure 8-9.

Figure 8-9: Sustainability principles and objectives

Targets and initiatives have been developed to support the sustainability principles. These are outlined in Table 8-59. These initiatives and targets would be further refined as part of the design process, committed to in the Sydney Metro West Sustainability Plan and included in the contract documents for all detailed design, construction and operations contracts.

Table 8-59: Sydney Metro West sustainability initiatives and targets

Principle	Category	Sustainability initiatives and targets	Project life cycle phase				
			Planning	Design	Construction	Operations	End of life
Demonstrate leadership *Deliver a world class metro that is environmentally and socially conscious, and demonstrates innovation.*	**Embedding sustainability objectives into decision making**	• Integrate environmental and social principles into the project framework	●			●	●
		• Establish collaborative working relationships with stakeholders	●	●	●	●	●
	Transparency and assurance	• Develop performance targets across all sustainability focus areas	●	●	●	●	●
		• Develop a streamlined outcomes-focussed approach to applying sustainability rating tools on the project	●				
		• Obtain a high Infrastructure Sustainability rating for relevant infrastructure		●	●	●	
		• Obtain a high Green Star rating for relevant infrastructure and precincts		●	●	●	
		• Develop an assurance framework and reporting system to assist Sydney Metro and contractors in reliably reporting against sustainability targets		●	●	●	
		• Monitor sustainability performance and provide public sustainability reports			●	●	●
	Capture sustainability benefits	• Document and evaluate environmental and social costs and benefits	●	●	●	●	●
		• Adopt whole of life costing model to maximise benefits	●	●	●	●	●
	Encourage innovation that delivers sustainability benefits	• Identify pathways to pilot new technology and approaches	●	●	●	●	●
		• Identify opportunities to enable better sustainable approaches	●	●	●	●	●
		• Engage with research organisations and look for opportunities to facilitate the uptake of new technologies and approaches	●	●	●	●	●
	Emerging trends, approaches and priority areas for consideration	• Adopt circular economy principles and practices, including increased use of recycled and innovative materials in the construction supply chain		●	●	●	●
		• Prioritise blue (water related) and green (natural and designed greening such as landscaping/planting) infrastructure	●	●			
		• Engage with local Aboriginal communities to develop integrate Aboriginal cultural values appropriately into design	●	●	●	●	
		• Consider the future role of emerging technologies in relation to transport infrastructure and precinct development	●	●	●	●	

Principle	Category	Sustainability initiatives and targets	Project life cycle phase				
			Planning	Design	Construction	Operations	End of life
Tackle climate change *Integrate a comprehensive climate change response, and drive excellence in low carbon solutions*	**Infrastructure and operations will be resilient to the impacts of climate change**	• Identify all relevant climate change risks		●	●	●	
		• Identify and implement adaptation measures to mitigate all very high, high and medium risks for the project	●	●	●	●	
		• Identify sites vulnerable to flooding, and mitigate impacts where feasible	●	●	●	●	
		• Ensure sensitivity testing is carried out on ventilation and air conditioning equipment		●	●	●	
		• Ensure emergency procedures adequately address extreme weather events				●	
		• Protect sensitive construction equipment from the effects of extreme climate and weather			●	●	
		• Continued engagement with key stakeholders to develop and implement appropriate responses to interdependent risks		●	●	●	
	Reduce energy use and carbon emissions	• Identify and prioritise areas where the greatest reductions in carbon and energy can be achieved	●	●	●	●	
		• Use energy efficient equipment, methods, and practices			●		
		• Local sourcing of materials where feasible	●	●	●	●	
		• Adopt 25kV AC traction system	●	●	●		
		• Use an Under Platform Supply system to reduce the cooling load at stations	●	●	●		
		• Passive design features such as daylight, natural ventilation and passive cooling	●	●	●		
		• Energy efficient ventilation, air conditioning, pumps, escalators, lifts and appliances	●	●	●		
		• Efficient lighting and light control systems	●	●	●		
		• Adopt battery storage, other enabling technology where feasible	●	●	●		●
	Establish energy efficiency and renewable energy/offset targets	• Achieve at least a 20 per cent reduction in carbon emissions associated with operations, when compared to business as usual		●		●	
		• Offset 25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction			●		
		• Offset 100 per cent of the greenhouse gas emissions associated with consumption of electricity during operations	●			●	
		• Develop the Electricity and Offsets Procurement and Management Strategy and develop capacity to support implementation	●			●	
		• Mandate a minimum 15 per cent improvement on the current (2019) minimum performance requirement stipulated in the National Construction Code/Building Code of Australia	●	●			
		• Source 10 – 20 per cent of the low voltage electricity required at above ground stations and stabling facility from onsite renewable energy sources	●	●	●		
Manage resources efficiently *Achieve whole-of-life value through efficient use and management of resources*	**Minimise potable water use**	• Set targets and monitor potable water use		●	●	●	
		• Integrate current best-practice water-efficient features, equipment and appliances at stations, stabling facility and construction sites	●	●	●	●	
		• Avoid use of potable water for non-potable purposes if non-potable water is available	●	●	●	●	
		• Set and implement targets for the use of non-potable water in concrete	●	●	●		
	Maximise non-potable water opportunities	• Undertake a water balance to inform feasibility for reuse initiatives		●	●	●	
		• Identify and implement opportunities for treatment and reuse on the project, including water from tunnelling works, concrete batching, casting facilities		●	●		
		• Connect to district recycled water networks where feasible	●	●	●	●	
		• Harvest and reuse rainwater at permanent and temporary facilities where feasible	●	●	●	●	
	Minimise waste through the project lifecycle	• Target 95 per cent construction and demolition waste recycling	●		●		
		• Enable recycling of waste streams from office facilities and customers	●	●	●	●	
		• Plan for final disposal of operational assets, such as train carriages		●	●		●
		• Use modular, prefabricated and precast structural and finishing materials	●	●	●	●	

Principle	Category	Sustainability initiatives and targets	Project life cycle phase				
			Planning	Design	Construction	Operations	End of life
	Reduce materials consumption	• Minimise the use of concrete and steel	●	●			
		• Dematerialisation of components and finishes		●	●		
	Reduce embodied carbon and increase use of recycled materials	• Undertake lifecycle assessments and minimise the embodied impacts of materials, through the selection of low carbon alternatives and considering durability and local sourcing	●	●	●		
		• Minimise the embodied impacts of concrete through the adoption of project-wide supplementary cementitious materials use target and set targets for the use of alternate binder systems on non-structural elements		●	●		
		• Minimise the embodied impacts of steel through maximising the use of recycled steel and steel produced using energy-reducing processes		●	●		
		• Maximise the use of engineered timber for structural elements	●	●	●		
		• Investigate and implement trials and pilot programs to demonstrate the viability of recycled alternatives		●	●		
		• Engage with industry bodies to identify best practice low-impact alternative materials		●	●		
		• Prioritise products made from recycled content		●	●	●	
	Manage spoil effectively	• Minimise volumes of excavation	●	●	●		
		• Beneficial reuse of 100 per cent of usable spoil	●	●	●		
	Practice environmentally responsible sourcing	• Source 100 per cent of all timber products from either re-used timber, post-consumer recycled timber, Forest Stewardship Council or Programme for the Endorsement of Forest Certification certified sources	●	●	●		
Drive supply chain best practice *Collaborate with key stakeholders to drive a lasting legacy in workforce development, industry participation and sustainable procurement*	**Influence contractors, subcontractors and materials suppliers**	• Ensure procurement strategies are consistent with ISO:20400 Sustainable Procurement Guidelines	●	●	●	●	●
		• Ensure supply chain sustainability objectives are adopted downstream	●	●	●	●	●
		• Provide sustainability training to high impact suppliers		●	●		
	Increase supply chain transparency and responsibility	• Adopt ethical governance principles and practices, including the use of Environmental Product Declarations and eco-labelling		●	●	●	●
		• Conduct due diligence to ensure supply of materials and equipment align with human rights legislation and environmental standards	●	●	●	●	●
	Drive improvements in workforce development and industry participation	• Increase diversity within the workforce and supply chain	●	●	●	●	
		• Develop workforce skills which support skill shortages, transferable skills and new technologies	●	●	●	●	
		• Increase local employment and participation of small and medium enterprises including Recognised Aboriginal Businesses	●	●	●	●	
		• Inspire future talent and develop capacity in the sector	●	●	●	●	
		• Provide opportunities for social enterprise		●	●	●	●
Value community and customers *Respond to community and customer needs, promote heritage, liveable places and wellbeing for current and future generations*	**Protect and promote Aboriginal and non-Aboriginal heritage and culture**	• Avoid or minimise impacts to heritage	●	●	●		
		• Identify and implement opportunities to enhance heritage and cultural values via design and interpretation	●	●	●		
		• Develop partnerships with relevant stakeholders to identify heritage places and promote heritage values	●	●		●	
		• Ensure key Aboriginal stakeholders are meaningfully engaged	●	●	●	●	
		• Create opportunities for archaeological research and interpretation	●	●	●		
		• Develop Aboriginal cultural design principles for the project and integrate into project outcomes	●	●	●	●	

Principle	Category	Sustainability initiatives and targets	Project life cycle phase				
			Planning	Design	Construction	Operations	End of life
	Prioritise community and customer wellbeing	• Design in accordance with best practice urban design principles	●	●			
		• Incorporate Crime Prevention Through Environmental Design principles	●	●		●	
		• Design to minimise urban heat island and associated health risks	●	●	●	●	
		• Prioritise indoor environmental quality	●	●	●		
		• Promote Customer Centric Design	●	●	●	●	
		• Provide new public spaces which are adaptable and appropriate for a range of uses by the community	●	●	●	●	
		• Ensure efficiency and durability of built infrastructure that requires minimum expenditure in maintenance and upkeep by users including housing	●	●	●	●	●
	Enable and promote active transport access and public transport usage	• Provide secure access, covered bicycle parking and safeguard for future expansion	●	●	●	●	
		• Design to enhance connectivity to Blue-Green Grids and integrate with surrounding active transport network such as footpaths, public and green spaces, and bicycle paths	●	●	●	●	
		• Station interchanges designed in accordance with the modal hierarchy to prioritise more equitable, safe and sustainable modes of transport and an enjoyable station environment for users	●	●	●		
		• Measure health benefits of active transport and public transport as an outcome of the project	●			●	
	Deliver community benefits	• Ensure the community and local stakeholders are engaged and kept informed of project activities		●	●	●	●
		• Provide information in ways that are easily accessible, taking into consideration dominate language groups	●	●	●	●	●
		• Deliver initiatives that benefit local communities and provide positive social outcomes		●	●	●	
		• Consider opportunities for residual land to enhance precinct development and assist local communities	●	●	●	●	●
Respect the environment *Minimise impacts and take opportunities to provide environmental improvements*	**Minimise environmental impact**	• Target zero major pollution incidents			●	●	●
		• Reduce sources of pollution through the development and implementation of a Construction Environmental Management Framework	●	●	●	●	
		• Ensure environmental management plans and systems are in place		●	●	●	
		• Avoid or minimise noise and vibration impacts	●	●	●	●	
		• Early identification and management of soil and groundwater contamination issues	●	●	●	●	
		• Design to minimise light spill in accordance with standards	●	●	●	●	
		• Develop an appropriate response to reduce air pollution	●	●	●	●	
		• Develop appropriate responses to manage stormwater and groundwater contamination and runoff	●	●	●	●	
	Promote ecological functions and biodiversity	• Avoid or minimise impacts to biodiversity, particularly with regard to endangered, vulnerable and threatened species, habitats and communities	●	●	●	●	
		• Preserve ecological function through appropriate planning, management and financial controls	●	●	●	●	
		• Contribute to the restoration and conservation of local ecological communities	●	●	●	●	
		• Consider connectivity of existing ecosystems and impact on fauna movements	●	●	●	●	
	Provide and promote green infrastructure	• Provide a high level of open green space at precincts, where feasible		●	●	●	
		• Provide green roofs and green walls at stations, inside the corridor and precincts, where feasible	●	●	●	●	
		• Use endemic species in landscaping and prioritise use of Aboriginal knowledge (six seasons) in asset management	●	●	●	●	
		• Integrate water sensitive urban design solutions	●	●	●	●	

8.20.5 Climate change

Identification and risk assessment approach

The climate change risk assessment and adaptation planning process carried out for Sydney Metro West has been designed to align with the principles of AS5334-2013 Climate change adaptation for settlements and infrastructure – a risk-based approach. This document draws extensively on AS/NZS ISO31000-2009 Risk management – principles and guidelines.

A climate change workshop was undertaken as part of the definition design process at which participants considered climate change projections for the region and the potential impact these would have on a range of aspects related to construction and operation.

The identification and assessment of climate change risks for the Concept involved consideration of hazards, potentially affected project elements, likelihood and consequence. The approach is summarised below:

- Hazard – climate or climate-influenced attributes with potential to influence the operation and maintenance of Sydney Metro West
- Affected element – the component of the operation and/or maintenance of Sydney Metro West that would be impacted by the hazard. This may also include users of Sydney Metro West and affected elements of the surrounding environment
- Risk rating – utilising a likelihood and consequence rating system, an assessment of the way hazards could influence the element is made and a risk rating assigned.

Future climate

The Australian climate is likely to experience a greater frequency and severity of extreme weather events due to climate change.

Detailed projections based on regional climate models for the east coast of Australia and modelling reported in the Intergovernmental Panel on Climate Change Fifth Assessment Report (Intergovernmental Panel on Climate Change, 2013) are presented below in Table 8-60.

Table 8-60: Summary of climate change projections – Sydney region

	Baseline (1986-2005)	2030	2070	2090
Temperature				
Sydney CBD				
Average maximum temperature (°C)	22.6	23.6	25.2-26.1	26.4-27.4
Average temperature (°C)	18.6	19.6	21.3-22.0	22.2-23.3
Average minimum temperature (°C)	14.6	15.6	17.4-18.0	18.0-19.3
Days over 35°C	4.1	5.3	9.2-11.8	12.6-16.6
Parramatta CBD				
Mean average maximum temperature (°C)	23.4	24.4	26.1-26.9	27.2-28.2
Average temperature (°C)	17.8	18.8	20.6-21.3	21.4-22.6
Mean average minimum temperature (°C)	12.2	13.3	15.1-15.6	15.6-16.9
Days over 35°C	12.3	16.1	25.0-31.9	32.1-42.6
Rainfall				
Sydney CBD				
Mean annual rainfall (mm)	1276	1380	1135-1173	836-890
2.5% Annual Exceedance Probability daily rainfall event (mm)	328	346	379-392	397-413
Parramatta CBD				
Mean annual rainfall (mm)	1027	1097	918-944	699-730
2.5% Annual Exceedance Probability daily rainfall event (mm)	293	309	339-350	355-369
Extreme rainfall (all)				
Climate change factor for extreme rainfall events (%)	-	+5.6	+15.8	+21.3
Wind speed (all)				
Average wind speed (%)	-	-0.5	N/A	-1.1
Relative humidity (all)				
Average relative humidity (%)	-	-0.6	N/A	-1.5
Atmospheric concentration of CO2 (all)				
Atmospheric concentration of CO2 (ppm)	369 (in 2000)	449	541	935

As a consequence of these projections (especially increased temperatures and reduced annual rainfall) there could be increases in the number of days during which the Forest Fire Danger Index will be greater than 50 (Severe).

Potential risks

Operation

Climate change could have potential direct and indirect impacts relevant Greater Sydney and more specifically to the Sydney Metro West infrastructure and operations. While the types of impacts are relatively well understood, their severity and extent are uncertain. Risks therefore need to be identified and assessed and strategies to address them developed. To effectively manage climate change risks, each stage in the project should consider the most up to date climate change projections and design guidelines. The climate risks require ongoing review and response by designers and constructors.

The climate change risk assessment process for the Concept identified the following risks after the implementation of climate change adaption measures (residual risks):

- Fourteen medium ('tolerable') risks
- Thirteen low ('acceptable') risks
- No very high ('unacceptable') risks or high ('undesirable') risks were identified.

The fourteen medium risks included issues in the following categories:

- Increasing daily, annual and extreme temperatures – which could lead to rail infrastructure damage (for example track twisting) and inability of air conditioning units to maintain design temperatures for customers and staff
- Increase in the intensity of extreme rainfall and changes to flooding – which means potential for inundation of station entrances and damage to rail infrastructure
- Increase in sea levels – leading to potential inundation of rail infrastructure
- Combined effect of increase in extreme temperatures, severe weather events and natural disasters – which could cause disruptions to services and hazards within stations
- Increase in atmospheric concentrations of carbon dioxide in addition to hotter and wetter climate – which could result in carbonation of concrete and structures not lasting their required lifespan and/or requiring additional maintenance.

The types of climate change adaption measures considered (in addition to the 'business as usual' measures that would be implemented) included:

- Space proofing of tunnels and stations to allow for expansion ventilation and cooling systems
- Providing appropriate redundancy and back up for key systems including power, ventilation and cooling
- Consideration of microclimates (including cooling via landscape treatments and planting) around stations as part of the design process.

Construction

The types of climate change risks during construction would be associated with severe weather events, such as the increased frequency and severity of rainfall events placing increased pressure on erosion and sediment control measures and/or resulting in the flooding of the tunnels and/or construction sites.

However, construction of the initial stages of the Concept is likely to occur in the near future at a time when climate change risks cannot be differentiated from the current climate.

8.20.6 Greenhouse gas emissions

Greenhouse gas is a collective term for a range of gases that absorb outgoing infra-red radiation reflected from the earth which in turn generates heat. This heat warms the atmosphere. This is known as the greenhouse effect and is linked to climate change. Human activities, including the combustion of carbon-based fuels increase the concentration of greenhouse gases in the atmosphere. This leads to greater absorption of infra-red radiation and an increase in atmospheric temperature. This is known as the enhanced greenhouse effect.

Operation

When operational, Sydney Metro West would provide an attractive alternative mode of public transport that may result in a mode shift from road to rail. Subject to the extent of mode shift, the Concept would have the potential to result in a net reduction in greenhouse gas emissions.

Operational greenhouse gas emissions would predominantly be associated with electrical consumption to power the following:

- Metro trains
- Station facilities
- Signalling and communications
- Tunnel ventilation
- Stabling and maintenance facility
- Water treatment plants.

Construction

Greenhouse gas emissions would be generated during the construction of the Concept, with substantial energy-consuming activities anticipated to occur over the construction period. Greenhouse gas emissions would predominantly be generated as a result of:

- Combustion of fuel in construction plant, equipment and vehicles – these would be Scope 1 emissions (direct emissions occurring on-site)
- Electricity consumption for the tunnel boring machines – these would be Scope 2 emissions (occurring off-site at power stations)
- Electricity used at construction sites – these would be Scope 2 emissions (occurring off-site at power stations)
- Embodied emissions in key construction materials, including cement and steel – these would be Scope 3 emissions (energy and resources of construction materials consumed to produce a particular construction material)
- Emissions from vegetation clearance or construction waste – these would be Scope 1 but would be very low to negligible as minimal vegetation clearing is required.

8.20.7 Management approach and performance outcomes

Identified performance outcomes for sustainability are:

- The construction and operation of Sydney Metro West is consistent with the Sydney Metro Environment and Sustainability Policy
- Sustainability initiatives are incorporated into the planning, detailed design and construction of the Concept
- Infrastructure Sustainability Council of Australia (ISCA) IS rating of 65 Gold – Version 2.0 (or equivalent) and a 5-Star Green Star rating are achieved during design and construction for appropriate components
- Design of stations and stabling buildings achieve at least a 15 per cent improvement over performance requirements set out in Section J of the National Construction Code.

Identified performance outcomes in relation to climate change and greenhouse gas emissions for operation and construction of the Concept are provided in Table 8-61.

Table 8-61: Climate change and greenhouse gas emissions performance outcomes

Operational performance outcomes	Construction performance outcomes
• Comprehensively address climate change risks during the design life of Sydney Metro West for all risks rated 'medium' or higher • 100 per cent of the greenhouse gas emissions associated with consumption of electricity during operation are offset.	• 25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction are offset.

The management approach for sustainability and climate change would be established for each stage of the Concept. For Stage 1, the management approach is described in Chapter 26 (Sustainability and climate change – Stage 1).

8.20.8 Matters to be addressed in staged applications

Sustainability, climate change and greenhouse gas and energy assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Sustainability

The Environmental Impact Statement for each stage application would confirm consistency with the Sydney Metro West Sustainability Plan.

Climate Change

The climate change assessments will include, as relevant to the stage:

- Identification of possible climate related impacts with an emphasis on any that are projected to undergo a substantial change
- Identification of components that may be vulnerable to the climate change impacts
- Identification of possible current and future controls that may increase the resilience of future stage components to climate impacts
- Recommendation what should be considered, and how to establish if further information is needed, to adequately assess climate change risk.

Greenhouse gas and energy

The greenhouse gas and energy assessments will include, as relevant to the stage:

- Identification of the potential greenhouse gas emissions
- Identification of mitigation and management measures to reduce potential emissions of greenhouse gas.

An assessment of sustainability and climate change for Stage 1 is provided in Chapter 26 (Sustainability and climate change – Stage 1).

8.21 Cumulative impacts

8.21.1 Overview of cumulative benefits or impacts

Cumulative benefits or impacts have the potential to occur when benefits or impacts from a project interact or overlap with benefits or impacts from other projects and can potentially result in a larger overall effect (positive or negative) on the environment, businesses or local communities. Cumulative impacts may occur during construction stages when projects are constructed or operated concurrently or consecutively. Projects constructed consecutively (or sequentially) can have construction activities occurring over extended periods of time with little or no break in construction activities. This has the potential for increased impacts and construction fatigue for local communities.

The overall effect of cumulative benefits or impacts could be positive or negative, depending on the nature of the project and the nearby communities and environment. Once Sydney Metro West is operational, other projects which interrelate may enhance the Concept and create positive cumulative benefits.

The extent to which another development or activity could interact with the construction and/or operation of the Concept would depend on its scale, location and/or timing of construction. Generally, cumulative impacts would be expected to occur where multiple long-duration construction activities are undertaken close to, and over a similar timescale of, construction activities for the Concept, or where consecutive construction activities occur in the same area. Additionally, operation of the Concept could cause cumulative benefits or impacts when it interrelates or possibly enhances the construction or operation of other projects.

Projects with potential to generate cumulative impacts with the Concept can be broadly categorised as:

- Major transport infrastructure projects, including public transport and road projects
- Large-scale urban development and other infrastructure projects.

Local strategic plans should also be considered where they may result in future development with potential cumulative impacts.

The following screening criteria would be applied to determine the projects to be included in the assessment of cumulative impacts for future project stages:

- Location – proximity to areas and activities assessed as part of each staged assessment
- Timeframe – whether the project occurs in the recent past or present or foreseeable future
- Scale – potential impacts of a scale that could cause cumulative impacts with each staged assessment
- Status – the stage of the project at the time of each staged assessment (including forecast timeframes for construction and operation). Stages includes approved projects, proposed projects and local strategic plans.

Potential cumulative impacts that may occur during either the operation or construction of the Concept was considered.

8.21.2 Assessment approach

This assessment involved:

- Identifying the types of projects and plans likely to generate cumulative impacts with the Concept
- Identifying the potential cumulative impacts during operation and construction of the Concept Developing a management approach to address the potential impacts identified
- Identifying performance outcomes
- Identifying the proposed scope of cumulative impact assessments for future stages.

8.21.3 Potential operational benefits and impacts

Sydney Metro West is planned and developed as part of the integrated transport network. Working with other projects, this would provide cumulative transport benefits where other public transport projects complement the operation of the Concept such as by increasing the number of people located within a station's catchment and improving travel times for customers.

Similarly, other transport and urban renewal projects in the vicinity of the Concept would provide cumulative placemaking benefits.

A summary of the potential types of cumulative benefits and impacts that could occur during operation of the Concept is provided in Table 8-62.

Table 8-62: Summary of potential cumulative operational benefits and impacts

Issue	Description of potential benefits and impacts
Placemaking	• Additional opportunities for urban renewal due to the combined operation of multiple projects • Additional amenity and placemaking benefits from enhanced pedestrian environments such as active transport links, improved surface and lighting.
Transport and traffic	• Additional benefits to public transport services where other projects complement the operation of the Concept such as by increasing the number of people located within a station's catchment and improving travel times for customers • Additional changes to the distribution of traffic and access arrangements, and associated changes in amenity, including noise, due to the combined operation of multiple projects.
Non-Aboriginal and Aboriginal heritage	• Improved sightlines for heritage-listed structures as a result of changes to buildings • Additional impacts (both positive and negative) to the setting or significance of heritage listed items and/or conservation areas due to changed views, access or functionality of an area as a result of multiple projects.
Landscape character and visual amenity	• Additional permanent and improved changes to the visual and landscape context of the Concept corridor where other urban renewal projects are developed.
Social impacts	• Extension of public transport catchments (as described above) could increase social benefits of the Concept, such as further reducing travel related stress by reducing time spent in congested conditions; and improving social cohesion from increased access to jobs, universities, services and social facilities.
Hydrology and flooding	• Additional changes to existing stormwater catchment flows due to the operation of multiple projects • Additional change in flooding behaviour if the loss of floodplain storage from multiple projects occurs.

8.21.4 Potential construction impacts

Potential cumulative impacts during construction of the Concept would be appropriately managed in accordance with the performance outcomes in Section 8.21.5. Specific mitigation measures would be developed as part of assessment of each subsequent stage.

A summary of potential types of cumulative impacts during construction of the Concept, associated with consecutive and/or concurrent projects is provided in Table 8-63.

Table 8-63: Summary of potential cumulative construction impacts

Issue	Description of potential impacts
Transport and traffic	• Potential temporary increase in traffic congestion and associated amenity impacts (such as noise, visual and air quality) on sensitive receivers near construction traffic routes • Potential temporary additional loss of street parking and other kerbside uses • Potential temporary additional disruptions or changes to the public transport network.
Noise and vibration	• Potential temporary increase in construction noise and vibration impacts to sensitive receivers in the short term due to multiple projects under construction at the same time • Potential construction noise and vibration impacts over long timeframes due to projects being constructed consecutively.
Property and land use	• Potentially additional temporary loss of public open space, parks and recreational facilities within localities • Additional private property acquisition.
Landscape character and visual amenity	• Potentially additional temporary visual impacts and changes to landscape character due to the presence of construction sites for multiple projects.
Business impacts	• Potentially additional temporary alterations to access, visibility and amenity of businesses • Potentially additional temporary changes (increases or decreases) in passing trade for local businesses and services • Potentially additional and prolonged increased demand for businesses that provide products and services to construction workers, providing benefits for local workers.
Social impacts	• Potentially additional temporary changes to the character of local areas • Potentially additional temporary amenity effects on local residents and use of community facilities • Potentially additional temporary effects on the way of life for residents where disruption occurs from the construction of other projects nearby or from projects that have been recently completed.

Issue	Description of potential impacts
Groundwater and ground movement	• Potentially additional groundwater drawdown impacts due to dewatering from multiple tunnelling or excavation projects • Potentially additional impacts on groundwater users due to reduced groundwater yields, reduced groundwater quality and/or direct impacts and damage to existing groundwater bores.
Surface water quality	• Potentially additional risk to water quality from surface water runoff due to increased areas of impervious surfaces.
Contamination	• Potentially additional mobilisation and interaction of contaminated groundwater with neighbouring lands with existing contamination.
Biodiversity	• Potentially additional loss of fauna habitat and native vegetation • Potentially additional impacts to habitat connectivity • Potentially increased threat to threatened or endangered communities and native flora and fauna.
Spoil, waste management and resource use	• Increased volume of spoil being generated within the Sydney metropolitan region due to concurrent tunnelling and construction projects, which may impact spoil reuse opportunities.

8.21.5 Performance outcomes

The identified performance outcome in relation to cumulative impacts is that cumulative impacts are to be minimised through co-ordination of construction activities and communication processes with nearby projects.

8.21.6 Matters to be addressed in staged applications

Cumulative impact assessments would be carried out at future stage(s) to determine potential impacts during both construction and operation. The scope of each assessment may vary depending on relevance to the stage and would be undertaken in accordance with any scoping report(s) or Secretary's Environmental Assessment Requirements issued for that stage.

Cumulative assessments will include, as relevant to the stage:

- Identification of projects with the potential to generate cumulative impacts through consultation with stakeholders and review of the Department of Planning, Industry and Environment's Major Projects planning portal, government agency databases and local council development application registers
- Application of a screening criteria – including location, timeframe, scale and status – to determine which of these projects are likely to generate cumulative impacts
- Identification of potential cumulative impacts
- Identification of mitigation measures and management strategies to address the potential cumulative impacts.

Assessment of cumulative impacts for Stage 1 are provided in each Stage 1 assessment chapter (Chapters 10 to 26).

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Part C | Sydney Metro West Stage 1

9 Stage 1 description

9 Stage 1 description

This chapter describes the likely key construction works for Stage 1 and identifies the construction sites required.

9.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to Stage 1, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 9-1.

Table 9-1: Secretary's Environmental Assessment Requirements – Stage 1 description

Reference	Secretary's Environmental Assessment Requirements	Where addressed
2. Environmental Impact Statement		
2.1	d. A description of Stage 1, including key components and activities (including ancillary components and activities) required to construct that stage	This chapter
	i. a concise description of different construction methods that were analysed and justification for preferred methods;	Section 9.4
3. Social and Economic (including property, land use and business impacts)		
3.7	Disruption to utilities and services	Section 9.6

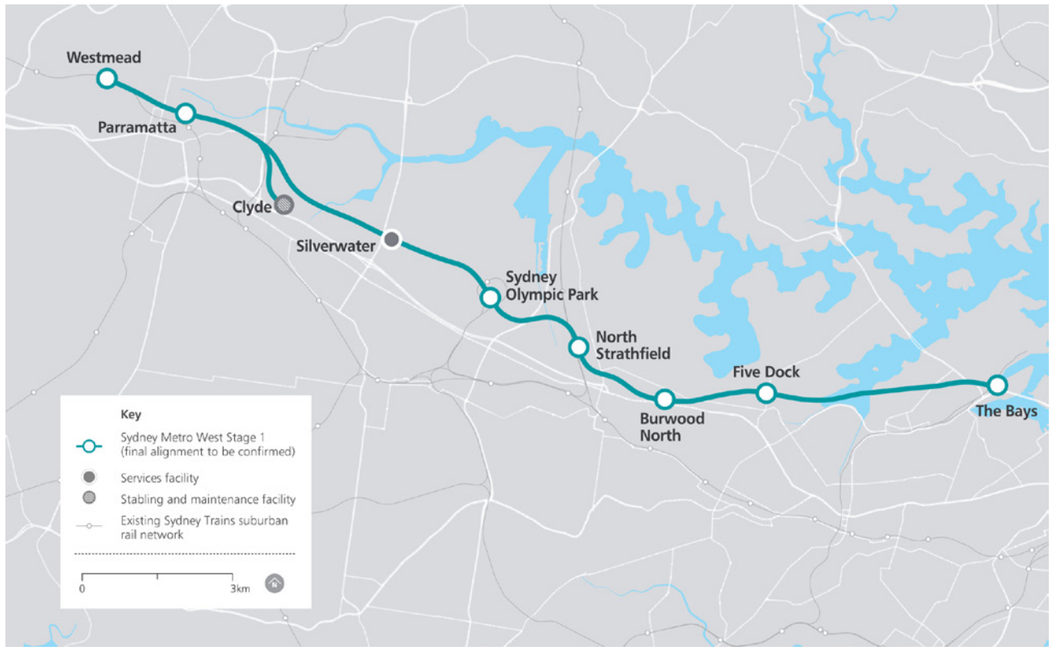


Figure 9-1: Location of Stage 1

9.2 Stage 1 overview

Stage 1 would involve major civil construction works for Sydney Metro West (Westmead to The Bays) including:

- Enabling works such as demolition, utility supply to construction sites, utility adjustments and modifications to the existing transport network
- Tunnel excavation including tunnel support activities
- Station excavation for new metro stations at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock and The Bays
- Shaft excavation for services facilities at Rosehill (within the Clyde stabling and maintenance facility construction site), between Five Dock Station and The Bays Station construction sites, and at Silverwater
- Civil work for the stabling and maintenance facility at Clyde including earthworks and structures for crossings of A'Becketts Creek and Duck Creek
- A concrete segment facility for use during construction located at the Clyde stabling and maintenance facility construction site
- Excavation of a tunnel dive structure and associated tunnels at Rosehill to support a connection between the Clyde stabling and maintenance facility and the mainline metro tunnels.

The Stage 1 alignment is indicative at this stage and has been used for the purposes of the environmental impact assessment, including all specialist investigations. During detailed design the alignment may change. Any changes to the alignment would be reviewed for consistency with the assessment contained in this Environmental Impact Statement including relevant mitigation measures, performance outcomes and any future conditions of approval.

The location of Stage 1, including the underground tunnel and construction sites for the stations and services facilities are shown on Figure 9-1. Further details and an indicative long section is shown on Figure 9-2(a) to Figure 9-2(h). Sydney Metro are also seeking Interim Corridor Protection through provisions in the State Environmental Planning Policy (Infrastructure) 2007. The proposed interim corridor is also shown on Figure 9-2(a) to Figure 9-2(h).

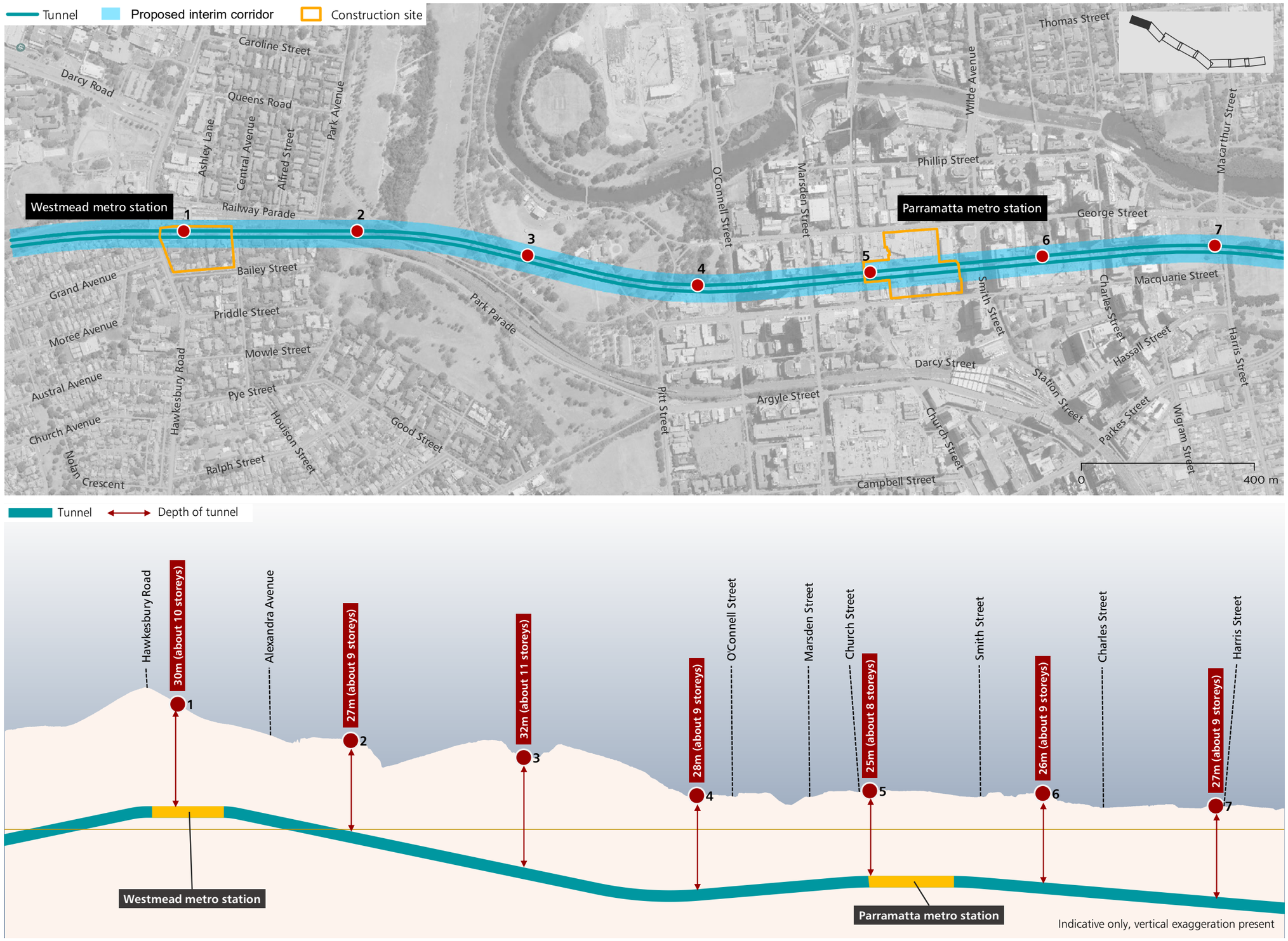


Figure 9-2(a): Indicative alignment plan and long section

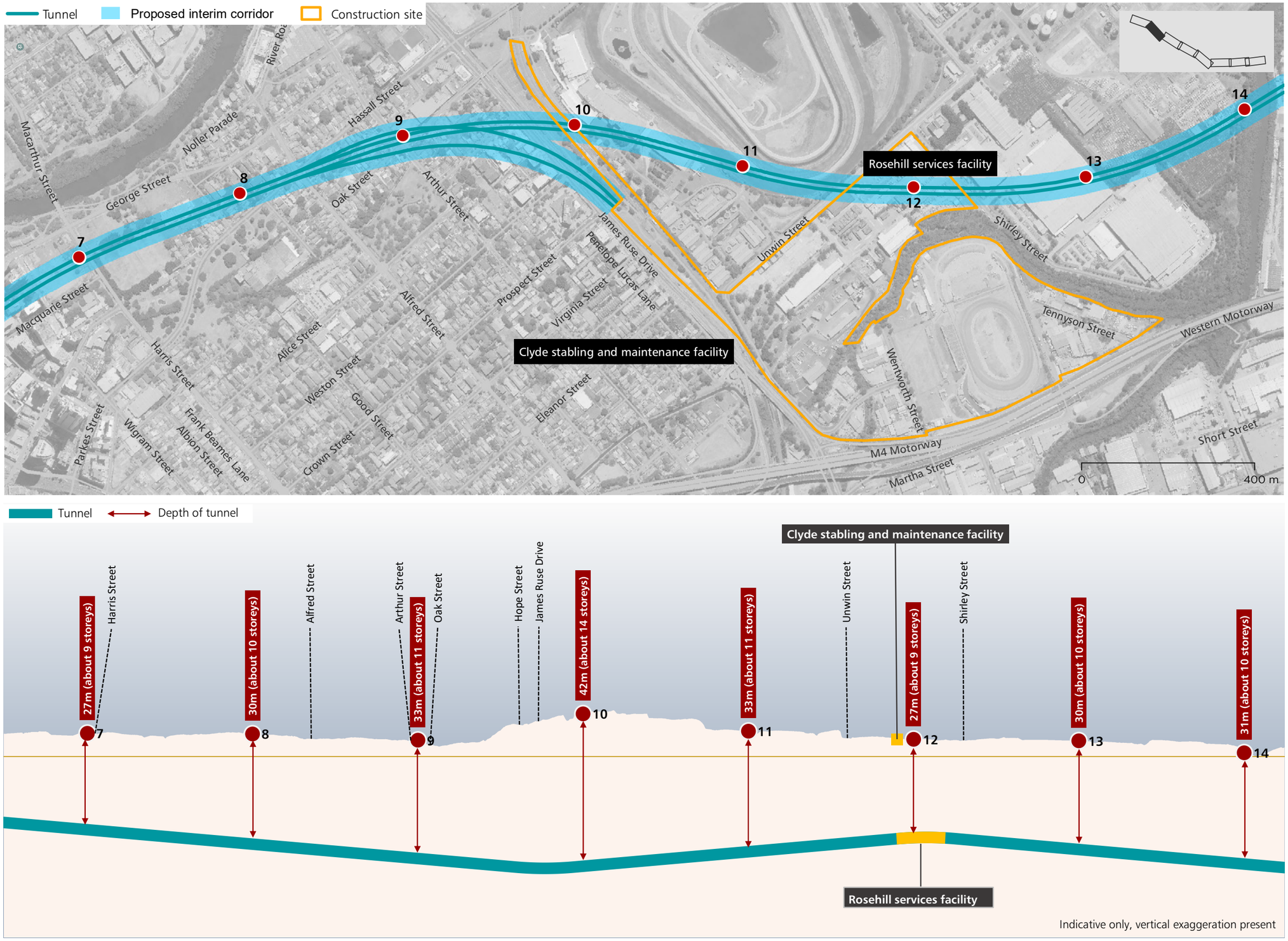


Figure 9-2(b): Indicative alignment plan and long section

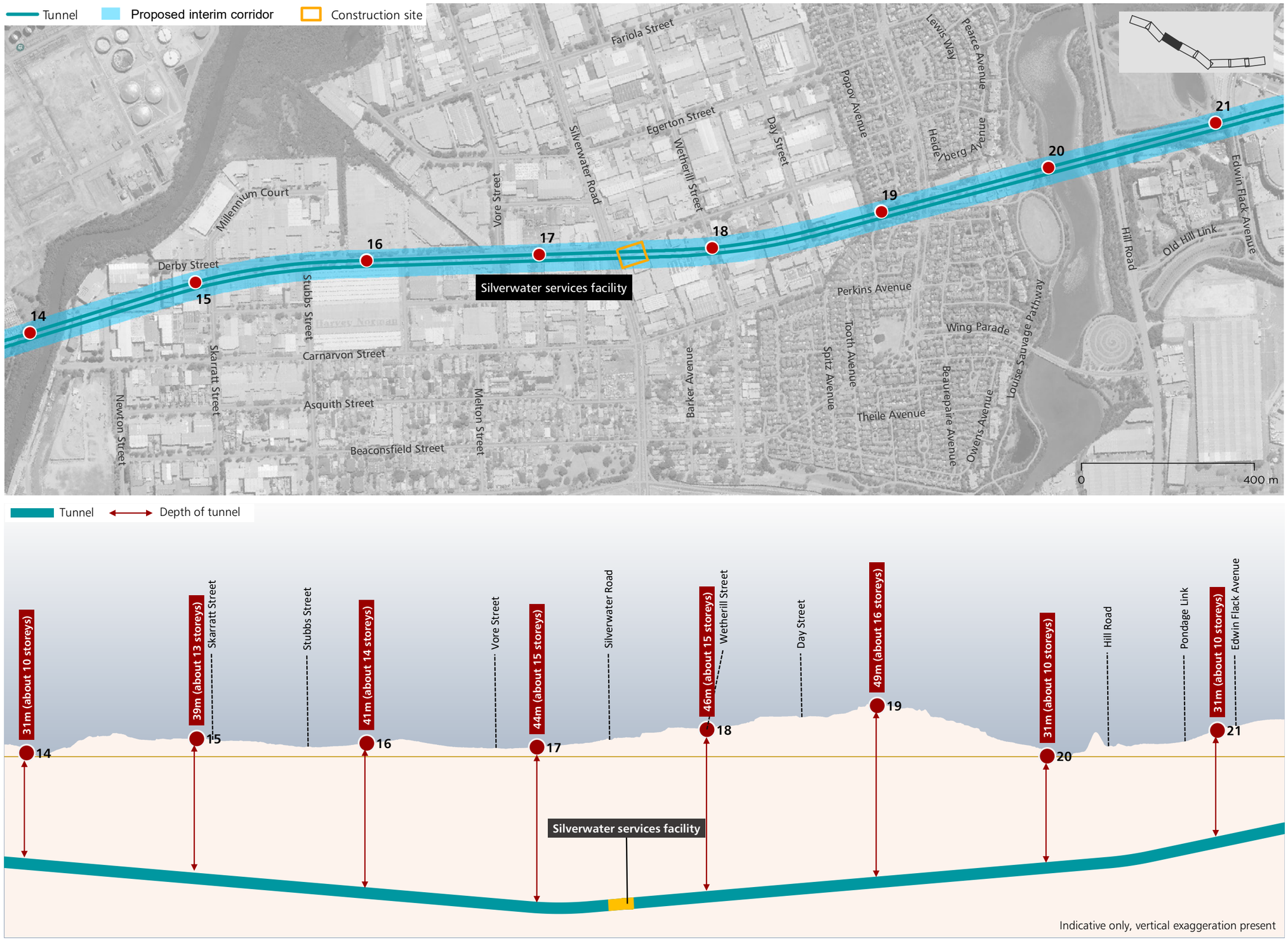


Figure 9-2(c): Indicative alignment plan and long section

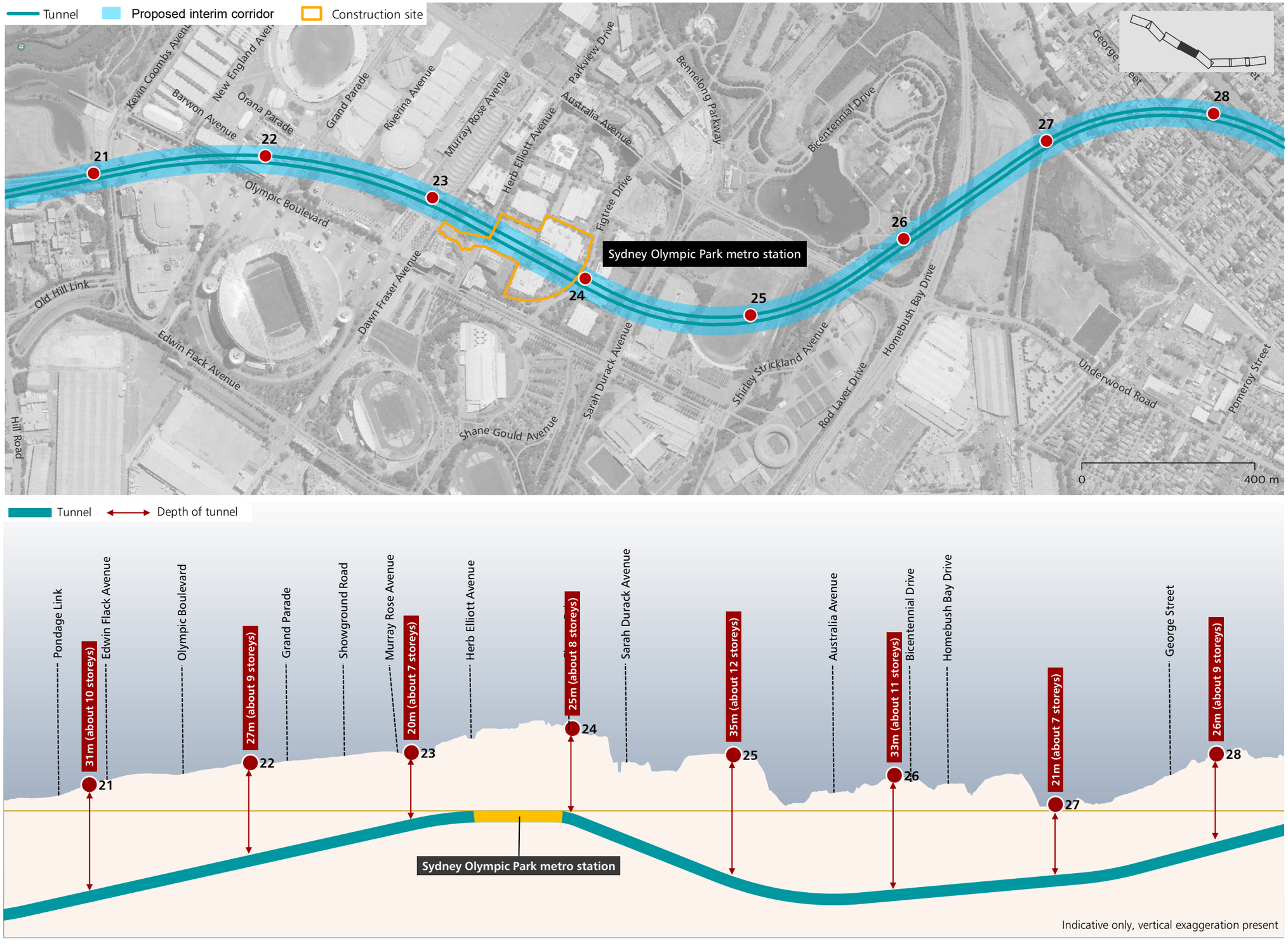


Figure 9-2(d): Indicative alignment plan and long section

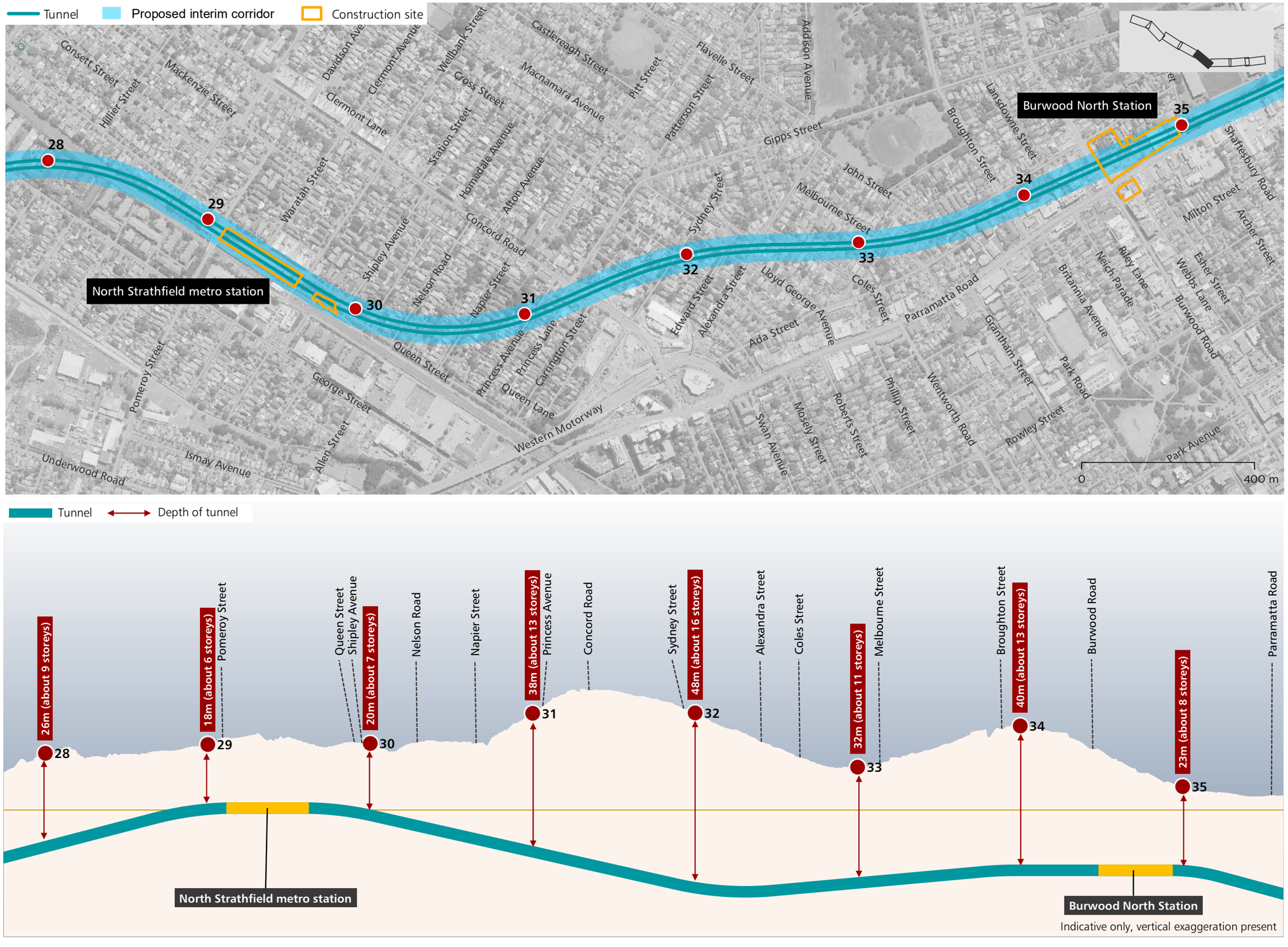


Figure 9-2(e): Indicative alignment plan and long section

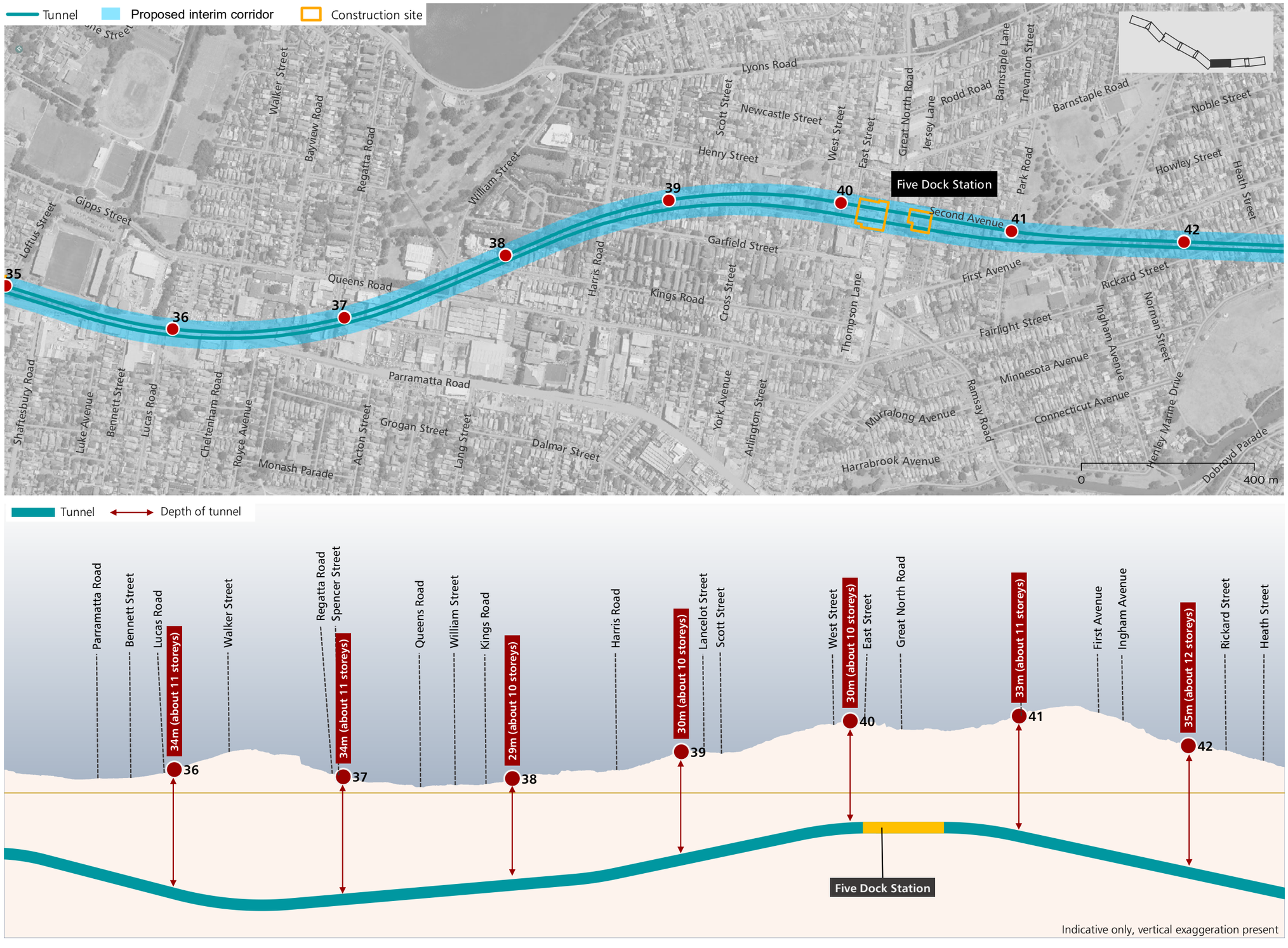


Figure 9-2(f): Indicative alignment plan and long section

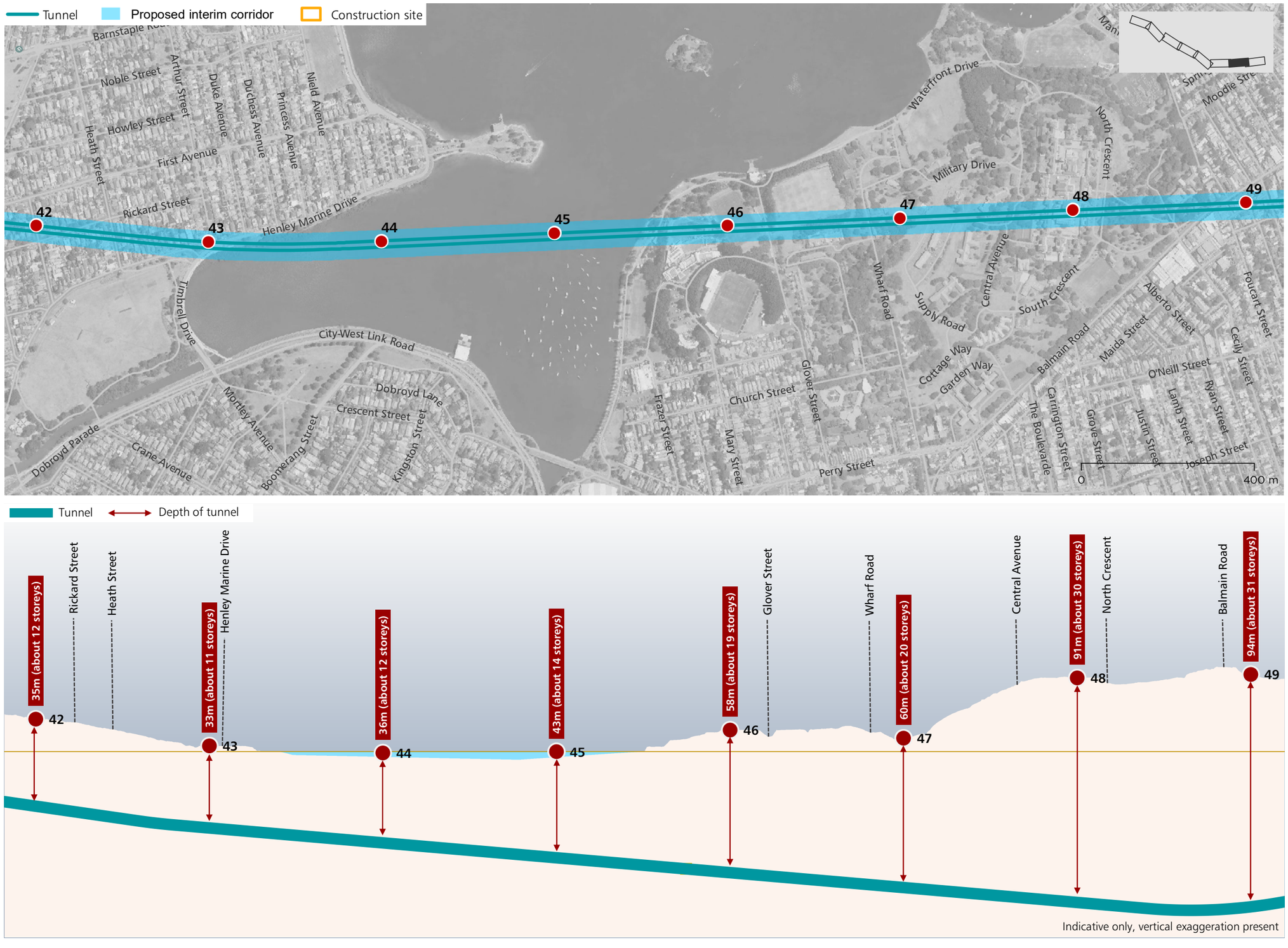


Figure 9-2(g): Indicative alignment plan and long section

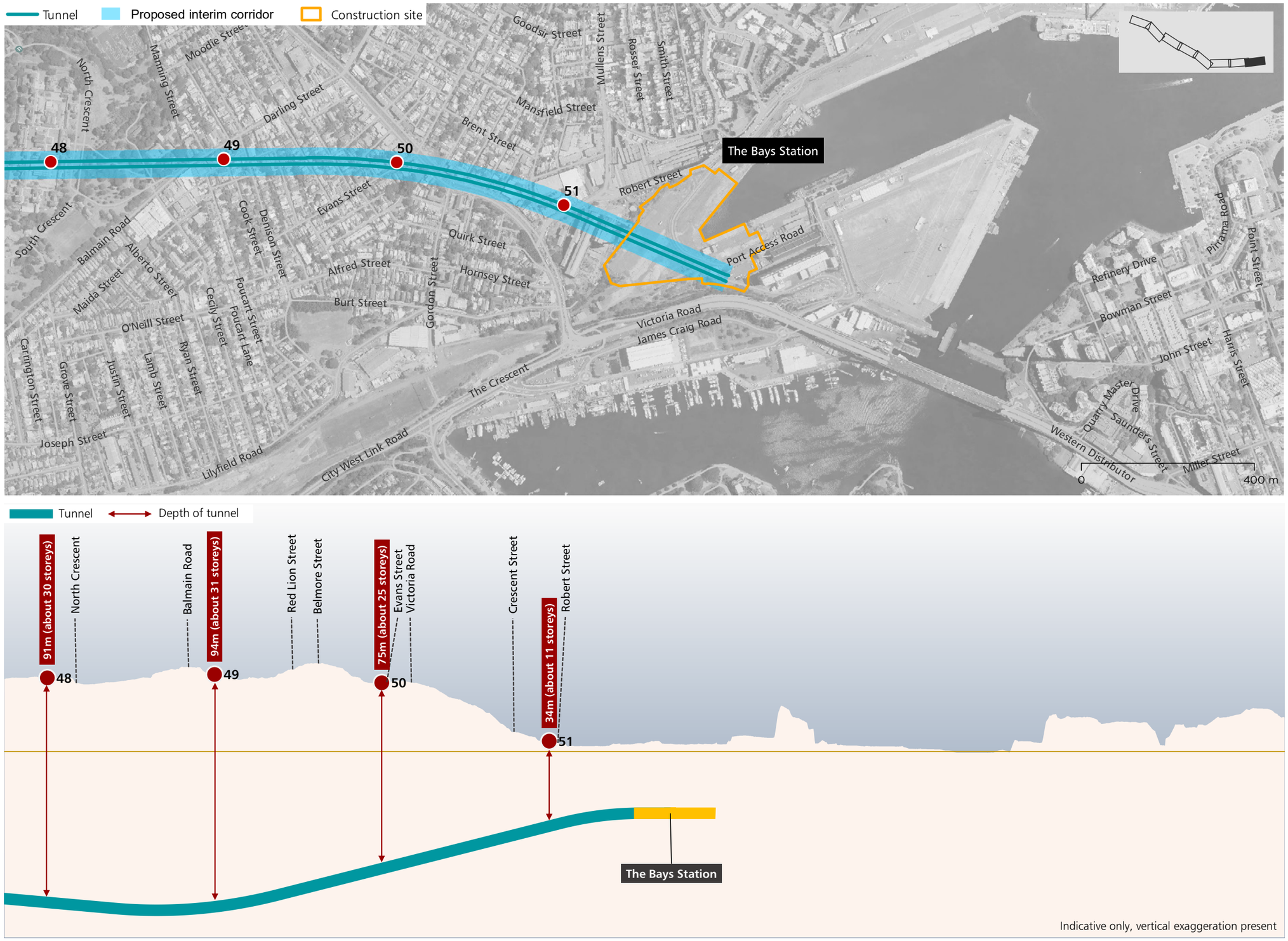
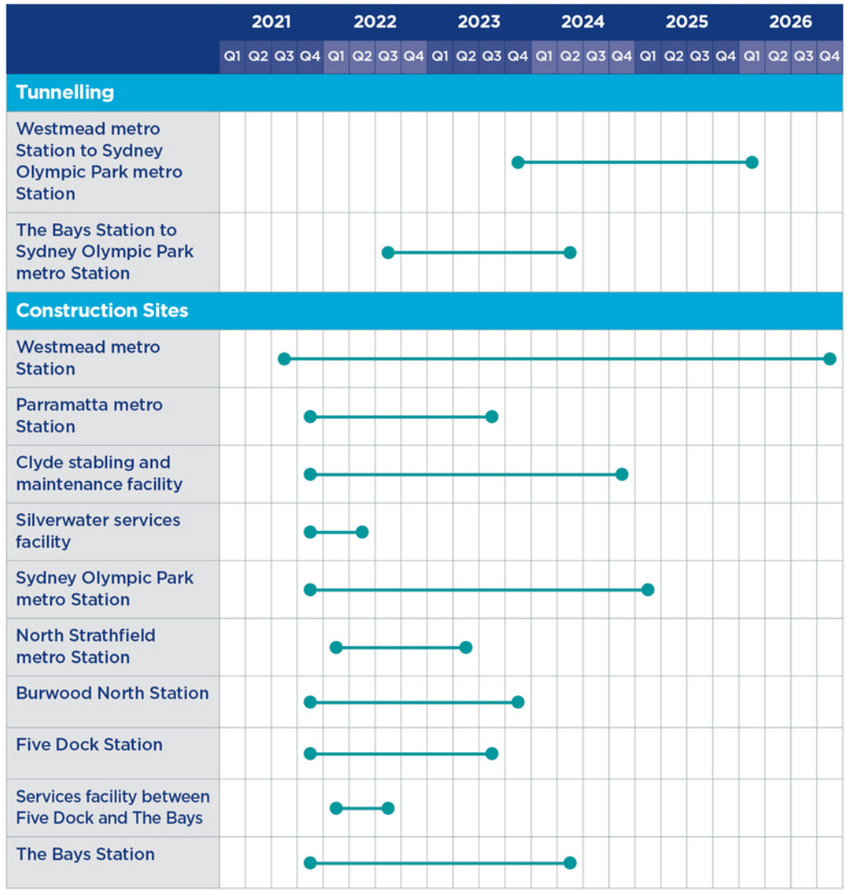


Figure 9-2(h): Indicative alignment plan and long section

9.3 Indicative construction program for Stage 1 - major civil works

Enabling works (preliminary construction works required to facilitate commencement of substantial construction) would likely begin prior to the commencement of major construction works. The total period for the major civil works (Stage 1- construction works) between Westmead and The Bays would be around five years followed by a further period for construction of stations, depots and rail systems with time also required to test and commission and bring the rail line into operation. An indicative construction program for just the major civil works (Stage 1) is shown in Figure 9-3. The actual program and commencement of the civil works at each construction site may vary and is subject to the final delivery strategy and actual construction program to be agreed with the successful contractor for each work package.



Note: This program only shows major civil works (Stage 1) indicative duration and not the total works.

Figure 9-3: Indicative construction program

9.4 Construction methods

9.4.1 Enabling works

Enabling works are activities that would typically be carried out before the start of substantial construction in order to make ready the key construction sites and to provide protection to the public. Enabling works are expected to include:

- Construction site establishment (refer to Section 9.5)
- Demolition of buildings and structures within the proposed construction footprint (refer to Section 9.6.4)
- Utility adjustments and protection (refer to Section 9.6.5)
- Utility supply to the construction sites including power and water (refer to Section 9.6.5)
- Transport network modifications to roads, public transport, and pedestrian and cyclist facilities (refer to Section 9.6.7)
- Heritage investigations, protection and archival recordings (refer to Chapter 12 (Non-Aboriginal heritage – Stage 1) and Chapter 13 (Aboriginal heritage – Stage 1))
- Additional geotechnical and contamination investigations and remediation where required (refer to Chapter 18 (Groundwater and ground movement – Stage 1) and Chapter 20 (Contamination – Stage 1)).

These works are described further in the relevant sections of this chapter.

9.4.2 Tunnels

Tunnel boring machines would be used to excavate twin tunnels about 21 kilometres long. The tunnel alignment for Stage 1 is shown in on Figure 9-2(a) to Figure 9-2(h).

The two bored tunnels would have a circular cross-section with an internal lined diameter of about six metres and an excavated diameter of about seven metres.

The following underground features would also be excavated using roadheaders and rock hammers:

- Cross passages between the two tunnels at intervals of about 240 metres to allow for emergency access
- Stub tunnels from the twin tunnels near Westmead metro station to safeguard a potential future extension to the metro network.

The centre lines of the two tracks would typically be about 14 metres apart, however this would depend on specific geological constraints and the need to avoid building basements. The tunnels would be lined with precast concrete segments to ensure the long term life of the asset and minimise groundwater inflow into the tunnel.

The depth of the tunnels would vary from about 15 to 90 metres deep due to changes in topography. The shallower tunnel sections would generally be near the tunnel portal at Rosehill and near cut-and-cover stations.

Tunnelling methods

Tunnel boring machines

Tunnel boring machines are likely to be used to excavate most of the twin tunnels as they are faster than roadheaders and excavate the desired tunnel profile, thereby reducing spoil volumes.

Each tunnel boring machine would typically consist of a shielded cutting head and trailing backup support services and mechanisms. At the front of the shield is a rotating cutter head, and behind the cutter head is a chamber where the excavated rock and sediments (spoil) are removed. The spoil is transferred to a conveyor to transport the spoil to the tunnel boring machine support site for removal. The tunnel boring machine is propelled forward by hydraulic jacks pushing off the previously erected segments or pushing off the tunnel wall with rock grippers. Photos of tunnel boring machines are shown in Figure 9-4 and Figure 9-5.

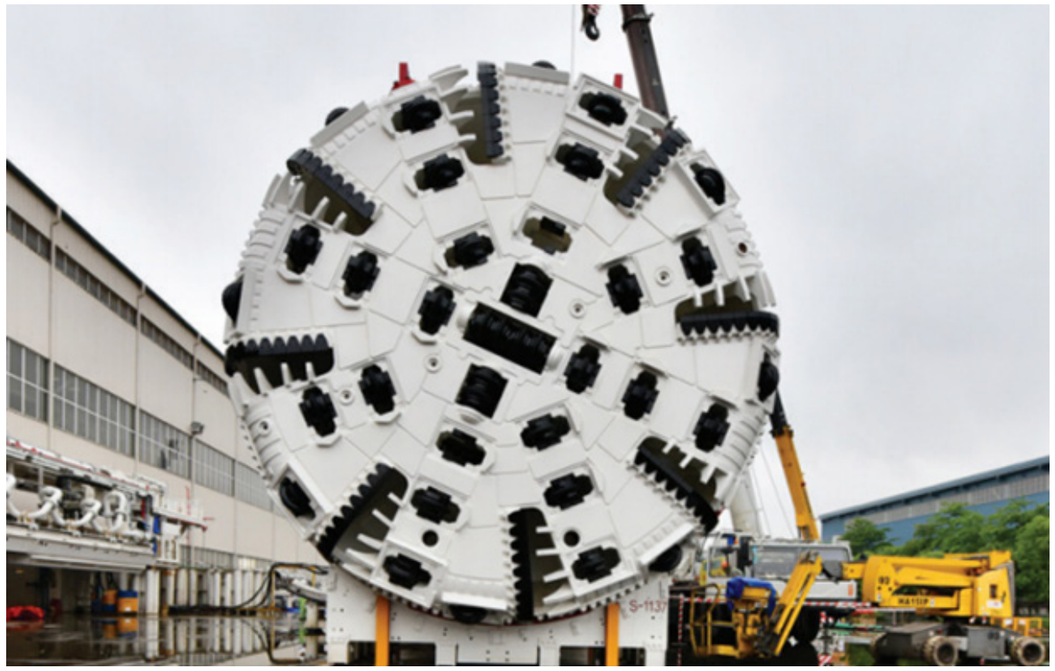


Figure 9-4: Photo of a tunnel boring machine cutter head

Figure 9-5: Photo of a tunnel boring machine at Epping Station on the Metro North West Line

Roadheaders

Roadheaders would be used to excavate irregular shaped tunnels such as stub tunnels, cross passages, crossover and turnback caverns and niches. These would generally be constructed following excavation of the main tunnels by the tunnel boring machines. Roadheaders would also be used to excavate mined station caverns, underground pedestrian connections, shafts and the connecting tunnels between the Rosehill dive structure and the mainline tunnels.

A roadheader is an excavation machine consisting of a boom mounted rotating cutter head mounted on bulldozer style tracks, a loading device, and a crawler track to move the machine forward into the rock face. A photo of a typical roadheader is shown in Figure 9-6. Tunnel support for roadheader sections would consist of a primary lining (likely to be pattern rock bolting and shotcreting) and a final cast in-situ or sprayed concrete lining.

Figure 9-6: Photo of a roadheader

Rock hammers

Excavators with rock hammer attachments would be used to excavate cross passages and niches within the tunnels. These would generally be constructed following excavation of the main tunnels by the tunnel boring machines. Tunnel support for rock hammer sections would consist of a primary lining (likely to be pattern rock bolting and shotcreting) and a final cast in-situ or sprayed concrete lining. A photo of a typical rock hammer is shown in Figure 9-7.

Figure 9-7: Photo of a rock hammer

Tunnel lining

Tunnels would be lined with precast concrete segments which are erected by the tunnel boring machines as it moves forward. The precast concrete segments would be manufactured at a dedicated precast facility at the Clyde stabling and maintenance facility construction site with storage at each tunnel boring machine launch site.

Tunnelling launch and support

Launch sites and sequence

It is anticipated that tunnelling would occur from two tunnel boring machine launch and support sites:

- Westmead metro station construction site
- The Bays Station construction site.

Two tunnel boring machines would be launched from each of the launch sites. Following launch of the tunnel boring machines, these construction sites would provide necessary support for the tunnelling operation including spoil storage and removal, power supply to the tunnel boring machines, fresh air ventilation, grout batching, water treatment and disposal, material storage as well as office facilities, worker amenities and parking. A photo of the Sydney Metro City & Southwest Marrickville dive site, which is a tunnel boring machine launch site, is shown in Figure 9-8.

Tunnelling would occur concurrently, with the use of four tunnel boring machines. The tunnelling sequence is shown on Figure 9-9.

Figure 9-8: Photo of the Sydney Metro City & Southwest Marrickville dive site

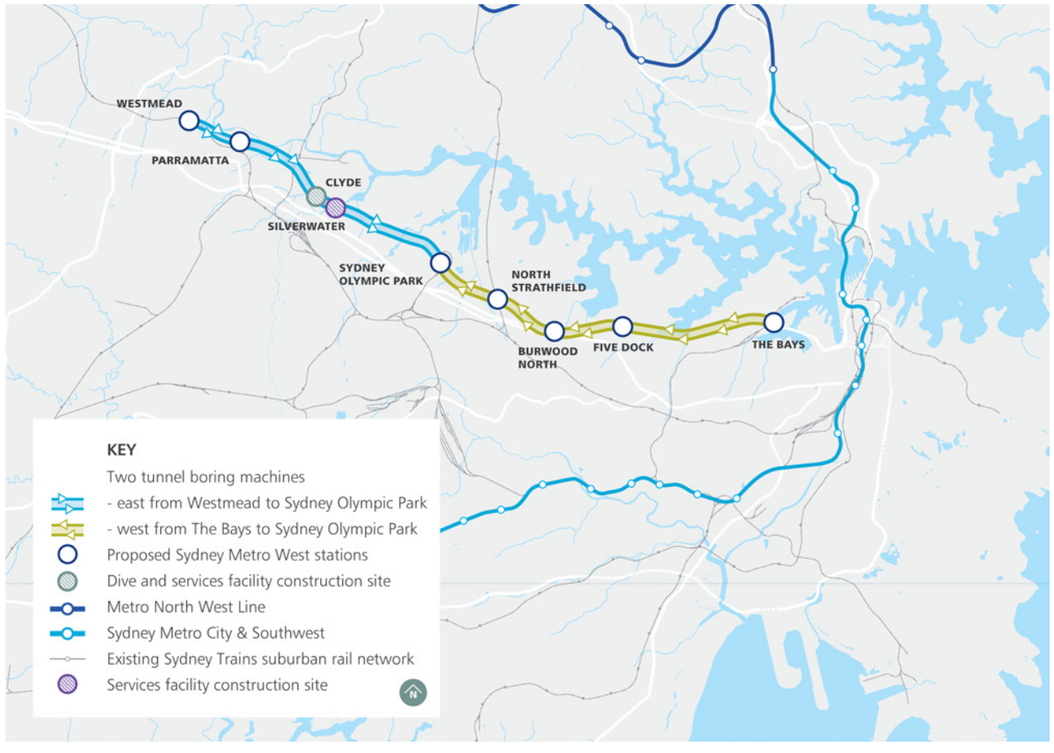


Figure 9-9: Indicative tunnelling sequence

Tunnelling from Westmead

Two tunnel boring machines (one for each tunnel) would be launched from the Westmead metro station construction site. These two tunnel boring machines would be driven about nine kilometres eastwards to the Sydney Olympic Park metro station construction site.

The tunnel boring machines would be launched from the station box excavation. Station box excavation may be carried out using excavators and rock hammers, however, drill and blast or penetrating cone fracture techniques may also be used (described in Section 9.4.2).

The tunnel boring machines would be dismantled and retrieved at the Sydney Olympic Park metro station construction site.

Tunnelling from The Bays

Two tunnel boring machines (one for each tunnel) would be launched from The Bays Station construction site. These two tunnel boring machines would be driven about 11 kilometres westwards to the Sydney Olympic Park metro station construction site.

The tunnel boring machines would be launched from the station box excavation. Station box excavation may be carried out using excavators and rock hammers, however, drill and blast or penetrating cone fracture techniques may also be used (described in Section 9.4.2).

The tunnel boring machines would be dismantled and retrieved at the Sydney Olympic Park metro station construction site.

Support services

The two launch sites would require support services for the tunnel boring machines, incorporating power supply, fresh air ventilation, work trains, grout batching plant, storage space for precast concrete lining segments, water supply, drainage and water treatment, workforce facilities, and spoil handling and removal facilities. Section 9.5.1 and Section 9.5.10 provides further details regarding these construction sites at Westmead metro station and The Bays Station respectively.

The tunnel boring machine support sites and the station and services facility construction sites would provide fresh air ventilation (both the extraction of air and the provision of fresh air) to the tunnels during construction to ensure the safety of workers. Fresh air ventilation fans would operate 24 hours per day, seven days per week during tunnelling and station construction.

Work trains may be required within the tunnels to transport materials, precast concrete lining segments and the workforce to the cutting face. If these are used, temporary rail tracks for the work trains would be progressively laid in sections as the tunnel boring machines advance. At the completion of tunnelling, the temporary rail tracks would be removed. Alternatively, transport of materials into the tunnels may be carried out with conveyor systems and special purpose rubber tyred vehicles.

9.4.3 Stations

Seven stations are proposed along the tunnel alignment for Stage 1. This section provides an overview of the station excavation and structural work required at each of these stations.

Station excavation and structural work

Excavation method

The depth of the stations would vary from about 18 to 35 metres. Excavation of the stations would usually be carried out using excavators and rock hammers. Due to the anticipated impacts associated with this excavation method, several contemporary alternatives were explored.

Preliminary construction planning suggests that track sawing, wire cutting, rock bursting/splitting or penetrative cone fracture could be used to supplement other excavation methods to reduce overall construction noise and vibration impacts.

At most sites, controlled blasting is likely to result in an overall reduced duration of excavation, including the associated impacts from rock hammering. In order to achieve compliance with the relevant criteria for blasting, the use of rock hammers would still be necessary until appropriate offset depths for blasting are reached.

Based on construction planning, the preferred excavation method for the stations would be a combination of rock hammers, excavators and controlled blasting. Initial excavation at each station site would involve the use of rock hammers and excavators until appropriate offset depths are reached in order to achieve compliance with the relevant blasting criteria. Controlled blasting may also be used for the construction of vertical shafts for the services facilities at Rosehill, Silverwater and between Five Dock and The Bays (described in Section 9.4.4). Based on the anticipated ground conditions, the depth at which blasting could commence at each site is provided in Table 9-2.

The blasting charge sizes would likely be between 0.25 kilograms and five kilograms. The initial charge size would be selected to meet the relevant criteria and increased as the excavation becomes deeper (and the offset distances to receivers increases). Further details regarding controlled blasting and appropriate mitigation are provided in Chapter 11 (Noise and vibration – Stage 1).

Table 9-2: Indicative initial depth of controlled blasting

Construction site	Indicative initial depth of controlled blasting (metres)[1]
Westmead metro station	15
Parramatta metro station	20
Clyde stabling and maintenance facility	15 (dive structure) 20 (services facility shaft)
Silverwater services facility	15
Sydney Olympic Park metro station	15
North Strathfield metro station	15
Burwood North Station	15
Five Dock Station	15
Services facility between Five Dock and The Bays	15
The Bays Station	20

Note 1: 15 metres is the equivalent of around five storeys below ground, and 20 metres is the equivalent of around six to seven storeys below ground

Cut-and-cover stations

Cut-and-cover construction is proposed for Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North and The Bays metro stations.

A typical construction method for cut-and-cover station excavation is shown in Figure 9-10. Generally, the construction method would involve:

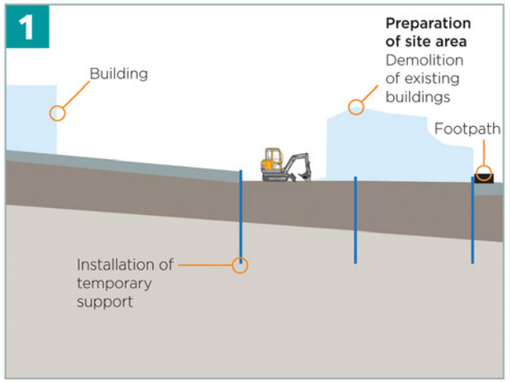
- Securing the site perimeter, demolishing buildings and diverting utilities
- Establishing site access roads, signalised intersections and hardstand areas
- Excavating the station from the surface down to the level of the base slab with a temporary shoring retention system in place.

As noted above, a temporary shoring retention system would be required to maintain the stability of the open excavation and minimise groundwater ingress in soft/weak ground. The retention system would likely consist of one or more of the following:

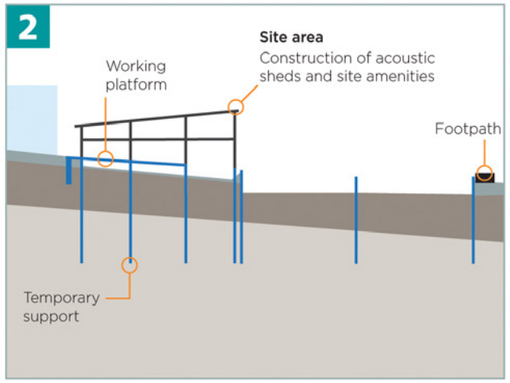
- Secant piles in areas of potentially soft/weak and permeable soil/rock
- Diaphragm walls in areas of potentially soft/weak and permeable soil/rock at substantial depths
- Soldier piles with sprayed concrete panels between.

With the exception of Parramatta metro station and North Strathfield metro station construction sites (as regular out of hours excavation works are not proposed at these sites), acoustic sheds are proposed at cut-and-cover stations, although alternative means of achieving the same noise outcome (reduced noise to receivers), such as acoustic panels over the station excavations, may be adopted. Specific noise mitigation measures would be determined during detailed construction planning taking into account construction program, construction working hours and construction traffic management in accordance with the Construction Noise and Vibration Standard (refer to Appendix E).

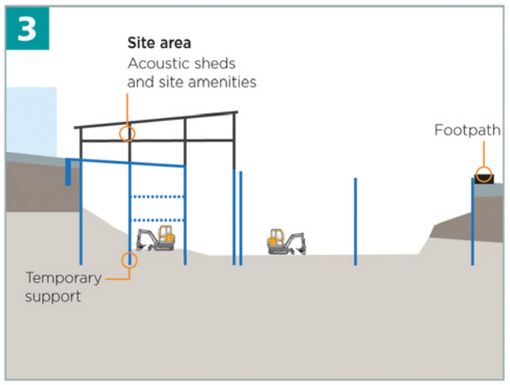
Typically, station excavation would occur prior to arrival of the tunnel boring machines although at some sites the tunnel boring machines may pass through prior to completion of station excavation. The construction of the station would progress down to the level of the base slab with intermediate temporary horizontal braces, anchors and shoring installed as required.



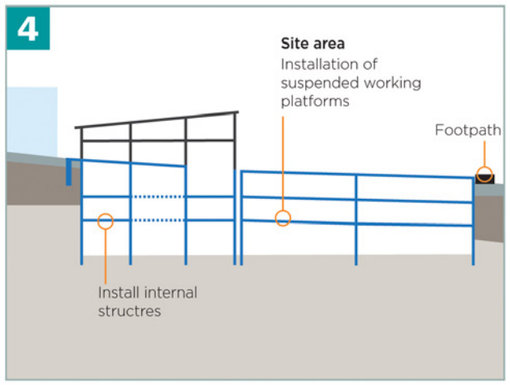
Demolition and piling works



Construction of acoustic sheds and site amenities



Initial excavation and installation of working platforms



Excavation

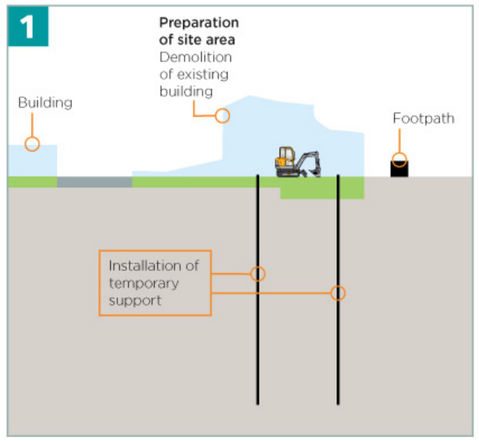
Figure 9-10: Typical cut-and-cover station construction

Mined cavern stations

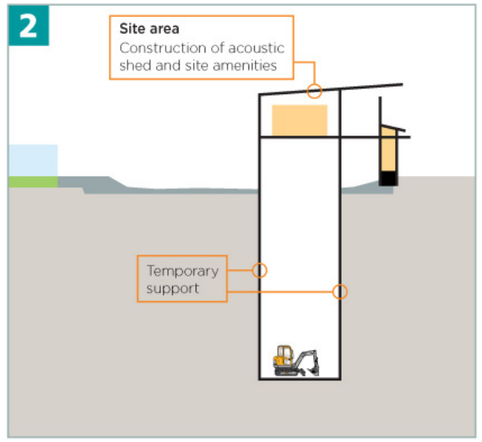
Five Dock Station would be constructed as binocular mined caverns. A typical construction method for cavern station excavation is shown in Figure 9-11.

Acoustic sheds are proposed at the Five Dock Station construction site, although alternative means of achieving the same noise outcome, such as acoustic panels over the shaft excavations, may be adopted. The specific noise mitigation measures would be determined during detailed construction planning taking into account the construction program, construction working hours and construction traffic management in accordance with the Construction Noise and Vibration Standard (Appendix E).

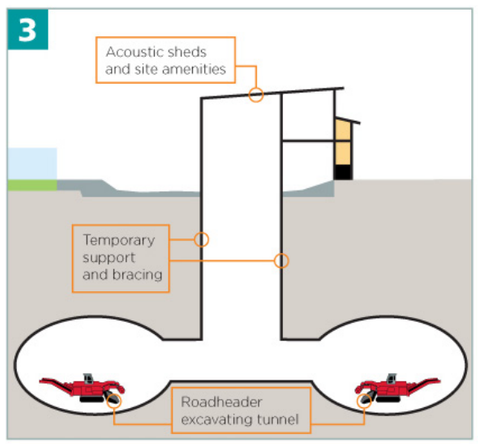
For mined cavern stations, the shafts for future station entry and vertical transport would be typically offset from the location of future station platforms. Shafts would be progressively excavated from the surface within the footprint of the future vertical transport to an intermediate floor level. Roadheaders and other excavation equipment would then be lowered through the shaft to excavate the underground station cavern and pedestrian connections. Spoil would be moved to the shafts, transferred to the surface and then removed from site.



Demolition and temporary support works



Construction of acoustic shed and excavation shaft



Excavation of mined station from shaft

Figure 9-11: Typical cavern station construction

9.4.4 Services facilities

Vertical shafts would be constructed at Rosehill, Silverwater and between Five Dock and The Bays to house future services facilities. Stage 1 construction works for the services facilities would involve:

- Enabling works including protection or diversion of utilities and establishment of site access points
- Demolition of structures on the site and vegetation removal, where required
- Excavation of a vertical shaft to the tunnels below. This may be carried out using excavators and rock hammers, however drill and blast or penetrating cone fracture techniques may also be used (described in Section 9.4.3)
- Temporary lining and reinforcement of the shaft.

These sites are described further in Section 9.5.

9.4.5 Stabling and maintenance facility

Civil works for the formation of the stabling and maintenance facility would involve:

- Enabling works including protection or diversion of utilities and establishment of site access points
- Demolition of structures on the site and clearance of vegetation (if present)
- Import and placement of fill material. The stabling and maintenance facility would be designed and constructed to be protected from the one per cent Annual Exceedance Probability flood event. In some areas, this may also involve the construction of retaining walls
- Structures for crossings of A'Becketts Creek and Duck Creek.

A temporary precast concrete segment construction production facility to support tunnelling would also be located at the Clyde stabling and maintenance facility construction site (described in Section 9.5.3).

9.4.6 Dive structures and tunnel portals

A dive structure and tunnel portal would be constructed at Rosehill (within the Clyde stabling and maintenance construction site) to facilitate a surface connection to the Clyde stabling and maintenance facility. The construction of the dive structure and tunnel portal would generally involve:

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

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

9.5 Construction sites

A number of construction sites would be required for:

- Tunnel boring machine launch, support and retrieval
- Roadheader support
- Station excavation
- Services facility shaft excavation
- Civil works for the stabling and maintenance facility.

Wherever possible, construction sites would be co-located within the operational footprint to minimise the construction footprint and disruption to surrounding areas. Table 9-3 shows the proposed construction sites and their uses. All construction sites would provide staff facilities such as offices, lunch rooms and amenities.

Table 9-3: Construction site works

Construction site	Tunnel boring machine launch and support	Tunnel boring machine retrieval	Roadheader works and support	Spoil removal	Station excavation	Services facilities excavation	Construction staff facilities	Stabling and maintenance facility civil works	Creek crossings	Tunnel dive structure
Westmead metro station	●		●	●	●		●			
Parramatta metro station				●	●		●			
Clyde stabling and maintenance facility				●		●	●	●	●	●
Silverwater services facility				●		●	●			
Sydney Olympic Park metro station		●		●	●		●			
North Strathfield metro station				●	●		●			
Burwood North Station			●	●	●		●			
Five Dock Station			●	●	●		●			
Services facility between Five Dock and The Bays				●		●	●			
The Bays Station	●			●	●		●			

Site establishment activities would initially be carried out at each construction site. This would involve:

- Demolishing buildings and vegetation removal, where required
- Protecting and/or relocating utilities
- Providing services required for construction, such as power, water, sewer and communications
- Establishing site compound and ancillary facilities such as offices, amenities and workshops
- Establishing vehicle access and egress points
- Establishing truck wheel wash or rumble grid
- Establishing internal roads
- Establishing hardstand areas for storage and car parking
- Establishing site hoardings, noise barriers and/or fencing around the perimeter of the site.

Some of these site establishment activities may be carried out as enabling works (refer to Section 9.4.1).

9.5.1 Westmead metro station construction site

The Westmead metro station construction site would cover about 15,750 square metres within the block bound by the T1 Western Line rail corridor, Hawkesbury Road, Bailey Street and Hassall Street. The site currently contains residential and commercial buildings.

The construction site would be used to:

- Carry out the excavation of Westmead metro station and turnback cavern
- Launch and support two tunnel boring machines for the drive east to the Sydney Olympic Park metro station construction site.

This construction site would include tunnel boring machine support services including high voltage power supply, spoil storage and removal, fresh air ventilation, work train, grout batching plant, water supply, water treatment and disposal, material storage as well as office facilities, worker amenities and parking, and storage and installation of precast concrete lining elements.

This station would be constructed using a cut-and-cover technique and the turnback cavern would be constructed using a mined technique. The station excavation and cavern would require the removal of about 245,000 cubic metres of spoil and an additional 675,000 cubic metres of spoil would be removed from tunnelling works from the Westmead metro station construction site to Sydney Olympic Park station construction site.

Access to and egress from the Westmead metro station construction site would be left-in from Bailey Street via Hawkesbury Road and left-out via Hawkesbury Road.

The location and indicative layout of the Westmead metro station construction site, including vehicle access and egress, are illustrated in Figure 9-12.

Alexandra Avenue would be closed between Hassall Street and Hawkesbury Road during Stage 1. Traffic would be temporarily diverted via Hassall Street and Bailey Street, with new and altered traffic signals provided where required.

At the end of Stage 1 construction works at the Westmead metro station construction site, Alexandra Avenue would be permanently realigned between Hassall Street and Hawkesbury Avenue, including a new signalised intersection at Alexandra Avenue, Hawkesbury Road and Grand Avenue (refer to Figure 9-13).

The indicative construction program is outlined in Figure 9-14.

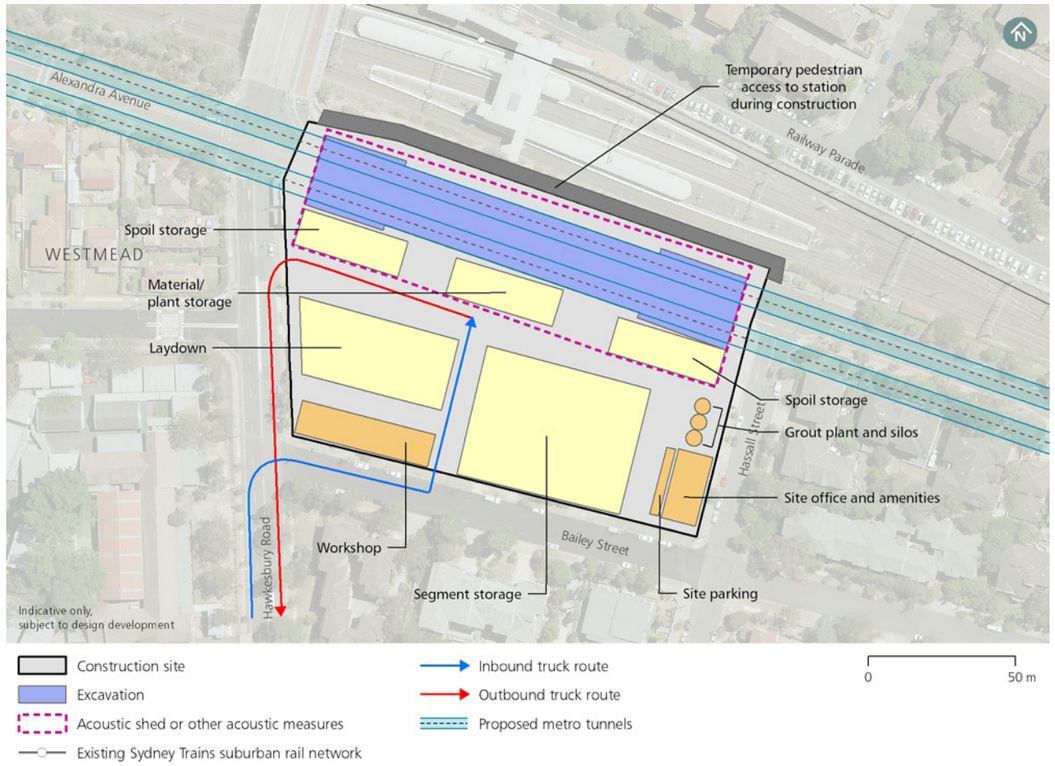


Figure 9-12: Westmead metro station indicative construction site layout

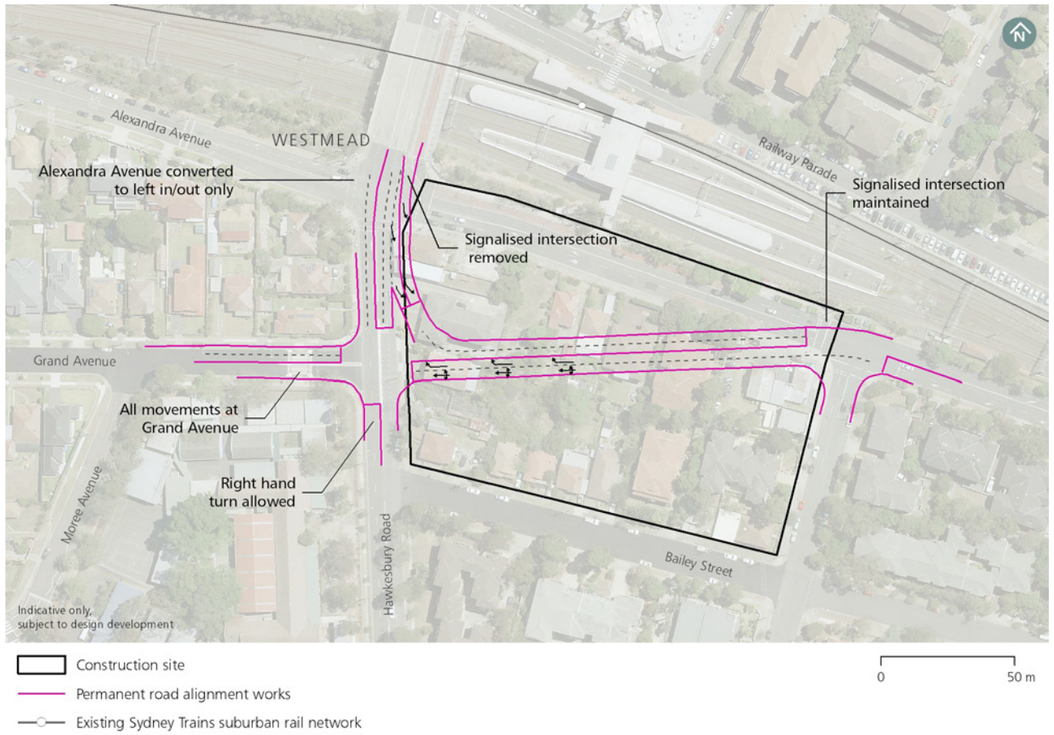


Figure 9-13: Westmead road realignment works

Construction activity	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
Enabling and demolition works																								
Station excavation																								
Tunnel boring machine support services and spoil removal																								
Crossover cavern excavation																								

Note: This program only shows major civil works (Stage 1) indicative duration and not the total works.

Figure 9-14: Westmead metro station construction site indicative construction program

9.5.2 Parramatta metro station construction site

The Parramatta metro station construction site would cover about 24,150 square metres within the block bounded by George, Church, Macquarie and Smith streets. The site currently contains commercial buildings and a multi-storey car park.

The construction site would be used to excavate Parramatta metro station using a cut-and-cover technique. This construction site would include spoil storage and removal, water supply, water treatment and disposal, material storage as well as office facilities, worker amenities and parking. The excavation would require the removal of about 125,000 cubic metres of spoil.

Access to and egress from the site would be right-in and left-out via George Street.

The location and indicative layout of the Parramatta metro station construction site, including vehicle access and egress, are illustrated in Figure 9-15.

The indicative construction program is outlined in Figure 9-16.

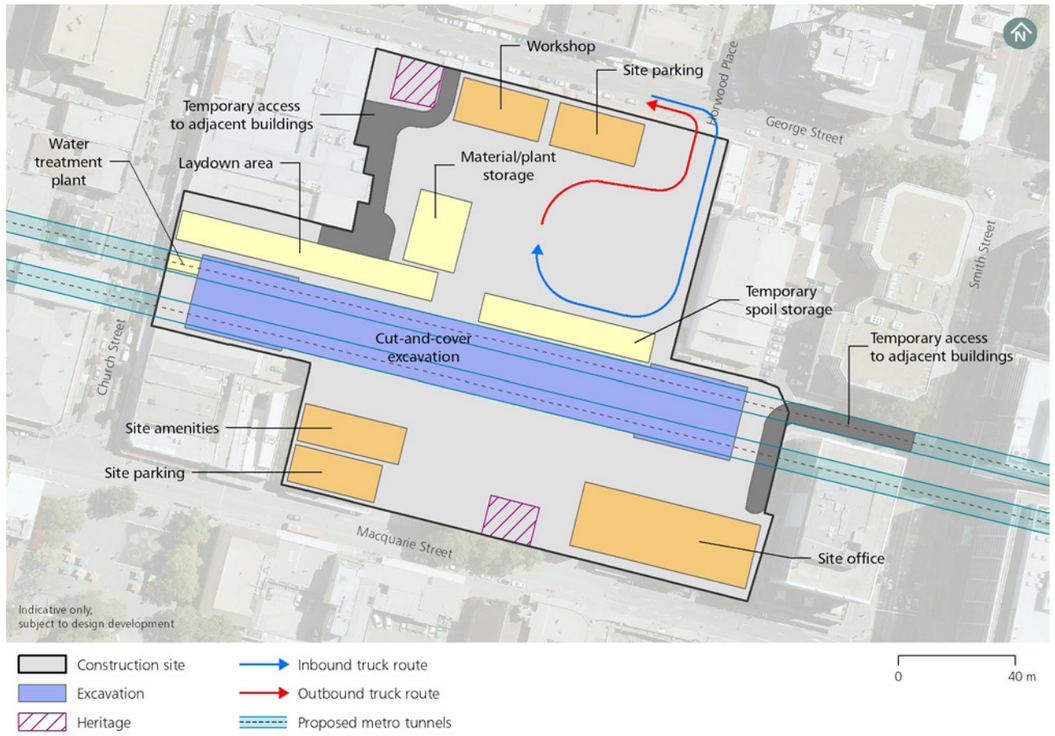


Figure 9-15: Parramatta metro station indicative construction site layout

Construction activity	2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Enabling and demolition works				●	●	●						
Station box excavation						●	●	●	●	●		

Note: This program only shows major civil works (Stage 1) indicative duration and not the total works.

Figure 9-16: Parramatta metro station construction site indicative construction program

9.5.3 Clyde stabling and maintenance facility construction site

The Clyde stabling and maintenance facility construction site would cover about 380,000 square metres between the M4 motorway, James Ruse Drive and Rosehill Gardens Racecourse. The site currently contains industrial and commercial buildings, Sydney Speedway (location on NSW Government owned land) and the redundant T6 Carlingford Line at Rosehill.

The site would be used to:

- Construct the land formation for the stabling and maintenance facility
- Construct structures over A'Becketts Creek and Duck Creek, including creek realignment works
- Construct and operate a temporary precast concrete segment production facility
- Excavate the Rosehill services facility
- Excavate and construct the Rosehill dive structure and tunnel portal (described in Section 9.4.6).

The formation of the site for the stabling and maintenance facility is described in Section 9.4.5. The stabling and maintenance facility formation would cover about 330,000 square metres of the construction site.

This construction site would include spoil storage and removal from the excavations for the services facility shaft and dive structure and portal, water supply, water treatment and disposal, material storage as well as office facilities, worker amenities and parking. It would also include a section of the redundant T6 Carlingford Line required for the construction of future stages of Sydney Metro West.

Kay Street and Unwin Street would be permanently realigned around the construction site and would include a bridge over the future metro rail tracks.

The excavation of the Rosehill dive structure, tunnel portal and services facility would require the removal of about 195,000 cubic metres of spoil.

Access to and egress from the site would be via Wentworth Street to Parramatta Road.

The location and indicative layout of the Clyde stabling and maintenance facility construction site, including vehicle access and egress is illustrated in Figure 9-17.

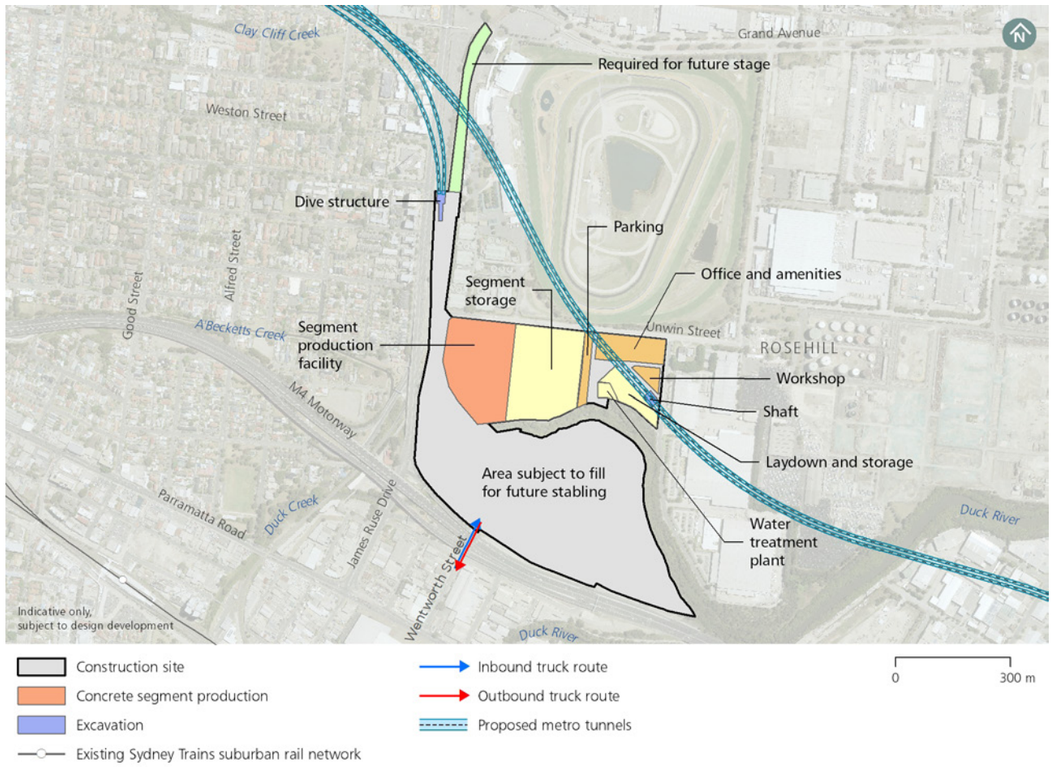


Figure 9-17: Clyde stabling and maintenance facility indicative construction site layout

Road and creek realignment works

The permanent realignment of Unwin Street and Kay Street around the Clyde stabling and maintenance facility (refer to Figure 9-18) would maintain the existing two-lane road configuration and would be designed to accommodate B-double trucks. The realigned road would cross over the redundant T6 Carlingford Line, A'Becketts Creek and Duck Creek. The road would be elevated on piles for about 500 metres to avoid flooding impacts.

A'Becketts Creek and Duck Creek would be realigned during Stage 1 as shown in Figure 9-18.

The creeks would generally flow through culverts and new open channels, and would be naturalised where possible.

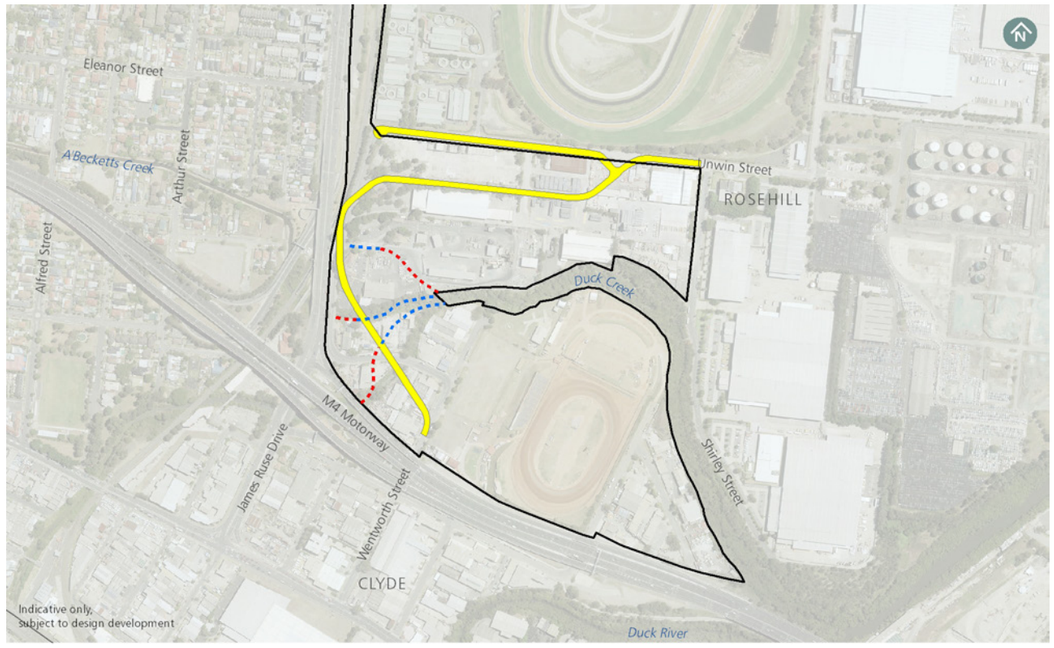


Figure 9-18: Clyde road and creek realignment works

Temporary precast concrete segment production facility

The temporary precast concrete segment production facility and storage yard would be established at the north-east end of the construction site and would cover about 120,000 square metres of the construction site. The concrete segment production facility would cover about 60,000 square metres, and the storage yard would cover about 60,000 square metres. Works would include site establishment and enabling works for the production facility and storage yard, construction of sheds for segment production, and construction of production infrastructure such as concrete batching plant. Waste water treatment facilities would also be established at the facility.

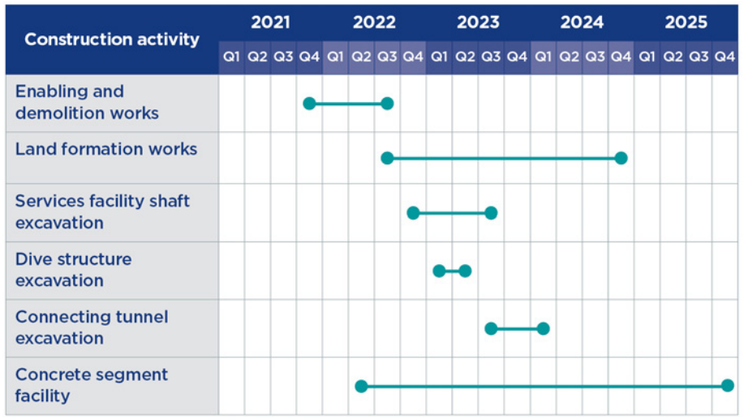
Rosehill services facility

Construction of the services facility would involve excavation of a shaft to the mainline tunnels below. This would require removal of about 20,000 cubic metres of spoil.

Rosehill dive structure and tunnel portal

A dive structure and tunnel portal would be constructed in Rosehill (within the disused part of the Carlingford Rail Line) to provide for a future connection from the Clyde stabling and maintenance facility to the mainline tunnels. The construction of the dive structure and tunnel portal is described in Section 9.4.6. Underground connecting tunnels would be excavated by road header from the tunnel portal to the mainline tunnels.

The indicative construction program for the Clyde stabling and maintenance facility is outlined in Figure 9-19.



Note: This program only shows major civil works (Stage 1) indicative duration and not the total works.

Figure 9-19: Clyde stabling and maintenance facility construction site indicative construction program

9.5.4 Silverwater services facility

The Silverwater services facility construction site would cover about 2,700 square metres on the corner of Silverwater Road and Derby Street. The site is currently a vacant lot.

The construction site would be used to excavate a shaft to the mainline tunnels below for a future services facility. This construction site would include spoil storage and removal from the shaft excavation, water supply, material storage as well as office facilities, worker amenities and parking.

The shaft excavation would require the removal of about 20,000 cubic metres of spoil.

Access to and egress from the site would be left-in and left-out via Derby Street to Silverwater Road.

The location and indicative layout of the Silverwater services facility construction site, including vehicle access and egress is illustrated in Figure 9-20. The indicative construction program is outlined in Figure 9-21.

Figure 9-20: Silverwater services facility indicative construction site layout

Construction activity	2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Enabling and demolition works					●							
Services facility shaft excavation					●	―	●					

Note: This program only shows major civil works (Stage 1) indicative duration and not the total works.

Figure 9-21: Silverwater services facility construction site indicative construction program

9.5.5 Sydney Olympic Park metro station construction site

Sydney Olympic Park metro station construction site would cover about 23,900 square metres between Herb Elliot Avenue and Figtree Drive. The site contains commercial buildings.

The construction site would be used to:

- Carry out the excavation of Sydney Olympic Park metro station
- Retrieve the tunnel boring machines driven east from the Westmead metro station construction site and west from The Bays Station construction site.

This construction site would include spoil storage and removal, water supply, water treatment and disposal, material storage as well as office facilities, worker amenities and parking.

This station would be constructed using a cut-and-cover technique, requiring the removal of about 225,000 cubic metres of spoil.

Access to and egress from the site would be left-in and right-out via Herb Elliot Avenue.

The location and indicative layout of the Sydney Olympic Park metro station construction site, including vehicle access and egress is illustrated in Figure 9-22. The indicative construction program is outlined in Figure 9-23.

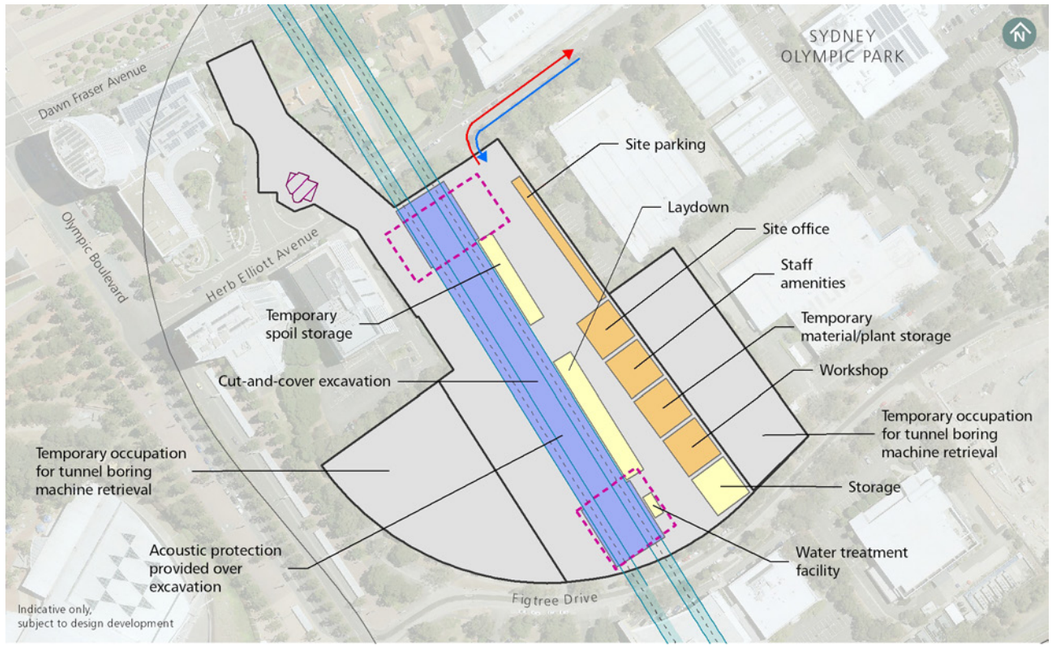


Figure 9-22: Sydney Olympic Park metro station indicative construction site layout

Construction activity	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
Enabling and demolition works				●	―	●																		
Station box excavation						●	―	―	―	―	―	●												
Tunnel boring machine retrieval														●							●			

Note: This program only shows major civil works (Stage 1) indicative duration and not the total works.

Figure 9-23: Sydney Olympic Park metro station construction site indicative construction program

9.5.6 North Strathfield metro station construction site

Construction of North Strathfield metro station would require two sites, a northern construction site and a southern construction site:

- The North Strathfield metro station northern construction site would cover about 6,500 square metres between the existing North Strathfield Station and Queen Street, bounded by Pomeroy Street to the north and the pedestrian entrance to the existing North Strathfield Station to the south. The site predominately comprises vacant land within the T9 Northern Line rail corridor, the northbound lane of Queen Street, and gardens at the eastern pedestrian entry to North Strathfield Station. This construction site would include spoil storage and removal, water treatment and disposal and material storage

- The North Strathfield metro station southern construction site would cover about 1,000 square metres and occupy land between the existing North Strathfield Station and Queen Street, bounded by Shipley Avenue to the south and the pedestrian entrance to the existing North Strathfield Station to the north. The site is currently used as a private car park and facilities site for the existing North Strathfield Station and rail lines. This site would be used for site offices, worker amenities and parking only.

The construction site would be used to excavate North Strathfield metro station using a cut-and-cover technique. This would require the removal of about 110,000 cubic metres of spoil.

Access to and egress from the North Strathfield Station northern construction site would be left-in and right-out via Queen Street. Access and egress from the North Strathfield metro station southern construction site would be from the existing access point on Queen Street.

The location and indicative layout of the North Strathfield metro station construction sites, including vehicle access and egress, is illustrated in Figure 9-24. The indicative construction program is outlined in Figure 9-25.

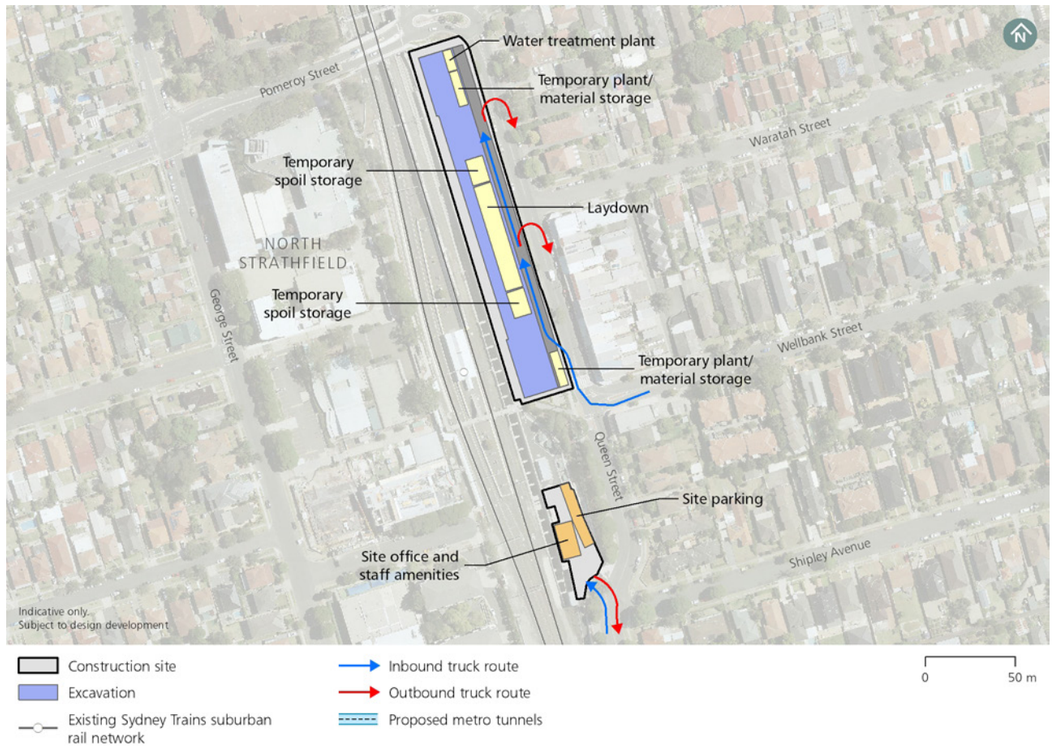


Figure 9-24: North Strathfield metro station indicative construction site layout

Construction activity	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
Enabling and demolition works					●																			
Station excavation						●	—	—	—	●														

Note: This program only shows major civil works (Stage 1) indicative duration and not the total works.

Figure 9-25: North Strathfield metro station construction site indicative construction program

9.5.7 Burwood North Station construction site

Construction of Burwood North Station would require two construction sites, a northern construction site and a southern construction site:

- The Burwood North Station northern construction site would cover about 12,900 square metres and would be located on Parramatta Road bound by Burwood Road and Loftus Street. This site currently contains a number of commercial and residential properties fronting Burwood Road
- The Burwood North Station southern construction site would cover about 1,400 square metres bound by Burwood Road, Parramatta Road and Esher Lane. The site currently contains commercial buildings.

The northern construction site would include spoil storage and removal, water supply, water treatment and disposal, material storage as well as office facilities, worker amenities and parking.

The northern construction site would be used to excavate Burwood North Station using a cut-and-cover technique. The crossover cavern would be constructed using a mined technique.

A shaft would be excavated at the southern construction site for the southern station entrance and connected to the station box via a mined adit. About 235,000 cubic metres of spoil would be removed from the Burwood North Station construction sites.

Access to and egress from the northern site would be left-in from Parramatta Road, and left-out to Loftus Street and Burwood Road. Access to and egress from the southern construction site would be left-in from Burwood Road and left-out to Parramatta Road.

The location and indicative layout of the Burwood North Station construction sites, including vehicle access and egress, is illustrated in Figure 9-26. The indicative construction program is outlined in Figure 9-27.

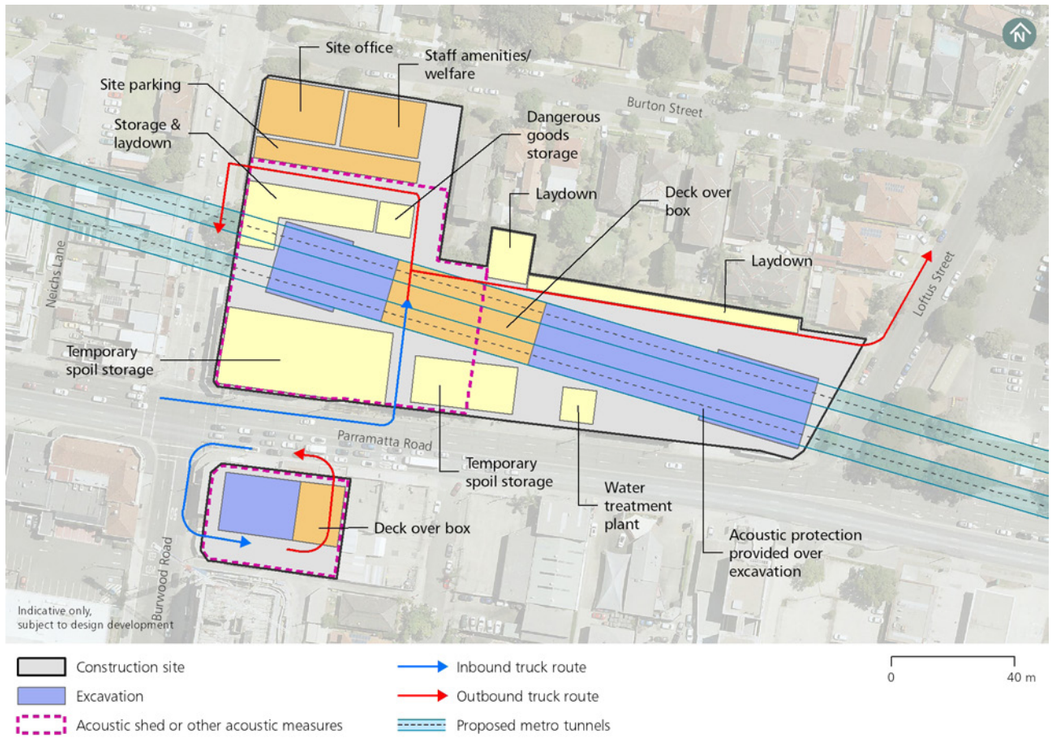


Figure 9-26: Burwood North Station indicative construction site layout

Construction activity	2021				2022				2023				2024			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Enabling and demolition works				●	●											
Station excavation (including southern shaft and adit)						●	●	●	●	●	●					
Turnback cavern excavation								●	●	●	●	●	●			

Note: This program only shows major civil works (Stage 1) indicative duration and not the total works.

Figure 9-27: Burwood North Station construction site indicative construction program

9.5.8 Five Dock Station construction site

Five Dock Station would require two construction sites, a western construction site and an eastern construction site:

- The Five Dock Station western construction site would cover about 4,150 square metres and would be located between Great North Road and East Street, to the north of Fred Kelly Place and south of St Albans Anglican Church. This site currently contains commercial buildings
- The Five Dock Station eastern construction site would cover about 2,150 square metres and would occupy the Second Avenue council car park and a number of residential properties located on Waterview Street.

The construction site would be used to excavate Five Dock Station using a mined technique. Shafts would be excavated within the two construction sites to the binocular station caverns to provide access during construction.

The construction sites would include spoil storage and removal, water supply, water treatment and disposal, material storage and office facilities, worker amenities and parking would be included at the eastern construction site. The excavations would require the removal of about 165,000 cubic metres of spoil.

Access to and egress from the western construction site would be left-in and left-out via Great North Road. Access to and egress from the eastern construction site would be left-in from Waterview Street and left-out on Second Avenue to Great North Road.

The location and indicative layout of the Five Dock Station construction sites, including vehicle access and egress is illustrated in Figure 9-28. The indicative construction program is outlined in Figure 9-29.

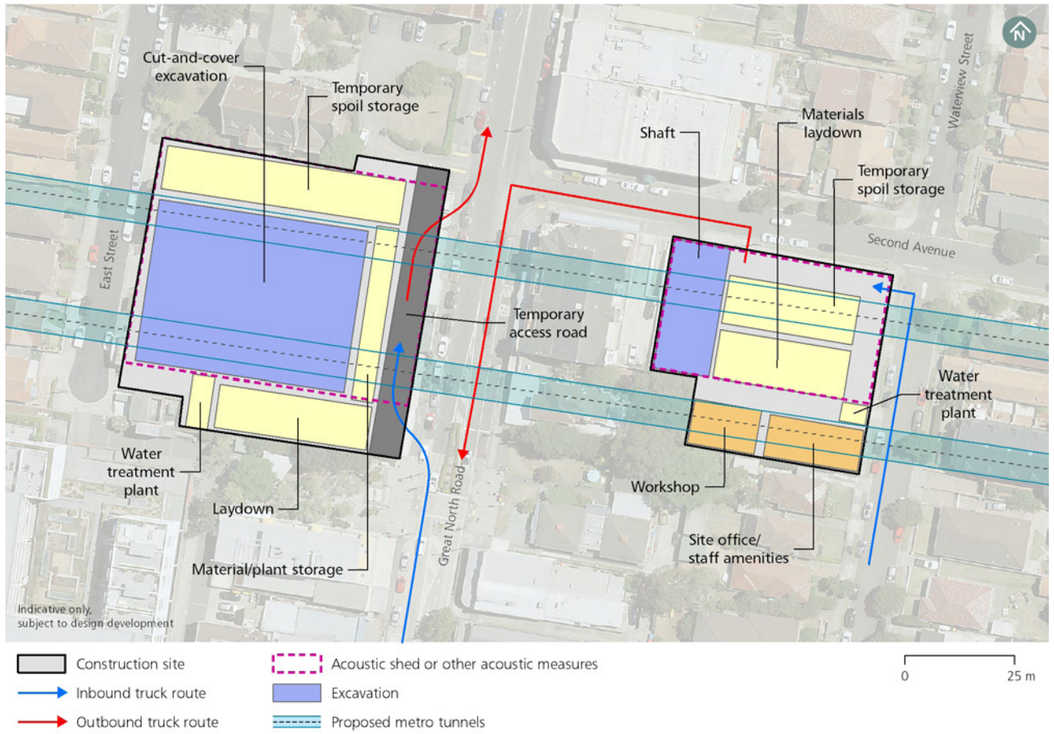


Figure 9-28: Five Dock Station indicative construction site layout

Construction activity	2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Enabling and demolition works				●	●							
Cut-and-cover shaft excavation						●	●					
Station cavern excavation							●	●	●	●	●	●

Note: This program only shows major civil works (Stage 1) indicative duration and not the total works.

Figure 9-29: Five Dock Station construction site indicative construction program

9.5.9 Services facility between Five Dock and The Bays

A services facility is required between Five Dock Station and The Bays Station for fresh air ventilation and emergency egress during operations of the electric train fleet. To meet rail operations of the electric train fleet and engineering requirements, the facility would need to be located within a zone determined by an approximate distance of 3.5 kilometres from both Five Dock Station and The Bays Station, and the horizontal curvature of the rail line.

A part of Stage 1, construction would involve the excavation of the shaft to the mainline tunnels below. The construction site would need to be around 4,500 square metres, and the shaft would have a footprint of around 20 metres by 20 metres.

The construction site would include spoil storage and removal from the shaft excavation, water supply, water treatment, material storage, office facilities, workers amenities and parking. Stage 1 construction works (including site establishment and shaft excavation works) would likely occur over a period of around 12-18 months.

The location of the services facility is currently being investigated. The following locational and design criteria would be used as part of determining the preferred location:

- The site would not be located on existing residential land
- There would be no removal of vegetation that constitutes a locally occurring Plant Community Type
- There would be no direct impacts on items listed on the State Heritage Register
- There would be no direct impacts to significant elements of any locally listed heritage items
- The construction of the facility would not result in any negative impacts to groundwater users, groundwater dependent surface flows or groundwater dependent ecosystems.

In addition to the above, the facility would need to achieve the performance outcomes set for the Concept – refer to Chapter 8 (Concept environmental assessment).

Potential impacts associated with Stage 1 construction works at the services facility construction site would vary depending on its location and proximity to sensitive receivers, such as residences and community facilities. The types of impacts and environmental performance during shaft excavation works for similar services facilities constructed at Epping and Cheltenham for the Metro North West Line, and those that could occur for a services facility between Five Dock and The Bays, are discussed in Appendix H.

9.5.10 The Bays Station construction site

The Bays Station construction site would cover about 61,200 square metres in front of the former White Bay Power Station. The site primarily comprises industrial and wharf operations for White Bay.

The construction site would be used to:

- Carry out the excavation of The Bays Station
- Launch and support two tunnel boring machines for the drive west to the Sydney Olympic Park metro station construction site.

This construction site would include tunnel boring machine support services including high voltage power supply, spoil storage and removal, fresh air ventilation, work train, grout batching plant, water supply, water treatment and disposal, material storage as well as office facilities, worker amenities and parking, and storage and installation of precast concrete lining elements.

This station would be constructed using a cut-and-cover technique, requiring the removal of about 155,000 cubic metres of spoil. An additional 860,000 cubic metres of spoil would be removed from tunnelling works from The Bays Station construction site to the Sydney Olympic Park metro station construction site.

Access to and egress from the construction site would be from James Craig Road via Port Access Road, Sommerville Road and Solomons Way. Port Access Road would be relocated prior to Stage 1 and is subject to a separate planning approvals process.

The location and indicative layout of The Bays Station construction site, including vehicle access and egress is illustrated in Figure 9-30. The location for a potential conveyor to a barge to remove spoil is discussed in Section 9.6.1 and shown on Figure 9-30. The indicative construction program is outlined in Figure 9-31.

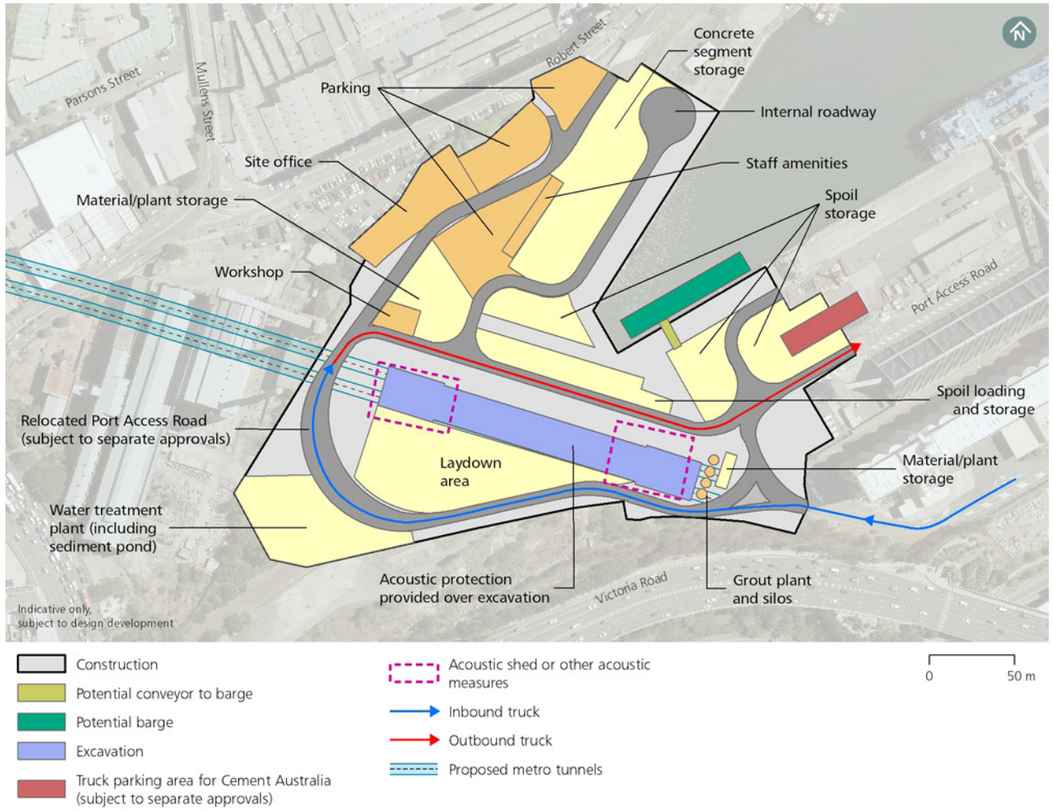


Figure 9-30: The Bays Station indicative construction site layout

Construction activity	2021				2022				2023				2024			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Enabling and demolition works			●													
Station excavation			●							●						
Tunnel boring machine support services and spoil removal							●							●		

Note: This program only shows major civil works (Stage 1) indicative duration and not the total works.

Figure 9-31: The Bays Station construction site indicative construction program

9.6 Other construction elements

This section provides an overview of other construction elements that may occur at one or more of the construction sites.

9.6.1 Spoil management

It is estimated that excavation for Stage 1 would generate about 2,762,000 cubic metres of spoil, including all tunnels, stations, shafts and dive structures. Indicative volumes for each construction site are provided in Table 9-4.

Further details on the impacts associated with spoil generation and management is provided in the relevant chapters of this Environmental Impact Statement including Chapter 10 (Transport and traffic – Stage 1), Chapter 23 (Air quality – Stage 1) and Chapter 24 (Spoil, waste management and resource use – Stage 1).

Table 9-4: Indicative spoil generation by construction site

Construction site	Volume of spoil (m^3)
Westmead metro station	245,000
	675,000 (from tunnelling to Sydney Olympic Park metro station)
Parramatta metro station	125,000
Clyde stabling and maintenance facility	20,000 (services facility shaft)
	90,000 (dive structure)
	85,000 (connecting tunnels)
Silverwater services facility	20,000
Sydney Olympic Park metro station	225,000
North Strathfield metro station	110,000
Burwood North Station	235,000
Five Dock Station	165,000
Services facility between Five Dock and The Bays	35,000
The Bays Station	155,000 860,000 (from tunnelling to Sydney Olympic Park metro station)

9.6.2 Construction traffic

Proposed access to and egress from the construction sites is described in Section 9.5.1 to Section 9.5.10. Wherever possible, access and egress is proposed to be directly via major arterial roads.

Construction traffic would be managed through the Construction Traffic Management Framework (refer to Appendix F). Construction traffic management plans for each site would be submitted to the relevant roads authority for review before work starts. Further information relating to haulage routes, the daily profile of construction traffic movements for each site, construction traffic impacts and mitigation is provided in Chapter 10 (Transport and traffic – Stage 1).

9.6.3 Construction hours

Proposed construction hours are shown in Table 9-5. These hours have been developed based on a balanced consideration of the construction program and the need to minimise noise and traffic related impacts. As the tunnel boring machines would operate continuously, the tunnelling and associated support works would need to be carried out up to 24 hours per day and seven days per week.

Most aboveground construction works would be carried out during the following hours:

- 7am to 6pm Monday to Friday
- 8am to 1pm Saturdays
- No works on Sundays or Public Holidays.

However, other substantial construction works (as identified in Table 9-5) would need to be carried out outside these hours.

Table 9-5: Proposed construction hours

Construction works	Construction hours	Comments or exceptions
Underground construction works		
Tunnelling	• 24 hours per day, seven days per week	Construction works at tunnel support sites that support tunnelling may need to occur 24 hours per day, up to seven days per week.
Underground excavation at station construction sites and the Clyde stabling and maintenance facility construction site (refer to Section 9.4.3)	• 24 hours per day, seven days per week	Construction works requiring rail possessions may need to be carried out outside standard construction hours up to 24 hours per day, seven days per week. Construction works requiring the temporary possession of roads or to accommodate road network requirements may need to be carried out outside standard daytime construction hours during periods of low demand to minimise safety impacts and inconvenience to motorists.
Aboveground construction works		
Demolition **Aboveground construction works**	• 7am to 6pm Monday to Friday • 8am to 1pm Saturdays • No works on Sundays and Public Holidays.	Aboveground work supporting underground construction works (e.g. concrete pumping, truck loading) are expected to be required 24 hours per day, up to seven days per week where noise mitigation is in place. Aboveground work at Parramatta metro station and North Strathfield metro station construction sites would generally be restricted to standard construction hours. Saturday works at Parramatta metro station and The Bays Station construction sites may be carried out between 8am to 6pm. Construction works requiring rail possessions may need to be carried out outside the standard construction hours up to 24 hours per day, seven days per week. Construction works requiring the temporary possession of roads or to accommodate road network requirements may need to be carried out outside the standard daytime construction hours during periods of low demand to minimise safety impacts and inconvenience to commuters.
Construction traffic for material supply to, and spoil removal from, tunnelling and underground excavation (station and services facility sites)	• 24 hours per day, seven days per week	Restrictions would be in place during peak hours and special events. At locations where night-time sensitive noise receivers are close to construction sites, substantial construction vehicle movements are likely to be restricted during evening and night-time periods.
Utility management and power supply works	• 24 hours per day, seven days per week	Utility works requiring the temporary possession of roads may need to be carried out outside standard daytime construction hours during periods of low demand to minimise safety impacts and inconvenience to motorists.

Other construction works that would be carried out outside of standard daytime construction hours would include:

- Work determined to comply with the relevant noise management level at the nearest sensitive receiver
- Work required to be carried out during rail possessions
- Delivery of materials outside approved hours as required by the NSW Police or other authorities for safety reasons
- Emergency situations where it is required to avoid the loss of lives and property and/or to prevent environmental harm
- Situations where agreement is reached with affected receivers.

Except for emergencies, construction works would not take place outside standard daytime construction hours without prior notification of local residents, businesses and the Environment Protection Authority.

9.6.4 Demolition

It is anticipated that construction of Stage 1 would require the demolition of about 114 buildings. Some demolition would occur in the enabling works phase before substantial construction works begin.

The indicative number of buildings proposed to be demolished at each construction site and their current primary use is provided in Table 9-6.

Table 9-6: Indicative number and types of buildings proposed for demolition

Construction site	Commercial	Industrial	Residential	Subtotal
Westmead metro station	4	0	14	**18**
Parramatta metro station	16	0	0	**16**
Clyde stabling and maintenance facility	0	50	0	**50**
Silverwater services facility	0	0	0	**0**
Sydney Olympic Park metro station	3	0	0	**3**
North Strathfield metro station	0	0	0	**0**
Burwood North Station	12	0	4	**16**
Five Dock Station	6	0	5	**11**
The Bays Station	0	0	0	**0**
Totals	**41**	**50**	**23**	**114**

Typically, access to and egress from construction sites during demolition would use existing driveways however, alternative site access may be required. Indicative heavy vehicle movements associated with the demolition phase are provided in Chapter 10 (Transport and traffic – Stage 1).

Demolition would be carried out by licensed demolition contractors and in a staged manner where possible. Typically, building demolition would involve:

- Establishment of hoarding, scaffolding and protection barriers around the perimeter of the site
- All services into the buildings would be decommissioned and made safe and redundant
- A hazardous materials assessment would be carried out prior to stripping and demolition of the main structure
- Soft stripping internal building materials
- Demolition of the building using an excavator, bobcat, cranes or other conventional methods following a top-down approach. Temporary propping and/or waterproofing would be provided for structural integrity of adjacent structures as required during the demolition works.

If any hazardous materials are found, they would be removed and disposed of in accordance with the relevant legislation, codes of practice and Australian Standards.

Materials such as bricks, tiles, timber, plastics and metals would be sorted where feasible and reasonable, and sent to a waste facility with recycling capabilities.

Construction contractors would be required to meet the requirements of the Construction Environmental Management Framework (refer to Section 9.7).

Structures other than buildings to be cleared and/or demolished are listed in Table 9-7.

Table 9-7: Indicative structures other than buildings proposed for clearance and/or demolition

Construction site	Structure type
Westmead metro station	• Vacant land • Existing roadways
Parramatta metro station	• Multi-storey car parking • Existing roadways
Clyde stabling and maintenance facility	• Recreational land • Existing roadways
Silverwater services facility	• Vacant land
North Strathfield metro station	• Paved car parking • Vacant land
Five Dock station	• Paved car parking
The Bays Station	• Paved industrial land

9.6.5 Utilities management

Utilities would need to be adjusted, relocated and/or protected where there is a possibility they would otherwise be impacted by construction. Utilities which may require protection and/or relocation include water, sewer, stormwater, drainage, recycled water, electricity, gas and communications assets. The location of utilities has been determined from Dial Before You Dig plans, utility geographic information system data supplied by the utility companies, and local authority and council records. Further investigation and consultation with service asset owners would be carried out as the design develops to confirm exact locations, heights and depths of the utilities.

Where an existing utility conflicts with the proposed design, it may be necessary to:

- Provide physical protection for the utility where the utility is not directly affected but may be indirectly affected by vibration or accidental impact. Protection could include constructing a piled wall between the excavation and the utility, plating over the utility to minimise the impact of construction traffic, or marking out or fencing off the location of a utility to avoid it being accidentally damaged
- Modify construction methods to avoid impacting a nearby utility. For example, this could involve using only hand excavation and compaction tools such as hand digging tools, a vibration plate or pedestrian rollers where compacting within a specified distance of utilities
- Wrap and support the utility service to provide mechanical protection
- Relocate the utility around the construction site
- Abandon the utility.

Table 9-8 summarises the major utilities in the vicinity of Stage 1 construction sites which may require treatment.

Table 9-8: Major utilities in the vicinity of Stage 1 construction sites

Construction site	Utility type							
	High voltage cable	Sewer	Water main	Stormwater	Communications	Gas	Signal post (Transport for NSW)	Sydney Trains assets
Westmead metro station	●	●	●	●	●	●	●	●
Parramatta metro station	●	●	●	●	●	●		
Clyde stabling and maintenance facility	●	●	●	●	●	●		
Silverwater services facility	●	●	●	●	●	●		
Sydney Olympic Park metro station	●	●	●		●	●		●
North Strathfield metro station	●	●		●	●			
Burwood North Station	●	●	●	●	●	●		
Five Dock Station	●	●	●	●	●	●		
The Bays Station	●	●	●	●	●			

A utilities coordination manager would be appointed for Stage 1 to coordinate the delivery of the utility works. Utility works includes any construction or physical modification of utility infrastructure to ensure continual operation of utility assets/services during Stage 1. Utility work does not include investigative works (such as surveying or potholing of utility assets) to gather information to inform design and construction methodologies.

Preliminary consultation has been held with the utility owners in Table 9-9. In addition, Sydney Metro would consult with local councils and utility providers to identify any opportunities to support future initiatives or utility augmentations. Consultation with utility providers would continue during detailed design and construction to mitigate the risk of unplanned and unexpected disturbance of utilities.

Table 9-9: Preliminary consultation with utility owners

Utility type	Utility owners
Electricity	• Ausgrid • Transgrid • Endeavour Energy
Water/Sewer/ Stormwater/ Recycled Water	• Sydney Water • AquaNet Recycled Water • Council (Local Authorities) – Various • Relevant parts of Transport for NSW
Gas	• Jemena Gas • Caltex • Viva Energy
Telecommunications	• NBN • Telstra • Optus/Uecomm • Vocus Communications (Amcon/Nextgen/M2/Dodo/iprimus/Engine/Commander) • TPG (AAPT/Powertel/Pipenetworks/Soul Australia Communications) • Verizon/Worldcom • AARNet • Vodafone

The utilities coordination manager would:

- Establish a utilities working group with nominated representatives from utility service providers that may be impacted by Stage 1
- Review design and construction methodologies to assist with identifying potentially impacted utility assets
- Assist with coordination of design and construction methodology reviews by utility service providers to identify necessary utility works
- Communicate with the working group and Sydney Metro's contractors' delivery teams to understand the proposed program of works to coordinate intercepting, interconnecting and interrelated works and manage priorities as they may arise
- Observe utility works, where relevant
- Manage escalation of utility work-related issues within Sydney Metro and the utility service providers as required.

If receivers are anticipated to be impacted by proposed utility works, respite periods would be considered throughout the coordination and management of the utility works in accordance with the Construction Noise and Vibration Standard (Appendix E) and a future Community Communications Strategy. Respite may be offered in the form of a reduction or absence of noise emissions for a period of time, or by removing the affected receiver from the noise emission point source (e.g. dinner/movie tickets and/or alternative accommodation offers). Consideration of respite would take into account many factors, including but not limited to the predicted noise level, duration, time of day, surrounding land uses and community feedback. The utility coordination manager would endeavour to coordinate works to avoid the same receiver being affected more than three consecutive nights as much as possible. Furthermore, the utilities coordination manager would endeavour to stagger the timing of works by different contractors that affect the same receiver as much as possible in order to maximise the respite period between the works.

9.6.6 Utilities and power supply

Utilities such as water, sewer and telecommunications would need to be supplied to each of the major construction sites. Generally, these utilities are located close to the sites (such as the adjacent footpath) and the supply is considered 'business as usual' for supply companies.

Power supply

High voltage power supply would be required for the operation of tunnel boring machines at the Westmead metro station construction site and The Bays Station construction site and for roadheaders at the station sites and services facility sites. The power supply for each site would need to be brought in from existing substations outside the Stage 1 corridor. Table 9-10 describes the power supply required at each construction site. Indicative supply routes are provided on Figure 9-32 to Figure 9-35.

Power supply routes would generally be located within existing road reserves. Construction of these power supply routes would generally be carried out by open trench. Underbores would be used when crossing major infrastructure or to avoid other major constraints.

Preliminary consultation has been carried out with energy suppliers. A program of ongoing consultation is underway to further assess the requirements for Stage 1.

Construction contractors would be required to meet the requirements of the Construction Environmental Management Framework (refer to Section 9.7).

Table 9-10: Construction power supply requirements

Construction site	Supply source	Supply source	Power (mega volt ampere)
Westmead metro station	Endeavour	West Parramatta Zone substation	15
Parramatta metro station	Endeavour	West Parramatta zone substation	4
Clyde stabling and maintenance facility	Endeavour	Rosehill Zone substation	10
Silverwater services facility	Ausgrid	Silverwater Road 11 kilovolt line	4
Sydney Olympic Park metro station	Ausgrid	Herb Elliot Avenue 11 kilovolt line	4
North Strathfield metro station	Ausgrid	Queen Street 11 kilovolt line	4
Burwood North Station	Ausgrid	Parramatta Road 11 kilovolt line Burton Street feeder line	8
Five Dock Station	Ausgrid	Second Avenue 11 kilovolt line	8
The Bays Station	Ausgrid	Rozelle sub-transmission substation	35

Figure 9-32: Westmead metro station – power supply route

Figure 9-33: Parramatta metro station – power supply route

Figure 9-34: Clyde stabling and maintenance facility – power supply route

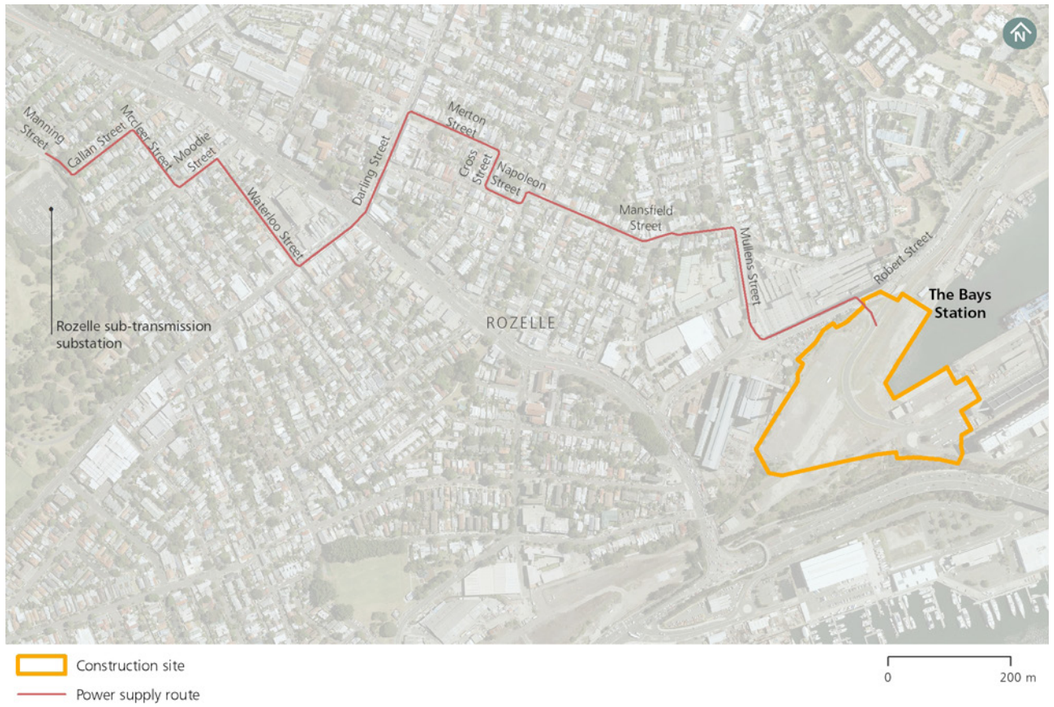


Figure 9-35: The Bays Station – power supply route

Use of generators

At a number of the station construction sites, generators may be used instead of providing a mains power connection, or for a period of time prior to the mains power supply becoming available. Each generator is likely to be around 1,000 kVA in order to supply the necessary power for Stage 1. Generators would be managed to minimise potential noise impacts as required, including acoustic attenuation and appropriate site positioning. The likely sites and number of generators required is as follows:

- Westmead metro station – three generators
- Parramatta metro station – one generator
- Sydney Olympic Park metro station – one generator
- North Strathfield metro station – one generator
- Burwood North Station – three generators
- Five Dock Station – three generators
- The Bays Station – one generator.

9.6.7 Transport network modifications

This section provides an overview of the modifications anticipated to be required to the road network, the public transport network and the pedestrian and cyclist network in the vicinity of each construction site. Further details and the potential impacts of these modifications are provided in Chapter 10 (Transport and traffic – Stage 1).

Road network

It is anticipated that road network modifications would be required to facilitate construction of Stage 1. These modifications are outlined in Table 9-11. The modifications would be reviewed by the construction contractor during the preparation of construction traffic management plans, with the objective of minimising disruptions to the road network.

Table 9-11: Indicative road network modifications

Construction site	Indicative road network modifications
Westmead metro station	Temporary road network changes (for the duration of Stage 1 construction): • Detour between Hawkesbury Road and Hassall Street (via Bailey Street) around the closed section of Alexandra Avenue • Modification of traffic signals at the Hawkesbury Road/Alexandra Avenue and Alexandra Avenue/Hassall Street intersections • Signalisation of the Hawkesbury Road/Bailey Street intersection • Removal of about 35 parking spaces on Hassall Street and Bailey Street adjacent to the construction site and to accommodate signalisation infrastructure. Permanent road network changes (at the end of Stage 1 construction): • Closure and realignment of Alexandra Avenue between Hassall Street and Hawkesbury Road • New signalised intersection at Hawkesbury Road, Grand Avenue, and the realigned Alexandra Avenue • Modification of traffic signals at the Hawkesbury Road/Alexandra Avenue and Alexandra Avenue/Hassall Street intersections.
Parramatta metro station	• Temporary closure of Horwood Place for the duration of Stage 1 construction • Construction of temporary rear access lanes for properties fronting Church Street • Permanent removal of around 850 off-street car parking spaces accessible from Horwood Place – including the City Centre Car Park and a small at-grade car park • Permanent removal of around 35 on-street parking spaces from Horwood Place.
Clyde stabling and maintenance facility	• Permanent realignment of Kay Street and Unwin Street around the construction site, including the construction of a bridge over the future metro rail tracks.
Silverwater services facility	• Temporary removal of around six on-street parking spaces on Derby Street near the construction site access and egress location for the duration of Stage 1 construction.
Sydney Olympic Park metro station	• Temporary closure of Herb Elliot Avenue (full or staged closures subject to ongoing design development) • Temporary relocation of taxi rank on Herb Elliot Avenue for the duration of Stage 1 construction • Pedestrianisation of Showground Road at the intersection with Dawn Fraser Avenue.
North Strathfield metro station	• Temporary removal of around 20 on-street parking spaces and the kiss and ride facilities on the western side of Queen Street between Wellbank Street and Pomeroy Street for the duration of Stage 1 construction.
Burwood North Station	• Temporary removal of around six on-street parking spaces on Loftus Street for the duration of Stage 1 construction • Permanent removal of Neichs Lane between Parramatta Road and Burwood Road.
Five Dock Station	• Temporary removal of around 12 on-street car parking spaces along Great North Road adjacent to the Five Dock Station western construction site for the duration of Stage 1 construction • Temporary removal of around 10 on-street car parking spaces on Waterview Street and Second Avenue adjacent to the Five Dock Station eastern construction site for the duration of Stage 1 construction • Permanent removal of around 12 restricted off-street parking spaces accessible from Second Avenue.
The Bays Station	• No modifications as part of Stage 1. The realignment of the Port Access Road and reconfiguration of Solomons Way would be subject to a separate approval process.

Public transport modifications

It is anticipated that some modifications would be needed to the public transport network to facilitate construction of Stage 1. These modifications are outlined in Table 9-12. The modifications would be reviewed during detailed design with the objective of minimising disruptions to public transport services. Final locations for relocation of public transport infrastructure would be determined in consultation with Transport for NSW, transport operators and local councils.

Table 9-12: Indicative modifications to public transport during construction

Construction site	Indicative public transport network modifications
Westmead metro station	• Relocation of bus stops on Alexandra Avenue between Hawkesbury Road and Hassall Street to the east of the Alexandra Avenue/Hassall Street intersection for the duration of Stage 1 construction. The final location of these bus stops would be determined as part a future stage
Parramatta metro station	• No modifications
Clyde stabling and maintenance facility	• No modifications
Silverwater services facility	• No modifications
Sydney Olympic Park metro station	• No modifications
North Strathfield metro station	• Temporary relocation of the bus stop on the western side of Queen Street north of Wellbank Street for the duration of Stage 1 construction • Reconfiguration of stairs and vertical transport connections from the existing North Strathfield Station to Queen Street to maintain access for the duration of Stage 1 construction
Burwood North Station	• Temporary relocation of bus stops along the northern and southern side of Parramatta Road and the eastern side of Burwood Road (adjacent to both the north and south sites) for the duration of Stage 1 construction
Five Dock Station	• No modifications
The Bays Station	• No modifications

Pedestrian and cyclist facilities

It is anticipated that some modifications would be needed to pedestrian and cyclist facilities to facilitate construction of Stage 1. These modifications are outlined in Table 9-13. The modifications would be reviewed by the construction contractor during detailed design and/or during the preparation of construction traffic management plans, with the objective of minimising disruptions to pedestrians and cyclists.

Table 9-13: Indicative modifications to pedestrian and cyclist facilities during construction

Construction site	Indicative pedestrian and cyclist network modifications
Westmead metro station	• Construction of a temporary pedestrian footpath to the existing Westmead Station on Alexandra Avenue between Hassall Street and Hawkesbury Road for the duration of Stage 1 construction • Relocation of bicycle racks and lockers on the northern side of Alexandra Avenue near the existing Westmead Station for the duration of Stage 1 construction.
Parramatta metro station	• Temporary closure of pedestrian and cyclist routes on Horwood Place for the duration of Stage 1 construction • Closure of Batman Walk between Macquarie Street and Macquarie Lane
Clyde stabling and maintenance facility	• Closure of the footpaths on Unwin Street and Kay Street
Silverwater services facility	• No modifications
Sydney Olympic Park metro station	• Pedestrianisation of Showground Road
North Strathfield metro station	• Temporary closure of the footpath along the western side of Queen Street adjacent to the construction site between Wellbank Street and Pomeroy Street for the duration of Stage 1 construction • Temporary relocation of pedestrian crossing across Queen Street from the north of Wellbank Street to the south of Wellbank Street for the duration of Stage 1 construction
Burwood North Station	• No modifications
Five Dock Station	• No modifications
The Bays Station	• No modifications

9.6.8 Construction plant and equipment

Plant and equipment likely to be used during construction are listed in Table 9-14. This list is indicative only. Actual plant and equipment used on site and the numbers required would be further refined during the detailed design phase of Stage 1.

Table 9-14: Indicative construction plant and equipment

Plant and equipment	Westmead metro station	Parramatta metro station	Clyde stabling and maintenance facility	Silverwater services facility	Sydney Olympic Park metro station	North Strathfield metro station	Burwood North Station	Five Dock Station	Services facility between Five Dock and The Bays	The Bays Station
Excavator	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Concrete cutter	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Jackhammer	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Diesel generator	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Compressor	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mobile crane	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water treatment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Piling rig	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Vibratory pile driver			✓							
Concrete boom pump	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pumps	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Articulated dump truck	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Frontend loader	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bulldozer	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Crawler crane	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Conveyors	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Air track drill	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Shotcrete robot	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dust scrubber	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ventilation fan	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mobile elevated work platforms	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Roadheader	✓		✓				✓	✓		
Rock breaker	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Jumbo drill rig	✓		✓	✓	✓		✓	✓	✓	✓
Subsurface concrete truck	✓		✓	✓	✓		✓	✓	✓	✓
Concrete pump	✓		✓	✓	✓		✓	✓	✓	✓
Portal crane	✓		✓	✓	✓		✓	✓	✓	✓
Flatbed trucks										✓
Access lift										✓
Tele-handler										✓
Front-end loader			✓							
Scraper			✓							
Grader			✓							

Plant and equipment	Westmead metro station	Parramatta metro station	Clyde stabling and maintenance facility	Silverwater services facility	Sydney Olympic Park metro station	North Strathfield metro station	Burwood North Station	Five Dock Station	Services facility between Five Dock and The Bays	The Bays Station
Backhoe			✓							
Vibratory roller			✓							
Steel drum roller			✓							
Compactor			✓							
Ballast tamper			✓							

9.6.9 Construction workforce

Table 9-15 provides a breakdown of the peak construction workforce numbers across the alignment. Sydney Metro has developed a Workforce Development and Industry Participation strategy which includes objectives to support local employment and business opportunities, provide skills development and increase workplace diversity.

Table 9-15: Construction workforce

Construction site	Peak workforce numbers
Westmead metro station	330
Parramatta metro station	150
Clyde stabling and maintenance facility	300
Silverwater services facility	40
Sydney Olympic Park metro station	370
North Strathfield metro station	150
Burwood North Station	150
Five Dock Station	190
Services facility between Five Dock and The Bays	40
The Bays Station	330

9.6.10 Demobilisation, rehabilitation and handover

At the end of the Stage 1 construction phase, the contractor(s) would demobilise all construction equipment, site sheds and other temporary construction site elements not required for future construction stages, and stabilise the construction sites prior to the construction of future stages.

Where elements (such as acoustic sheds, site offices and amenities) are required for future stages of construction, these may be retained on site at the completion of Stage 1.

9.7 Construction Environmental Management Framework

A Construction Environmental Management Framework was developed and successfully implemented as part of the Sydney Metro Northwest and Sydney Metro City & Southwest projects. This framework has been reviewed and amended to be applicable to Stage 1 and is provided in Appendix D.

The Construction Environmental Management Framework details environmental, management systems and processes for construction of Stage 1. Specifically, it details the requirements in relation to the content of the construction environmental management plan, sub-plans and other supporting documentation for each specific environmental aspect.

Part A | Introduction and context

1 Introduction

10 Transport and traffic – Stage 1

This chapter provides an assessment of the potential impact of Stage 1 on transport and traffic and identifies mitigation measures to address these impacts. This chapter draws on information in Technical Paper 1 (Transport and traffic).

10.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to transport and traffic, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 10-1.

Table 10-1: Secretary's Environmental Assessment Requirements – Transport and traffic Stage 1

Reference	Requirement	Where addressed
5. Transport and Traffic		
5.1	Commitments made in Section 9.1.2 of the Scoping Report.	Sections 10.6 to Section 10.15 Refer to Table 2 of Appendix A for Scoping Report requirements
5.2	Transport and traffic (vehicle, pedestrian and cyclists) impacts of construction, including, but not necessarily limited to: a. a considered approach to route identification and scheduling of construction vehicle movements;	Section 10.4
	b. the indicative daily number, frequency and size of construction related vehicles (passenger, commercial and heavy vehicles, including spoil management movements) across the construction schedule;	Sections 10.6 to Section 10.15
	c. the nature of existing traffic (types and number of movements) on construction access routes (including consideration of peak traffic times and sensitive road users and parking arrangements);	
	d. construction worker parking;	Section 10.5
	e. access constraints and impacts on public transport (infrastructure and services), pedestrians and cyclists and property; and	Sections 10.6 to Section 10.15
	f. the need to close, divert or otherwise reconfigure elements of the road, pedestrian and cycle network associated with construction of the project and the duration of these changes; and	
	g. impacts to on-street parking, loading, servicing and pick up, including to residents and businesses.	

10.2 Legislative and policy context

The Transport for NSW Traffic Modelling Guidelines (2013) were developed to provide consistency in traffic modelling practice and promote high quality model outputs. The approach to traffic modelling for this assessment aligns with the Traffic Modelling Guidelines and includes the following broad steps:

- Development of calibrated and validated base models to align with existing operational conditions along each construction vehicle route
- Development of future year base models to align with anticipated operational conditions in the year of peak construction activity (2023), including road network changes as a result of the future Parramatta Light Rail (Stage 1) and the operation of WestConnex (M4 East)
- Application of anticipated construction traffic demands to the future year base models to allow the identification of potential impacts to road network performance.

10.3 Assessment approach

10.3.1 Method

Overview

The methodology includes assessing project wide construction transport and traffic impacts, across the Stage 1 corridor, followed by a detailed analysis of impacts surrounding each construction site. The project wide impacts considered include:

- Pedestrian, cyclist, motorist safety
- Emergency services access
- Major special events
- Construction worker parking
- Spoil transport options.

The assessment methodology for construction transport and traffic impacts at each Stage 1 construction site considered five core components:

- Active transport network (pedestrians and cyclists)
- Public transport services
- Road network performance
- Parking
- Property access.

The method of assessment and assessment outputs for each of these components are summarised in Table 10-2. The modelling methodology for road traffic is described in more detail in Technical Paper 1 (Transport and traffic).

Table 10-2: Overview of approach to the construction transport and traffic assessment

Assessment component	Method of assessment	Assessment output
Active transport network	Analysis of changes to shared user paths, cycle ways, footpaths and pedestrian crossings.	Qualitative assessment of impacts on pedestrian and cycling networks and accessibility.
Public transport services	Analysis of changes to public transport routes and public transport stops, and service timeliness and efficiency.	Qualitative assessment of impacts on public transport performance (increase or decrease in travel times).
Road traffic	Analysis of road network performance based on traffic modelling.	Quantitative assessment of road network performance with and without Stage 1 construction traffic.
Parking	Analysis of number of removed parking spaces and availability of comparable alternative parking in nearby locations.	Qualitative assessment of parking availability during Stage 1 construction.
Property access	Analysis of existing access provisions and a comparison with access provisions during construction.	Qualitative assessment of property access during construction of Stage 1.

Consultation has been undertaken with other relevant parts of Transport for NSW including Transport Coordination.

Road traffic assessment methodology

The construction traffic impact assessment is based on the analysis of existing traffic movements on the road network near each Stage 1 construction site to determine the current operational performance and model future operational performance without Stage 1. Construction traffic from Stage 1 was then added to the existing network and analysed to identify potential impacts. The approach to traffic modelling carried out for this assessment aligns with the Transport for NSW Traffic Modelling Guidelines (2013).

For the purposes of this assessment, it was assumed that all spoil would be transported from each Stage 1 construction site by truck. As such, this assessment provides a potential worst-case assessment of road-based traffic. The use of other methods of transport, such as train or barge, may be possible subject to further investigation which would reduce the potential road traffic impacts as described in this chapter. Refer to Chapter 9 (Stage 1 description).

Consistent with the standard approach for traffic assessments on major infrastructure projects, traffic modelling was carried out for the AM (7-9 am) and PM (4-6 pm) peak periods only. These peak traffic periods represent a worst-case scenario because during these periods the road network experiences the maximum background traffic demand and the available spare capacity on the road network is at its most limited.

To assess the impact of the construction activities on the road network performance, intersections along the proposed construction routes between Stage 1 construction sites and the arterial road network were assessed using Aimsun modelling software. Vissim modelling software was used for The Bays Station construction site to provide consistency with existing modelling carried out for other major transport infrastructure projects in the Rozelle area. The main performance indicators for the modelling software was Intersection level of service (LoS) which measures the overall performance of the intersection. For this purpose, average delay from *Guide to Traffic Generating Developments* (Roads and Traffic Authority, 2002) was used. Criteria for these performance indicators are provided in Table 10-3. Additional intersection performance indicators are report in Technical Paper 1 (Transport and traffic).

Table 10-3: Level of service criteria

Level of service	Average delay (seconds per vehicle)	Traffic signals and roundabout operations
A	Less than 14	Good operation
B	15 to 28	Good with acceptable delays and spare capacity
C	29 to 42	Satisfactory
D	43 to 56	Operating near capacity
E	57 to 70	At capacity; at signals incidents will cause excessive delays
F	Greater than 70	Exceeds capacity; roundabouts require other control mode

Cumulative impact assessment methodology

Cumulative impacts have been assessed through a qualitative analysis and the use of traffic modelling (where available) to determine the performance of the road network with construction vehicle movements associated with other major projects expected to be occurring at the same time as Stage 1 based on current publicly available information.

10.3.2 Assumptions

Construction hours

As identified in Chapter 9 (Stage 1 description), tunnelling and station excavation activities would be carried out up to 24 hours per day and seven days per week. These activities would require construction vehicles for material supply and spoil removal, to also occur up to 24 hours per day and seven days per week.

The proposed timing of vehicle movements throughout the day for each construction site is identified for each construction site in Sections 10.6 to 10.15. The development of these truck movements has aimed to minimise movements during the AM (7-10 am) and PM (4-6 pm) peak traffic periods and during the night-time period.

Construction vehicles

Table 10-4 identifies the truck type for each Stage 1 construction site for spoil transport and the delivery of construction materials and equipment that has been assumed in the assessment. In some locations (such as at North Strathfield and Five Dock), further assessment is being undertaken to determine the suitability of using rigid truck and dog trailers.

Table 10-4: Construction vehicle types

Construction site	Truck type[1]
Westmead metro station	Rigid truck and/or truck and dog
Parramatta metro station	Rigid truck and/or truck and dog
Clyde stabling and maintenance facility	Rigid truck and/or truck and dog
Silverwater services facility	Rigid truck and/or truck and dog
Sydney Olympic Park metro station	Rigid truck and/or truck and dog
North Strathfield metro station	Rigid truck and/or truck and dog
Burwood North Station	Rigid truck and/or truck and dog Medium rigid truck
Five Dock Station	Rigid truck and/or truck and dog
The Bays Station	Rigid truck and/or truck and dog

Note 1: A truck and dog is the common term for a tipper truck and trailer.

10.4 Avoidance and minimisation of impacts

The design development of Stage 1 has included a focus on avoiding or minimising potential transport and traffic impacts. This has included:

- Minimising rail corridor works to reduce disruption to existing train stations and the T1 Western Line and T9 Northern Line operations
- Modifying the design to minimise impacts to existing commuter car parking around Westmead Station and town centre
- Locating the Parramatta metro station away from the existing Parramatta Station to avoid disrupting Sydney Trains operations at one of the busiest stations on the suburban rail network
- Adopting a cavern typology at Five Dock Station to minimise impacts to Great North Road
- Selecting tunnel boring machine launch, retrieval and support sites to allow tunnel spoil and transport of other materials to be managed away from busy CBD locations. Haulage routes have been developed to provide the most efficient route to the arterial road network
- Developing haulage routes in consultation with relevant sections of Transport for NSW including Transport Coordination that would minimise the use of local roads and use the most efficient route to the arterial road network.

10.5 Project wide impacts

10.5.1 Existing regional transport and traffic environment

The existing transport and traffic environment is considered from a regional perspective in Section 8.1.3 of Chapter 8 (Concept environmental assessment).

10.5.2 Pedestrian, cyclist and motorist safety

Access and egress arrangements at construction sites have been developed with consideration of pedestrian, cyclist and motorist safety. For example, the need for construction vehicles to perform a right turn to or from an arterial road to access a construction site has been avoided where possible.

Appropriate controls would be established where vehicles are required to cross footpaths to access construction sites. This may include manual supervision, physical barriers or temporary traffic signals as required. Road safety reviews or audits would be carried out at each of the construction site.

Options to further enhance pedestrian, cyclist and motorist safety near construction sites are currently being considered. This includes consideration of measures such as:

- Assessing the suitability of construction haulage routes through sensitive land use areas with respect to road safety
- Deployment of speed awareness signs in conjunction with variable message signs near construction sites to provide alerts to drivers
- Providing community education and awareness about sharing the road safely with heavy vehicles
- Specific construction driver training to understand route constraints, safety and environmental considerations such as sharing the road safely with other road users and limiting the use of compression braking
- Requiring the use of technology and equipment to improve vehicle safety, eliminate heavy vehicle blind spots, and monitor vehicle location and driver behaviour.

The introduction of additional heavy vehicles on the road network may introduce safety risks to pedestrians, cyclists and other motorists, especially where there is an increased likelihood for interaction with pedestrians and cyclists.

Key locations where pedestrian and cyclist safety issues may arise include:

- Construction site access and egress points where construction vehicles would interface with pedestrians using surrounding footpaths. This would be especially important in Westmead, Parramatta, Sydney Olympic Park, North Strathfield and Five Dock, where there are high volumes of pedestrians
- Construction sites where access and egress points, or construction vehicle routes would interface with marked cycle routes. This would occur at the Parramatta metro station, Sydney Olympic Park metro station, Burwood North Station, and Five Dock Station construction sites
- Locations where footpath widths are reduced around construction sites.

10.5.3 Emergency services access

The introduction of construction traffic is anticipated to result in minor impacts to the surrounding intersection performance. As such, there is not anticipated to be any substantial change to emergency vehicle access, except at the Westmead metro station construction site. Construction sites would be arranged so that emergency vehicle access to nearby buildings and the surrounding areas is maintained. Construction sites may also be made available for emergency vehicle passage if required. Consultation would be carried out with emergency service providers in relation to changed traffic conditions. This is particularly important in Westmead due to the close proximity of the Westmead metro station construction site to the Westmead health precinct.

10.5.4 Major special events

A large number of special events occur within the Parramatta CBD and Sydney Olympic Park precinct. Special events are also held at the Rosehill Gardens racecourse and sporting events are held at Leichhardt Oval.

The Transport for NSW special events management guidelines 2018, identifies the following classes of special events:

- Class 1: an event that impacts major transport systems and traffic and there is significant disruption to the non-event community. For example, an event that affects a principal transport route in Sydney, or one that reduces the capacity of the main highway through a country town
- Class 2: is an event that impacts local transport systems and traffic and there is low scale disruption to the non-event community. For example, an event that blocks off the main street of a town or shopping centre but does not impact a principal transport route or highway
- Class 3: is an event with minimal impact on local roads and negligible impact on the non-event community. For example, an on-street neighbourhood Christmas party
- Class 4: is an event that is conducted entirely under Police control (but is not a protest or demonstration). For example, a small march conducted with a Police escort.

Liaison would occur with event organisers of Class 1 and 2 events, and (as relevant) Transport for NSW including Transport Coordination, to provide appropriate management of construction vehicle movements to address potential impacts to event patrons, the public and the construction works. This may involve measures such as temporary adjustment to construction vehicle routes, construction working hours or potentially stopping works for the duration of the event.

Construction activities on road corridors would require a Road Occupancy Licence to close the road or lane for any period. The granting of a Road Occupancy Licence would generally be subject to network operation restrictions, which would preclude road closures during high-activity holidays such as New Year's Eve, or during the set up and pack down times for major events such as sports grand finals or during major road closures. Special events and the impact to transport and traffic is particularly important around the Parramatta metro station construction site and the Sydney Olympic Park metro station construction site.

Major special events near the Parramatta metro station construction site are shown in Table 10-5.

Table 10-5: Major special events in the Parramatta CBD

Indicative month	Event	Location
December/January	New Year's Eve	Centenary Square
January	Australia Day	Parramatta Park
February	Lunar New Year	Centenary Square
February	Tropfest	Parramatta Park
March	Parramasala	Prince Alfred Square
July	Winterlight Festival	Prince Alfred Square
July	Burramatta NAIDOC	Parramatta River Foreshore
October	Parramatta Lanes Festival	Throughout Parramatta CBD
November	Loy Krathong: Thai Water Festival	Parramatta River Foreshore
November	Christmas in Parramatta	Centenary Square
Year-round	Various sporting events	Western Sydney Stadium

There are more than 5,000 events of varying size are held each year at Sydney Olympic Park, with the existing Sydney Olympic Park Station being a major transport focus for access to and from these events. Larger events held within the precinct are shown in Table 10-6.

Table 10-6: Major special events in Sydney Olympic Park

Indicative month	Event	Location
April	Sydney Royal Easter Show	Sydney Showground
June	Supanova Comic Con and Gaming	Sydney Showground
January	The Sydney International	Sydney Olympic Park Tennis Centre
January	Sydney Festival	Sydney Olympic Park
Year-round	Music concerts	Throughout Sydney Olympic Park
Year-round	Football matches (Rugby Union, Rugby League, Australian Football League)	ANZ Stadium
Year-round	Soccer matches	ANZ Stadium
Year-round	Other sporting events	Various stadiums, Arenas and centres

10.5.5 Construction worker parking

Due to the generally constrained nature of the construction sites, car parking for construction workers would not be provided at most of the Stage 1 construction sites. With the exception of the Clyde stabling and maintenance facility construction site, each Stage 1 construction site would typically provide a limited number of parking spaces intended to be used by trade vehicles or other light vehicles that are required for travel between construction sites.

Most construction sites are near public transport services and construction workers would be encouraged to use these services. At The Bays Station construction site, the feasibility of providing shuttle bus services to transfer construction workers to and from major transport interchange(s) would be considered.

10.5.6 Spoil transport options

Road would be the primary transport method for transporting spoil from most construction sites. Road transport is considered feasible for all construction sites due to their location directly adjacent to the existing road network, in particular the proximity to the motorway and arterial road network. Opportunities to reuse spoil at the Clyde stabling and maintenance facility construction site would be maximised to minimise the number of required road based trips.

Other options for the transport of spoil by barge and trains have also been considered and are discussed further in Chapter 3 (Sydney Metro West development and alternatives).

10.6 Westmead metro station construction site

10.6.1 Existing environment

The Westmead metro station construction site is bound by Hawkesbury Road, Bailey Street, Hassall Street and the existing rail corridor. The location of the construction site and the surrounding transport network are shown on Figure 10-1.

Figure 10-1: Westmead metro station construction site transport network

Active transport network

Footpaths are provided along all roads near the construction site. High levels of pedestrian activity occur around the existing Westmead Station and the Westmead health and education precinct located about 400 metres north of the construction site. Darcy Road is a signposted High pedestrian activity area between east of Bridge Road and Hawkesbury Road.

Pedestrian crossings are provided at the following locations:

- Signalised crossings at the Hawkesbury Road/Alexandra Avenue intersection, the Hawkesbury Road/Railway Parade intersection and Hawkesbury Road/Darcy Road intersections (including a staged pedestrian crossing on the western approach of the Hawkesbury Road/Darcy Road intersection to accommodate bus lanes)
- Zebra crossings across Queens Road, across Railway Parade and across Hawkesbury Road (adjacent to Westmead Hospital car park and emergency area).

The cycle network surrounding the construction site includes:

- On-road route along Queens Road and within Parramatta Park
- Off-road shared paths on Mons Road, Darcy Road and Hawkesbury Road
- A separated on-road bicycle lane on the north side of Queens Road
- A marked cycle path adjacent to the zebra crossing across Hawkesbury Road near Queens Road
- Bicycle racks and lockers located on Railway Parade and Alexandra Avenue near Westmead Station.

Public transport services

A summary of the public transport services around the Westmead metro station construction site is provided in Table 10-7.

Table 10-7: Westmead metro station construction site existing public transport services

Public transport mode	Description
Rail	• Sydney Trains suburban rail network – T1 Western Line and T5 Cumberland Line • NSW TrainLink network – Blue Mountains Line • The future Parramatta Light Rail (Stage 1) including a Westmead Station stop (currently under construction)
Bus	• 14 bus routes (including two NightRide bus routes) • 17 school bus routes • One bus transitway (North-West Transitway) • Major bus stops on Darcy Road, Hawkesbury Road, Alexandra Avenue and Park Parade

Road traffic volume and patterns

The Great Western Highway is a major arterial road that carries a high volume of traffic through the road network surrounding the construction site. Hawkesbury Road (collector road) and Alexandra Avenue (sub-arterial road) form part of the North-West Transitway bus rapid transit route near the construction site. Key local roads near the construction site include Hassall Street (local road) and Railway Parade (local road).

During the morning peak hour, higher traffic volumes are experienced on the following routes near the construction site:

- Eastbound traffic on the Great Western Highway and Alexandra Avenue
- Northbound traffic on Hawkesbury Road and Hassall Street.

During the evening peak hour, higher traffic volumes are experienced on the following routes near the construction site:

- Westbound traffic on the Great Western Highway and Alexandra Avenue
- Southbound traffic on Hawkesbury Road and Hassall Street.
- The existing traffic volumes on the surrounding road network are provided in Table 10-8.

Table 10-8: Westmead metro station construction site existing traffic volumes (2019)

Road	Direction	Morning peak hour (vehicles per hour)	Evening peak hour (vehicles per hour)
Alexandra Avenue east of Hawkesbury Road	Eastbound	520	430
	Westbound	410	520
Great Western Highway west of Hawkesbury Road	Eastbound	1,770	1,100
	Westbound	1,100	2,570
Grand Avenue west of Hawkesbury Road	Eastbound	130	10
	Westbound	60	90
Bailey Street east of Hawkesbury Road	Eastbound	40	40
	Westbound	60	210
Hawkesbury Road south of Alexandra Avenue	Northbound	760	440
	Southbound	390	620
Hassall Street south of Alexandra Avenue	Northbound	520	130
	Southbound	160	450
Bridge Road north of Grand Avenue	Northbound	670	480
	Southbound	490	600

Intersection performance

Modelled intersection performance during the morning and evening peak hours for key intersections near the Westmead metro station construction site is shown in Table 10-9.

The existing performance of Hawkesbury Road/Grand Avenue and Hawkesbury Road/Bailey Street is due to these intersections not being signalised where the worst movement is reported, which for both intersections corresponds to vehicles turning out of Grand Avenue or Bailey Street onto Hawkesbury Road. Grand Avenue and Bailey Street are minor roads and therefore vehicles must give way to vehicles travelling on Hawkesbury Road. In addition, northbound queues at these intersections are the result of downstream queues from the Hawkesbury Road / Alexandra Avenue intersection.

High traffic volumes on most approaches at the Hawkesbury Road/Great Western Highway/Coleman Street intersection contributes to its existing performance during both peak hours.

At the Bailey Street / Hassall Street intersection, existing queuing along Hassall Street is the result of downstream queues from the Alexandra Avenue / Hassall Street intersection (northbound) and the Hawkesbury Road / Bailey Street intersection (westbound), due to vehicles avoiding the Hawkesbury Road / Alexandra Avenue intersection.

Table 10-9: Modelled peak hour existing intersection performance – Westmead metro station construction site (2019)

Intersection	Peak hour	Demand flow (vehicles per hour)	Average delay (second per vehicle)	Level of service
Hawkesbury Road/Alexandra Avenue	Morning	2,310	36	C
	Evening	2,259	45	D
Hawkesbury Road/Grand Avenue	Morning	1,264	79	F
	Evening	1,349	47	D
Hawkesbury Road/Bailey Street	Morning	1,246	25	B
	Evening	1,420	80	F
Hawkesbury Road/Priddle Street	Morning	1,245	10	A
	Evening	1,269	7	A
Hawkesbury Road/Amos Street	Morning	1,386	10	A
	Evening	1,388	45	D
Hawkesbury Road/Great Western Highway/Coleman Street	Morning	3,605	66	E
	Evening	3,825	>100	F
Bailey Street/Hassall Street	Morning	708	16	B
	Evening	646	5	A
Alexandra Avenue/Hassall Street	Morning	1,426	22	B
	Evening	1,405	13	A
Alexandra Avenue/Bridge Road	Morning	1,549	23	B
	Evening	1,422	10	A
Bridge Road/Grand Avenue	Morning	1,626	21	B
	Evening	1,408	46	D

On-street parking, loading, servicing and pick-up arrangements

On-street parking is provided on both sides of most local roads and is generally time-restricted to two hours on weekdays and Saturdays. Near the construction site, on-street parking is provided on the eastern side of Hawkesbury Road south of Alexandra Avenue. On-street parking is not provided on Alexandra Avenue between Hawkesbury Road and Hassall Street and on Hawkesbury Road between Alexandra Avenue and Queens Road. East of Hassall Street, on-street parking is provided along the southern side of Alexandra Avenue. North of the rail line, unrestricted 90-degree parking is provided along the southern side of Railway Parade, primarily serving commuters using Westmead Station.

Point to point transport service zone is located on the northern side of Railway Parade between Hawkesbury Road and Ashley Lane and a mail zone is located on the northern side of Alexandra Avenue near the existing Westmead Station entrance. There are no kiss and ride or loading zones on the roads immediately surrounding the construction site.

10.6.2 Potential impacts

Vehicle movement forecast and routes

The anticipated vehicle (light and heavy) one way movements at the construction site over a typical day are provided in Figure 10-2 and Figure 10-3 respectively.

The proposed primary haulage route is shown in Figure 10-4. Access to and egress from the construction site would be left in from Bailey Street and left out to Hawkesbury Road. The primary haulage route uses Hawkesbury Road to access the M4 Western Motorway to the south.

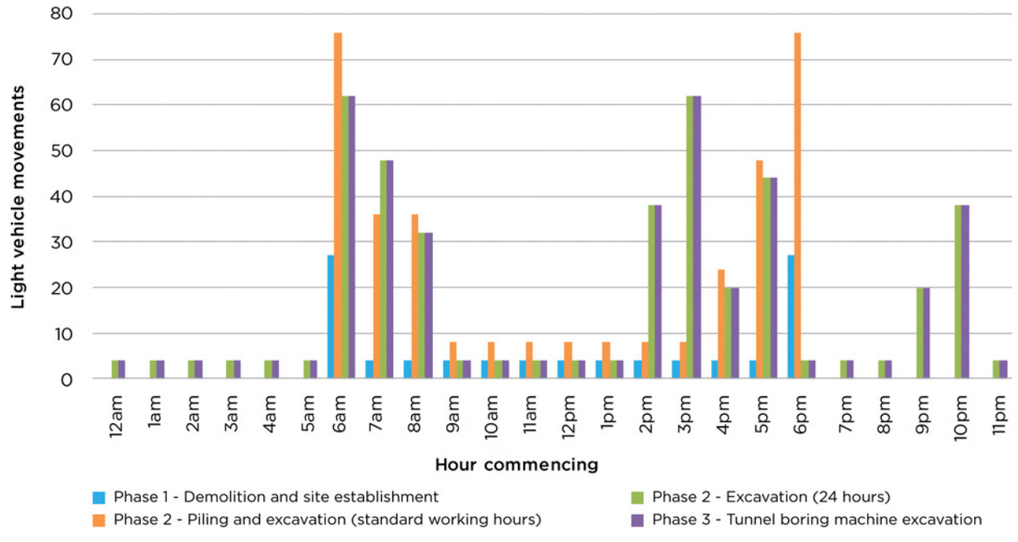


Figure 10-2: Hourly light vehicle movements at the Westmead metro station construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

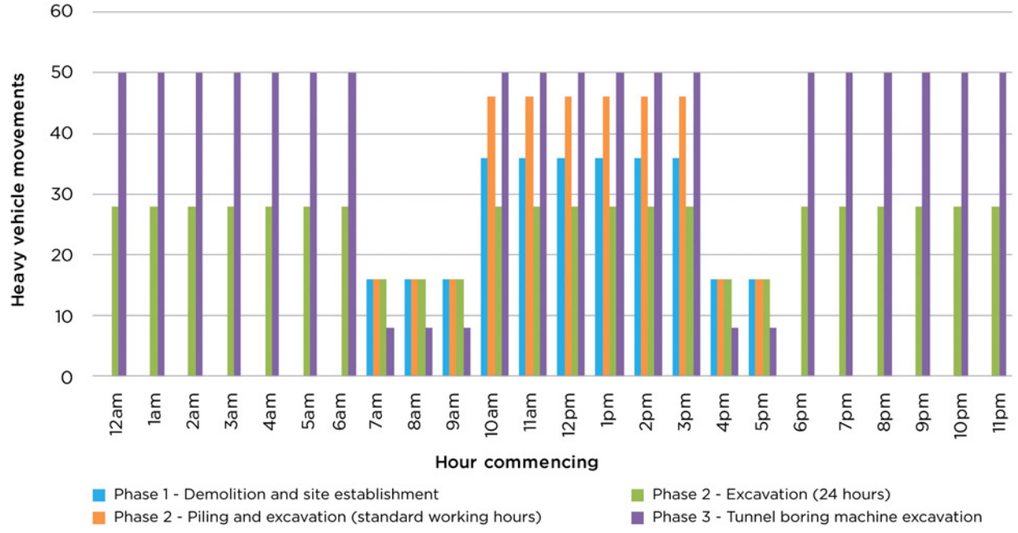


Figure 10-3: Hourly heavy vehicle movements at the Westmead metro station construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

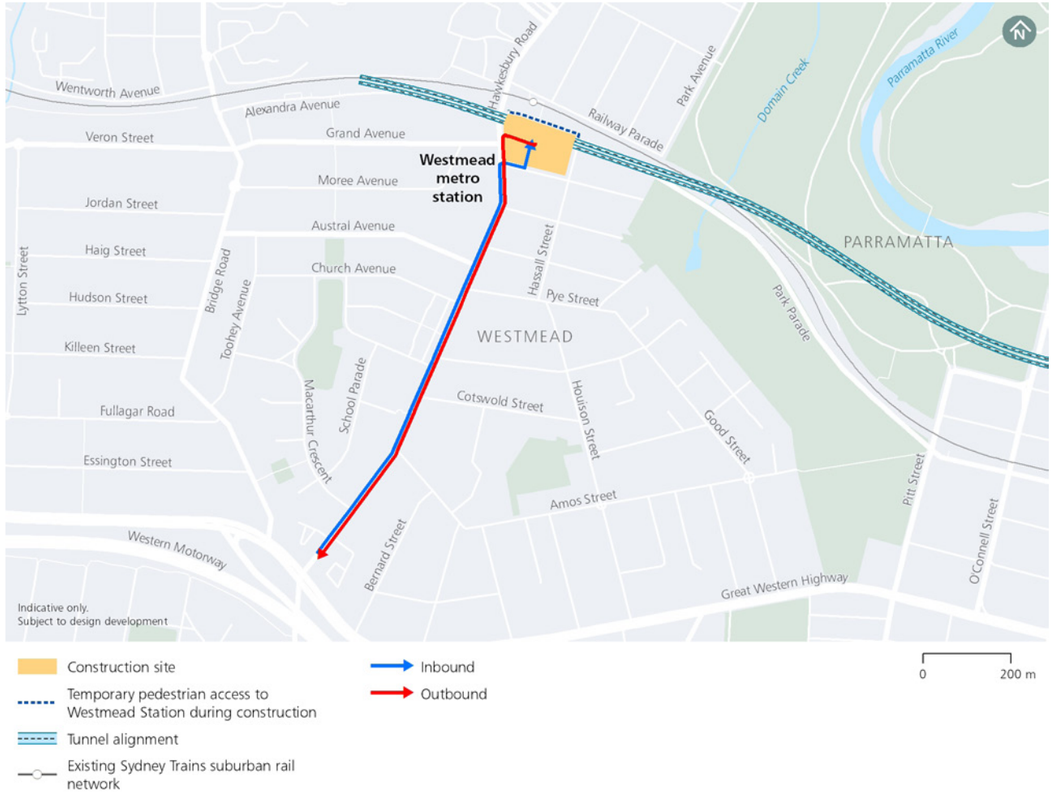


Figure 10-4: Westmead metro station construction site primary haul route

Active transport network

Overall, impacts to the pedestrian network would be minimal. East-west connectivity along the northern side of the construction site, and access to the existing Westmead Station would be maintained via a temporary pedestrian footpath, although there may be some periods when pedestrian access to the southern entrance to the existing Westmead Station would be restricted.

Existing signalised pedestrian crossings at modified intersections including Hawkesbury Road/Alexandra Avenue and Alexandra Avenue/Hassall Street would be maintained. The introduction of traffic signals and signalised pedestrian crossings at the Hawkesbury Road/Bailey Street intersection and Bailey Street/Hassall Street intersection would improve conditions for pedestrians.

Footpaths on both sides of Alexandra Avenue between Hawkesbury Road and Hassall Street would be temporarily closed during construction.

The bicycle racks and lockers located on the northern side of Alexandra Avenue near the existing Westmead Station may be temporarily relocated. If required, these facilities would be relocated close to their current location and therefore the potential impact to cyclists is expected to be minor.

Public transport services

A summary of the potential impacts to public transport services around the Westmead metro station construction site is provided in Table 10-10.

Table 10-10: Westmead metro station construction site public transport impacts

Public transport mode	Impact description
Rail	• No impact to services. If works are required within the rail corridor, these works would be carried out during rail track possessions.
Bus	• Potential temporary minor increase in travel time due to additional construction vehicles on the road network • Minor temporary impact as buses currently travelling along Alexandra Avenue east of Hawkesbury Road would be detoured along Hassall Street, Bailey Street and Hawkesbury Road • Minor temporary impacts as bus stops on Alexandra Avenue between Hawkesbury Road and Hassall Street would be relocated. Some customers may be required to walk an additional distance to alternative bus stops. The location of the relocated bus stops would be determined in consultation with Transport for NSW, City of Parramatta, and relevant bus operators.

Road network performance

Potential impacts to road network performance would be minimised through the implementation of the Construction Traffic Management Framework and mitigation measures identified in Section 10.16. This includes reducing vehicle movements in network peak periods and during school drop off and pick up periods.

Stage 1 would result in both temporary and permanent impacts on the surrounding road network.

Alexandra Avenue would be closed between Hassall Street and Hawkesbury Road during Stage 1 construction works and traffic would be temporarily diverted via Hassall Street and Bailey Street, with new and altered traffic signals provided where required.

At the end of Stage 1 construction works at the Westmead metro station construction site, Alexandra Avenue would be permanently realigned between Hassall Street and Hawkesbury Avenue, including a new signalised intersection at Alexandra Avenue, Hawkesbury Road and Grand Avenue.

Impacts associated with the temporary road network changes

Figure 10-5 shows the anticipated performance of key intersections in the year 2023 with and without Stage 1, for the temporary road network arrangement. Additional intersection performance indicators are provided in Technical Paper 1 (Transport and traffic).

Analysis of modelled intersection performance results shows that at some locations, changes to the road network to accommodate construction activities and the addition of construction traffic would result in an improvement in intersection performance.

Modification of the Hawkesbury Road/Alexandra Avenue intersection would improve its efficiency and overall intersection performance, and would lead to lower delays at the Hawkesbury Road/Grand Avenue and Hawkesbury Road/Bailey Street intersections. Similarly, modification of the Alexandra Avenue/Hassall Street intersection would result in lower delays to vehicles as the only conflicting movement is when a pedestrian phase is called during a signal cycle.

The improved performance of the Alexandra Avenue/Bridge Road intersection is due to Alexandra Avenue carrying a lower number of vehicles during construction, as (depending on destination) some detoured vehicles would preference Grand Avenue when travelling west of Hawkesbury Road.

The closure of Alexandra Avenue between Hawkesbury Road and Hassall Street would require vehicles to be temporarily rerouted via Hassall Street, Bailey Street and Hawkesbury Road, resulting in an additional travel distance of about 150 metres. This is a minor impact due to the small increase in travel distance and resultant small increase in travel time.

Modelled intersection performance with construction traffic indicates that the following intersections would experience a temporary reduced level of service:

- Hawkesbury Road/Priddle Street during the morning and evening peak hour. This is due to the closure of Alexandra Avenue, resulting in vehicles performing a detour. The majority of detoured vehicles would travel on Bailey Street, however some would instead travel on Priddle Street. This intersection would still operate with spare capacity with the addition of construction traffic
- Hawkesbury Road/Amos Street during the morning and evening peak hour. This intersection would still operate with spare capacity with the addition of construction traffic during the morning peak hour. During the evening peak hour, the deterioration in performance is due to downstream congestion emanating from the Hawkesbury Road/Great Western Highway/Coleman Street intersection
- Bailey Street/Hassall Street during the morning peak hour. As discussed above, this is due to most detoured vehicles traveling on Bailey Street while Alexandra Avenue is closed. This intersection would still operate with spare capacity with the addition of construction traffic.

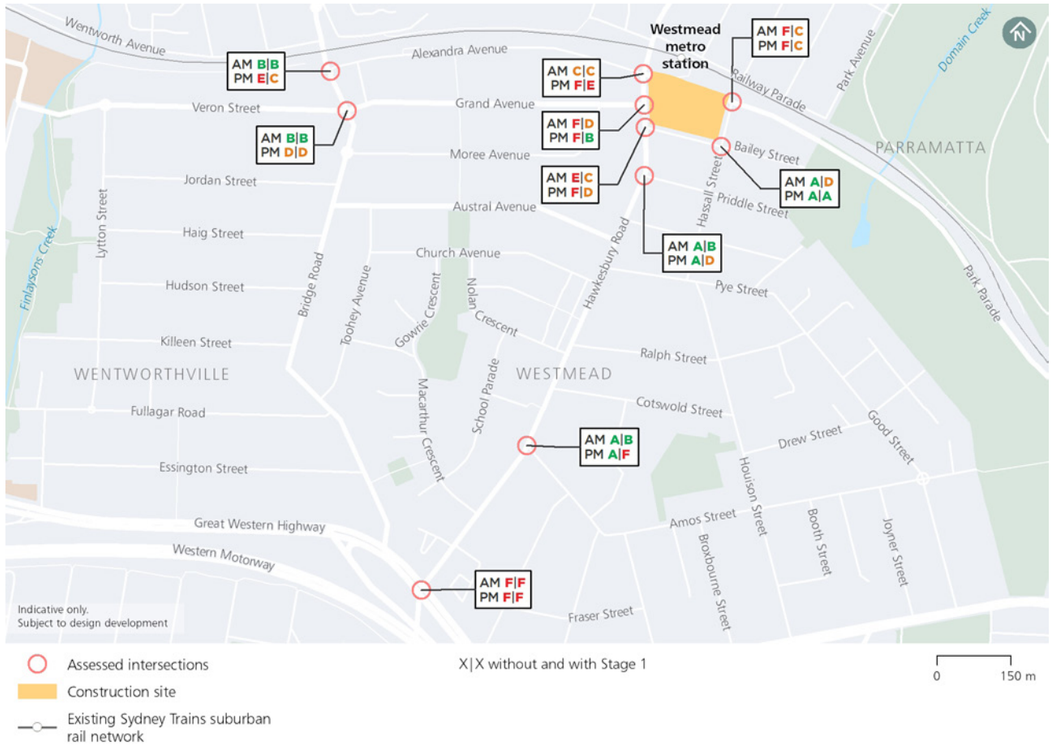


Figure 10-5: Westmead metro station construction site intersection performance (2023) (temporary)

Impacts associated with the permanent road network changes

Following station excavation and tunnelling works at Westmead metro station construction site, Alexandra Avenue would be permanently realigned to form a new intersection at Hawkesbury Road with Grand Avenue. Figure 10-6 shows the anticipated performance of key intersections in the year 2023 with and without Stage 1, for the permanent road network arrangement. Additional intersection performance indicators are provided in Technical Paper 1 (Transport and traffic).

Analysis of modelled intersection performance results shows that at some locations, the permanent realignment of Alexandra Avenue would result in an improvement in intersection performance. This is forecast to occur at the following intersections:

- Hawkesbury Road/Alexandra Avenue during the evening peak hour – from level of service F to A
- Hawkesbury Road/Grand Avenue during the morning and evening peak hour – from level of service F to C
- Hawkesbury Road/Bailey Street during the morning and evening peak hour – from level of service E to C and F to E, respectively
- Alexandra Avenue/Hassall Street during the morning and evening peak hour – from level of service F to B
- Bridge Road/Grand Avenue during the evening peak hour – from level of service D to C.

The permanent realignment of Alexandra Avenue would lead to a reduction in traffic on Hassall Street, Bailey Street and Alexandra Avenue west of Hawkesbury Road, reducing overall delays experienced at intersections along Hawkesbury Road at Alexandra Avenue, Grand Avenue and Bailey Street, and at the Alexandra Avenue/Hassall Street intersection.

Modelled intersection performance with construction traffic indicates that the following intersections would experience a reduced level of service:

- Hawkesbury Road/Priddle Street during the morning and evening peak hour – from level of service A to B and A to C, respectively. This intersection would still operate with spare capacity
- Alexandra Avenue/Bridge Road during the morning and evening peak hour – from level of service B to C and E to F, respectively. This intersection would still operate with spare capacity in the morning peak. The impact in the evening peak is due to additional vehicles travelling along Grand Avenue, and the Grand Avenue/Bridge Road intersection accommodating a higher number of vehicles with increased queue lengths on most approaches. This would result in congestion on the westbound approach of the adjacent Alexandra Avenue/Bridge Road intersection. Potential opportunities to mitigate the impacts at this intersection would be determined in consultation with relevant parts of Transport for NSW and Cumberland City Council and may include local area traffic management changes, intersection turning bans and similar
- Bridge Road/Grand Avenue during the morning peak hour – from level of service B to C. This intersection would still operate with spare capacity.

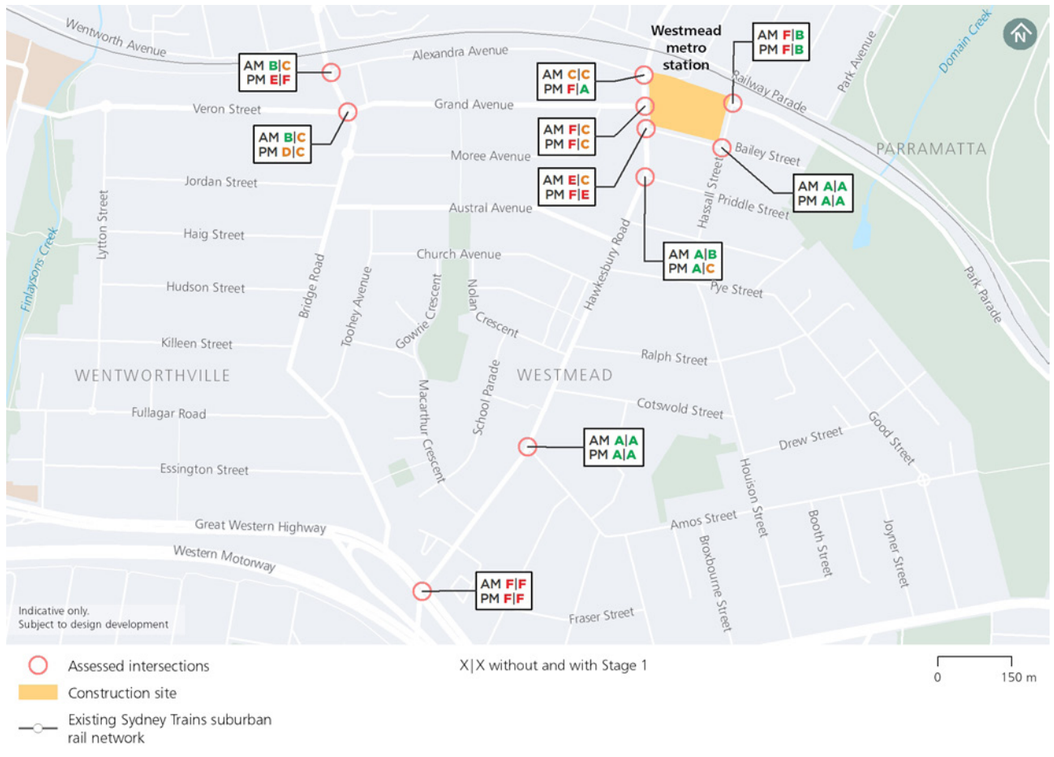


Figure 10-6: Westmead metro station construction site intersection performance (2023) (permanent)

Parking

The combined loss of on-street parking spaces would have minor impacts given the availability of parking on other local roads nearby.

On-street parking spaces would be temporarily removed along Hassall Street and Bailey Street adjacent to the construction site (about 10 parking spaces on each road). To accommodate signalisation, some additional parking spaces may be permanently removed at the Hawkesbury Road/Bailey Street (about four parking spaces) and Hassall Street/Bailey Street intersections (about 10 parking spaces).

Emergency vehicle access

Emergency response services, particularly those travelling to and from the Westmead health precinct may also be impacted by the closure of Alexandra Avenue. Emergency response vehicles that would have previously used Alexandra Avenue to travel between the Westmead health precinct and Parramatta CBD would be diverted onto Bailey Street and Hassall Street. Emergency services (Ambulance, Fire & Rescue and Police) would be consulted about the proposed road network changes during construction. The potential for ambulance services to travel through the site in specific circumstances would be further investigated during detailed construction planning.

10.7 Parramatta metro station construction site

10.7.1 Existing environment

The Parramatta metro station construction site would be located at Horwood Place and within the block bound by George Street, Church Street, Macquarie Street and Smith Street.

The location of the construction site and the surrounding transport network are shown on Figure 10-7.

Figure 10-7: Parramatta metro station construction site transport network

Active transport network

Footpaths are provided along both sides of all roads near the construction site. High levels of pedestrian activity occur around the existing Parramatta Station, bus interchange and Westfield Parramatta shopping centre. Church Street is the main north-south pedestrian route and includes a pedestrian only zone between Macquarie Street and Darcy Street. Phillip Street, George Street, Macquarie Street, Darcy Street, Hassall Street and Argyle Street provide the main east-west pedestrian routes between Parramatta Park, the Parramatta CBD and Harris Park.

Signposted high pedestrian activity areas near the construction site include:

- Church Street between Palmer Street and Macquarie Street
- Phillip Street between Marsden Street and Charles Street
- Charles Street between Phillip Street and George Street
- Horwood Place between George Street and Macquarie Street.

Pedestrian crossings are provided at the following locations:

- Signalised crossings at the Church Street/George Street intersection, the George Street/Smith Street intersection, the Macquarie Street/Smith Street intersection, the Church Street/Macquarie Street intersection, and across Macquarie Street between Church Street and United Lane
- Zebra crossings across Horwood Place and across the access road on the southern side of Macquarie Street between Horwood Place and Smith Street.

The cycle network surrounding the construction site includes:

- On-road east-west cycle route along Phillip Street, George Street and Macquarie Street, connecting to shared paths along O'Connell Street, Elizabeth Street and Macarthur Street to Parramatta River and Parramatta Park
- On-road north-south cycle routes along O'Connell Street, Horwood Place, Elizabeth Street, Smith Street and Church Street.

In the future, the active transport network will be modified in Parramatta CBD as part of the future Parramatta Light Rail (Stage 1). These changes include new pedestrian zones on Church Street and Macquarie Street, modification of scramble and midblock pedestrian crossings surrounding the construction site on Church Street, Macquarie Street, George Street and Smith Street, and adjustments to cycle routes on Macquarie Street.

Public transport services

A summary of the public transport services around the Parramatta metro station construction site is provided in Table 10-11.

Table 10-11: Parramatta metro station construction site existing public transport services

Public transport mode	Description
Rail	• Sydney Trains network – T1 Western Line, T2 Inner West and Leppington Line, T5 Cumberland Line • NSW TrainLink network – Blue Mountains Line, Western NSW Line • The future Parramatta Light Rail (Stage 1) including a new stop on Macquarie Street (currently under construction)
Bus	• 48 bus routes (including four NightRide bus routes) • 41 school bus routes • Three shuttle bus services – Parramatta CBD free public shuttle bus, Western Sydney University private shuttle, Parramatta Leagues Club private shuttle • Two bus transitways – North-West T-Way, Liverpool to Parramatta T-Way • Major bus stops on Argyle Street (Parramatta Interchange), Smith Street, Wilde Avenue, Victoria Road, Church Street • Bus lanes on Smith Street and Station Street East.
Ferry	• F3 Parramatta River Line.

Road traffic volume and patterns

The Great Western Highway is the major arterial road that carries a high volume of traffic through the road network surrounding the construction site. Key roads near the construction site include O'Connell Street (sub-arterial road), Macquarie Street (collector road), Pitt Street (sub-arterial road) and George Street (collector road). O'Connell Street operates in both directions north of Macquarie Street, and south of Macquarie Street it operates in the southbound direction only. Macquarie Street operates one-way in an eastbound direction. Prior to November 2019, George Street operated one-way in an eastbound direction however was recently converted to two-way operation between O'Connell Street and Harris Street as part of network modifications to accommodate Parramatta Light Rail (Stage1). Pitt Street operates one-way in a northbound direction, with buses only permitted to travel in a southbound direction.

During the morning peak hour, higher traffic volumes are experienced on the following routes in the vicinity of the construction site:

- Eastbound traffic on the Great Western Highway (near Pitt Street), Macquarie Street and George Street
- Northbound traffic on O'Connell Street (north of Macquarie Street) and Pitt Street
- Southbound bus traffic on Pitt Street.

During the evening peak hour, higher traffic volumes are experienced on the following routes in the vicinity of the construction site:

- Westbound traffic on the Great Western Highway near Pitt Street
- Northbound traffic on Pitt Street
- Southbound bus traffic on Pitt Street
- Eastbound traffic on George Street.

The existing traffic volumes on the surrounding road network are provided in Table 10-12.

The future road network near the Parramatta metro station will be modified to accommodate Parramatta Light Rail (Stage 1). These changes are expected to be implemented by 2023 and have been incorporated into the construction traffic modelling assessment.

Table 10-12: Parramatta metro station construction site existing traffic volumes (2019)

Road	Direction	Morning peak hour (vehicles per hour)	Evening peak hour (vehicles per hour)
Great Western Highway west of Pitt Street	Eastbound	1,780	940
	Westbound	990	1,790
Macquarie Street west of O'Connell Street	Eastbound	2,440	1,480
	Westbound	N/A	N/A
George Street east of Church Street[1]	Eastbound	780	510
	Westbound	N/A	N/A
Pitt Street north of Great Western Highway	Northbound	1,330	810
	Southbound	20	30
O'Connell Street south of George Street	Northbound	2,140	1,350
	Southbound	1,420	1,100
O'Connell Street north of Great Western Highway	Northbound	N/A	N/A
	Southbound	1,020	1,460

Note 1: George Street was converted to two way traffic flow as part of the future Parramatta Light Rail (Stage 1) works in November 2019

Intersection performance

Modelled intersection performance during the morning and evening peak hours for key intersections near the Parramatta metro station construction site is shown in Table 10-13.

Modelled intersection performance indicates that all intersections perform at level of service D or better during the morning and evening peak hour. Some intersections along Great Western Highway, O'Connell Street and Pitt Street are approaching capacity and experience queues that extend past adjacent intersections.

Table 10-13: Modelled peak hour existing intersection performance – Parramatta metro station construction site (2019)

Intersection	Peak hour	Demand flow (vehicles per hour)	Average delay (second per vehicle)	Level of service
Great Western Highway/Pitt Street	Morning	3,954	44	D
	Evening	3,410	32	C
Great Western Highway/O'Connell Street	Morning	2,894	29	C
	Evening	2,990	48	D
Pitt Street/Argyle Street/Park Parade	Morning	2,618	53	D
	Evening	2,040	28	B
O'Connell Street/Aird Street	Morning	1,438	6	A
	Evening	1,429	53	D
O'Connell Street/Argyle Street	Morning	1,881	15	B
	Evening	2,360	32	C
O'Connell Street/Hunter Street	Morning	1,608	<5	A
	Evening	1,872	24	B
O'Connell Street/Macquarie Street	Morning	3,291	13	A
	Evening	2,620	44	D
O'Connell Street/George Street	Morning	3,640	36	C
	Evening	2,671	22	B
George Street/Marsden Street	Morning	1,761	21	B
	Evening	1,713	20	B
George Street/Church Street	Morning	772	23	B
	Evening	587	27	B
George Street/Horwood Place	Morning	939	14	A
	Evening	808	17	B

On-street parking, loading, servicing and pick-up arrangements

On-street parking in Parramatta consists of free and paid parking. Immediately surrounding and within the construction site, there are some paid on-street parking spaces along Horwood Place, Macquarie Street and Church Street. On-street paid parking is also provided on a number of sections of George Street, particularly near Horwood Place and east of Smith Street. In contrast, there are no on-street parking spaces provided on Smith Street.

Kiss and ride and loading zones are located throughout the Parramatta CBD. Point to point transport service zones are located close to Parramatta Station on Fitzwilliam Street and Valentine Avenue.

10.7.2 Potential impacts

Vehicle movement forecast and routes

The anticipated vehicle (light and heavy) one way movements at the construction site over a typical day are provided in Figure 10-8 and Figure 10-9 respectively.

The proposed primary haul routes are shown in Figure 10-10. Access to and egress from the construction site would be right in and left out via George Street and Horwood Place. Light and heavy vehicles may also access the construction site right out and left in via this same intersection. Traffic control would be required to safely manage access and egress at this intersection and may include signals. Roads forming part of the construction vehicle route include Great Western Highway, Pitt Street, Macquarie Street, O'Connell Street, George Street and Victoria Road.

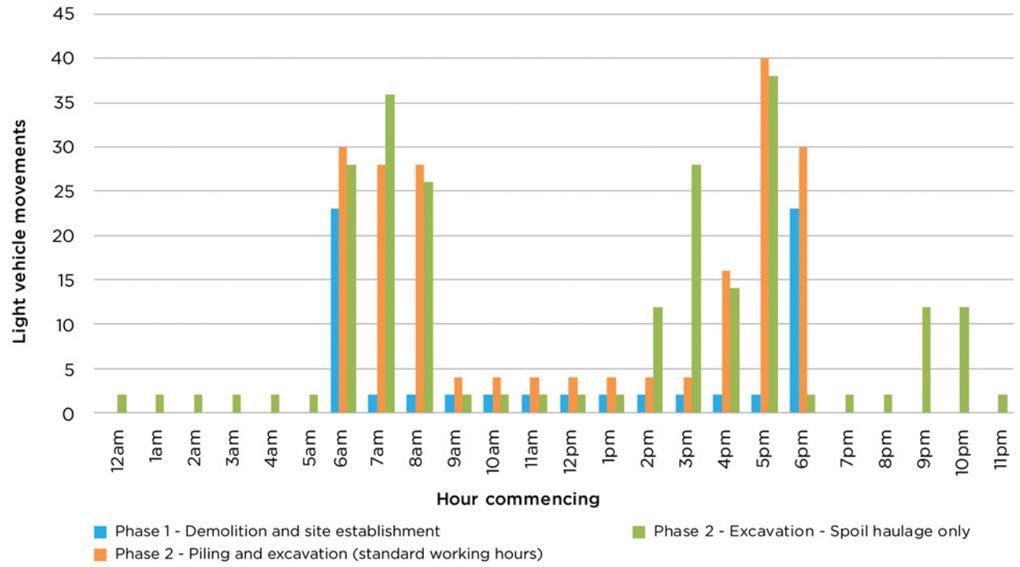


Figure 10-8: Hourly light vehicle movements at the Parramatta metro station construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

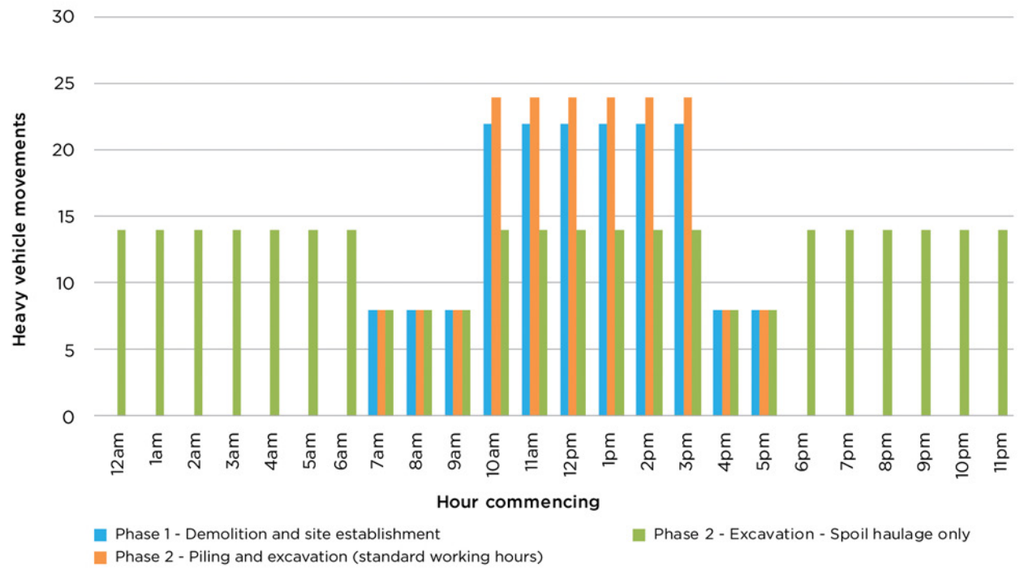


Figure 10-9: Hourly heavy vehicle movements at the Parramatta metro station construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

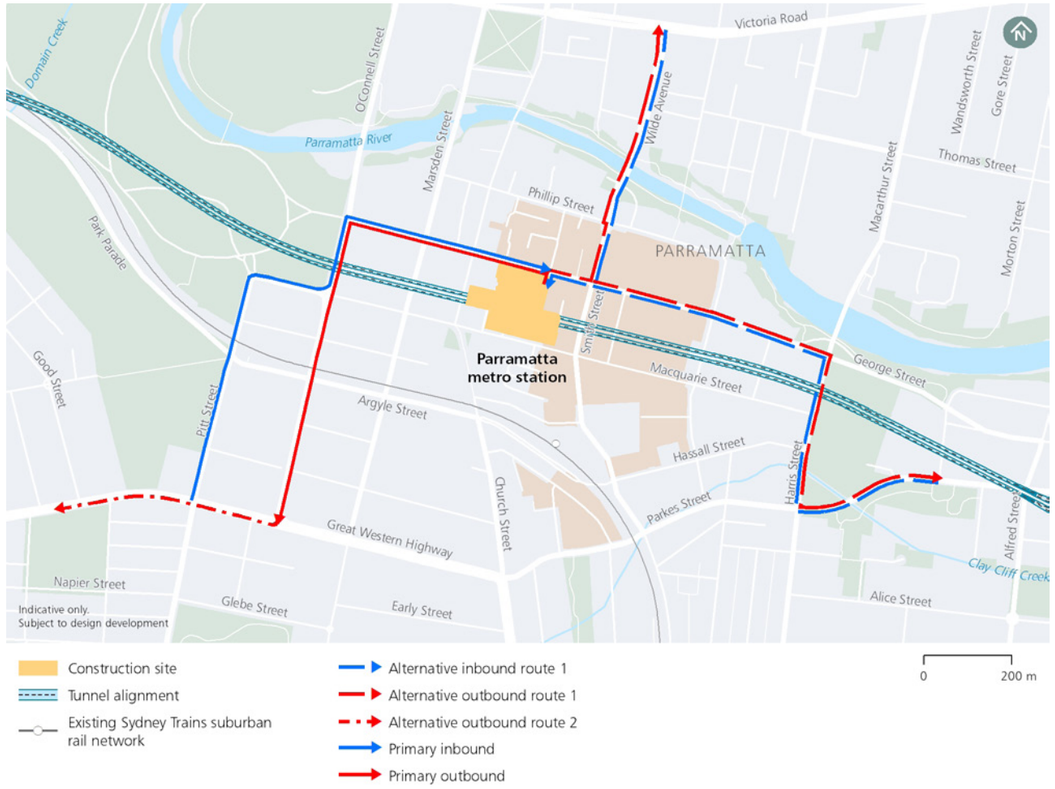


Figure 10-10: Parramatta metro station construction site primary haul routes

Active transport network

Existing pedestrian connectivity surrounding the Parramatta metro station construction site is expected to be maintained throughout construction. Horwood Place would be temporarily closed and north-south pedestrian connectivity would be maintained using Church Street and Smith Street.

Batman Walk, which is a short pedestrian-only lane, would be closed during construction. This lane connects Macquarie Street and Macquarie Lane and primarily functions as an access route to the City Centre (Horwood Place) car park. As this car park would be closed permanently, an alternative for this pedestrian route is not required.

Horwood Place is also designated on-road cycle route of moderate difficulty. As this would be temporarily closed during construction, cyclists would be required to travel via alternative roads. These could include Smith Street or Church Street. Given the closure of Horwood Place, the impact to cyclists is anticipated to be minor given the closure would be temporary and short in duration.

Public transport services

A summary of the potential impacts to public transport services around the construction site is provided in Table 10-14.

Table 10-14: Parramatta metro station construction site existing public transport impacts

Public transport mode	Impact description
Rail	• Potential temporary minor increase to light rail travel time (post Parramatta Light Rail Stage 1 opening) due to additional construction vehicles on the road network • No impact on suburban and intercity rail
Bus	• Potential temporary minor increase in travel time due to additional construction vehicles on the road network • No impacts to the operation of bus stops
Ferry	• No impact

Road network performance

Potential impacts to road network performance would be minimised through the implementation of the Construction Traffic Management Framework and mitigation measures identified in Section 10.16. This includes reducing vehicle movements in network peak periods and during school drop off and pick up periods.

Figure 10-11 shows the anticipated performance of key intersections in the year 2023 with and without Stage 1. Additional intersection performance indicators are provided in Technical Paper 1 (Transport and traffic).

Analysis of modelled intersection performance results shows that the Pitt Street/Argyle Street/Park Parade intersection improves with Stage 1. This is due to downstream changes at the Hawkesbury Road/Alexandra Avenue and Alexandra Avenue/Hassall Street intersections in Westmead, which would be modified during construction. The modification of these intersections would result in a reduction in westbound queues along Alexandra Avenue and Park Parade, improving the overall operational performance of the Pitt Street/Argyle Street/Park Parade intersection.

Modelled intersection performance with construction traffic indicates that the O'Connell Street/Argyle Street intersection would experience a temporary reduction in performance during the evening peak. This is due to the additional construction vehicles travelling on O'Connell Street in the southbound direction. Furthermore, O'Connell Street between Macquarie Street and Argyle Street is a major weaving segment, and the additional construction vehicles increases the difficulty for vehicles to change lanes, potentially resulting in increased congestion.

Traffic control measures would be required for the construction site access of George Street, and may include traffic signals. The final measures would be determined in consultation with Transport for NSW.

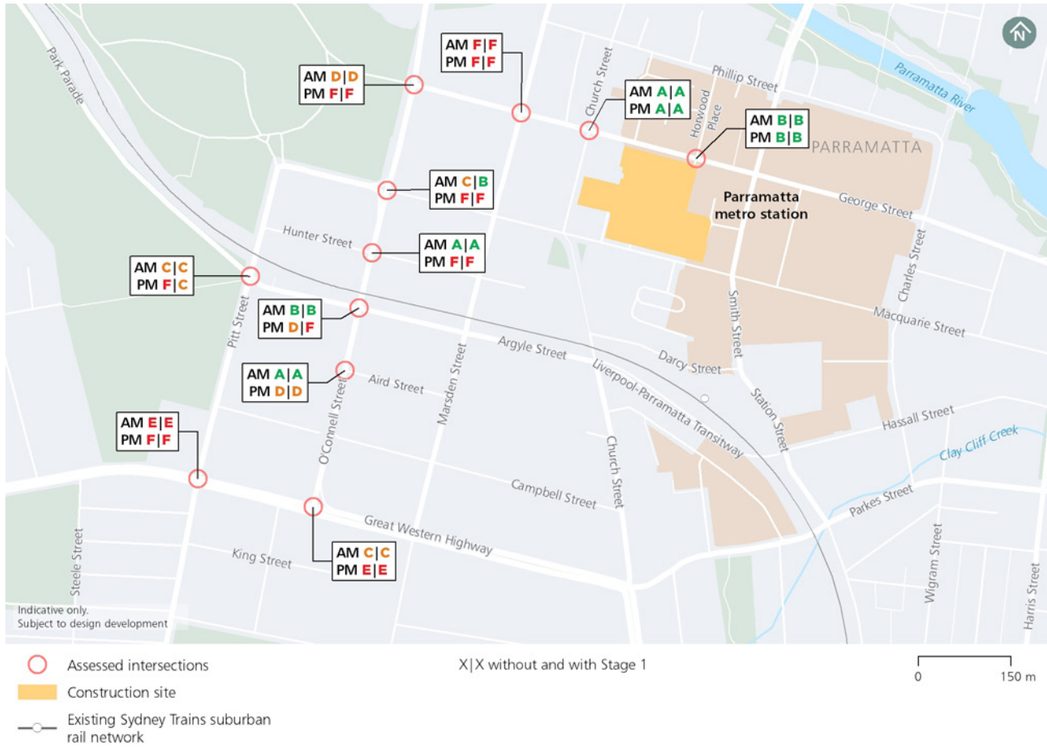


Figure 10-11: Parramatta metro station construction site intersection performance (2023)

Parking and property access

Several on-street and off-street parking spaces would be permanently removed. These include:

- About 30 metered on-street parking spaces in Horwood Place
- 20 off-street parking spaces accessible from Horwood Place and located to the rear of properties being acquired as part of Stage 1 at the Church Street/George Street intersection
- About 800 off-street parking spaces in the City Centre (Horwood Place) multi-level car park.

Closure of the City Centre (Horwood Place) car park is consistent with the City of Parramatta's approach of closing some council-owned parking facilities to allow redevelopment within Parramatta CBD, as stated in the Draft Parramatta CBD Public Car Parking Strategy (City of Parramatta, 2017b). The City of Parramatta strategy also identifies potential measures to offset this loss of car parking.

Existing rear access provided from Horwood Place for properties fronting Church Street would be maintained via an alternative access lane to be constructed at the start of the construction phase. This access lane would be accessible to and from George Street. Impacts to vehicles accessing these properties are anticipated to be minor with the potential increase in travel distance of up to 360 metres and potential increase in travel time of up to two minutes. Access from Macquarie Lane to properties fronting Smith Street that would remain during construction would be maintained via the existing laneway. Vehicular access to the rear access to 69 George Street would be maintained during construction.

Sydney Metro would consult affected property owners to develop alternative access arrangements. There would be no other impacts to private property access.

10.8 Clyde stabling and maintenance facility construction site

10.8.1 Existing environment

The Clyde stabling and maintenance facility construction site is bound by Shirley Street, Unwin Street, James Ruse Drive and the M4 Western Motorway. The location of the construction site and the surrounding transport network are shown on Figure 10-12.

Figure 10-12: Clyde stabling and maintenance facility construction site road network and indicative vehicle routes

Active transport network

The pedestrian network around the Clyde stabling and maintenance facility construction site is limited given the industrial land uses to the east of Rosehill Gardens racecourse and north of Duck River. Formal pedestrian crossings are limited and are generally a considerable distance from the construction site. Pedestrian volumes near the Clyde stabling and maintenance facility construction site are expected to be low.

Crossings are provided at the following locations:

- Signalised crossings at the Parramatta Road/Wentworth Street intersection
- Signalised crossings at Parramatta Road/James Ruse Drive intersection
- Pedestrian footbridge over James Ruse Drive near the now closed Rosehill Station.

The cycle network surrounding the construction site includes:

- M4 cycleway located near the southern boundary of the construction site
- Off-road shared path along the norther side of Parramatta Road
- On-road route along Kendall Street, Martha Street, Alfred Street, Prospect Street and Virginia Street.

Public transport services

A summary of the public transport services around the Clyde stabling and maintenance facility construction site is provided in Table 10-15.

Table 10-15: Clyde stabling and maintenance facility construction site existing public transport services

Public transport mode	Description
Rail	• No train services in close proximity to the construction site
Bus	• Four bus routes (including two NightRide bus routes) • Six school bus routes • Major bus stops on Alfred Street, James Ruse Drive and Parramatta Road

Road traffic volume and patterns

Parramatta Road is a major arterial road that carries high traffic volumes of at least 1,600 vehicles during the peak hour in each direction. West of Wentworth Street (collector road), the Parramatta Road westbound volumes are higher than eastbound volumes, with comparatively higher volumes experienced in both directions during the morning peak hour compared to the evening peak hour. To a lesser extent, traffic volumes on James Ruse Drive (arterial road) north of Parramatta Road are also high, ranging between 1,110 and 1,500 vehicles in each direction during the peak hour. This section of James Ruse Drive has a southbound morning peak direction and a northbound evening peak direction.

Given the industrial land uses east of James Ruse Drive, low traffic volumes are experienced on the local road network at Unwin Street (local road), Kay Street (local road) and Wentworth Street, with fewer than 280 vehicles per hour observed in each direction during both peak periods.

The existing traffic volumes on the surrounding road network are provided in Table 10-16.

Table 10-16: Clyde stabling and maintenance facility construction site existing traffic volumes (2019)

Road	Direction	Morning peak hour (vehicles per hour)	Evening peak hour (vehicles per hour)
Unwin Street west of Colquhoun Street	Eastbound	220	190
	Westbound	280	130
Parramatta Road west of Wentworth Street	Eastbound	1,730	1,600
	Westbound	2,110	1,950
Kay Street west of Wentworth Street	Eastbound	150	170
	Westbound	270	90
James Ruse Drive north of Parramatta Road	Eastbound	1,300	1,280
	Westbound	1,500	1,110
Wentworth Street north of Parramatta Road	Eastbound	260	120
	Westbound	150	180

Intersection performance

Modelled intersection performance during the morning and evening peak hours for key intersections near the Clyde stabling and maintenance facility construction site is shown in Table 10-17.

Modelled intersection performance indicates that all intersections currently perform at a level of service D or better during the morning and evening peak hour.

Table 10-17: Modelled peak hour existing intersection performance – Clyde stabling and maintenance facility construction site (2019)

Intersection	Peak hour	Demand flow (vehicles per hour)	Average delay (second per vehicle)	Level of service
Parramatta Road/James Ruse Drive	Morning	5,078	42	C
	Evening	4,764	53	D
Parramatta Road/Marsh Street	Morning	3,214	52	D
	Evening	3,430	40	C
Parramatta Road/Wentworth Street	Morning	4,044	15	A
	Evening	3,670	19	B
Wentworth Street/Kay Street	Morning	413	<5	A
	Evening	258	<5	A

On-street parking, loading, servicing and pick-up arrangements

Unrestricted on-street parking is provided on Kay Street, Unwin Street and Wentworth Street. Parking is prohibited on Parramatta Road and James Ruse Drive, with clearways in operation seven days a week during daylight hours (6 am to 7 pm Monday to Friday, 8 am to 8 pm Saturday and Sunday).

There are no kiss and ride, loading zone or point to point transport service zones on roads immediately surrounding the construction site.

10.8.2 Potential impacts

Vehicle movement forecast and routes

The anticipated vehicle (light and heavy) one way movements at the construction site over a typical day are provided in Figure 10-13 and Figure 10-14 respectively.

The proposed primary haul routes are shown in Figure 10-15. Access to and egress from the site would be from Wentworth Street. Roads forming part of the construction vehicle route include Parramatta Road and Wentworth Street.

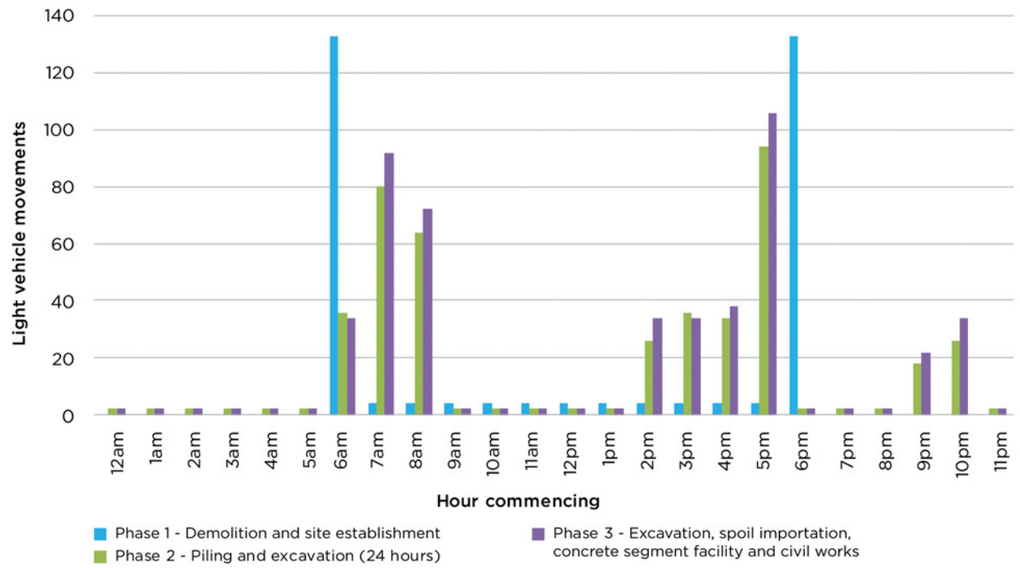


Figure 10-13: Hourly light vehicle movements at the Clyde stabling and maintenance facility construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

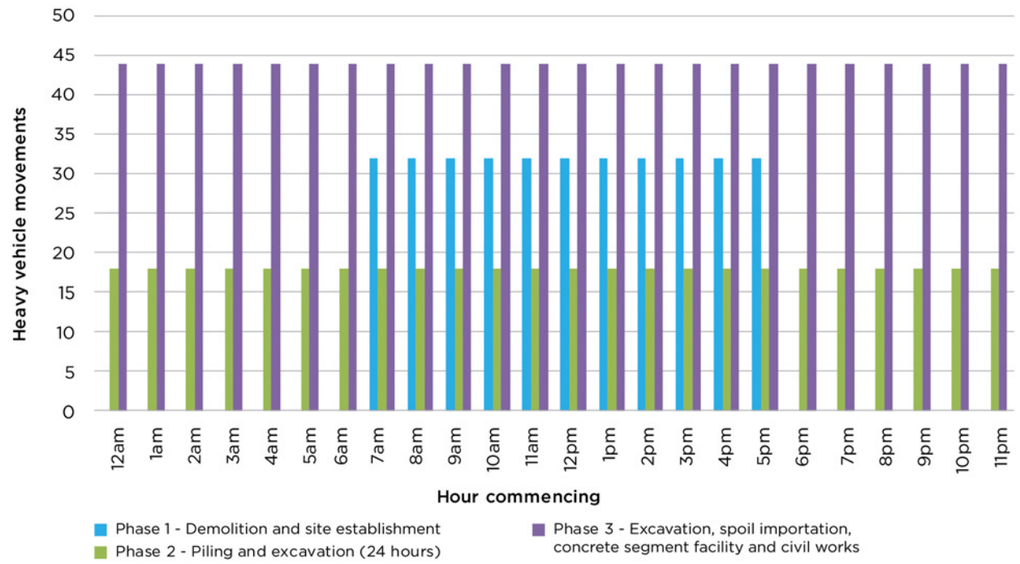


Figure 10-14: Hourly heavy vehicle movements at the Clyde stabling and maintenance facility construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

Figure 10-15: Clyde stabling and maintenance facility construction site primary haul routes

Active transport network

Footpaths located on Unwin Street and Kay Street would be removed to accommodate the construction site. These footpaths serve properties that would be within the construction site and therefore the impact to the pedestrian network is expected to be minimal. Pedestrian access through this area and on the realigned road would be managed to ensure safe pedestrian environments.

No impacts to the cycle network are anticipated during construction.

Public transport network

Bus services operate on Parramatta Road, which also forms part of the Clyde stabling and maintenance facility construction haul route. Minimal temporary impacts to buses are expected and would be limited to a potential minor increase in travel time due to the additional construction vehicles on the road network. No impacts are anticipated on the operation of bus stops.

The construction of the future Parramatta Light Rail (Stage 1) has resulted in the cessation of T6 Carlingford Line services and the closure of the existing Rosehill Station, as part of this line is being converted to allow for light rail operation. Replacement bus services will be in place until the light rail is operational. No impacts to the rail network, replacement bus services or light rail network are anticipated due to Stage 1.

Road network performance

Potential impacts to road network performance would be minimised through the implementation of the Construction Traffic Management Framework and mitigation measures identified in Section 10.16. This includes reducing vehicle movements in network peak periods.

Figure 10-16 shows the anticipated performance of key intersections in the year 2023 with and without Stage 1. Additional intersection performance indicators are provided in Technical Paper 1 (Transport and traffic).

Modelled intersection performance shows that Stage 1 would not result in a decline in intersection performance and that at some intersections, the addition of construction traffic would result in a temporary small reduction in demand flow and/or average delay due to the following factors:

- Additional 'latent' or 'unreleased' demand, which is traffic that is not able to be assigned in the model during the morning and/or evening peak period. These trips are assumed to still exist, however, these trips would be delayed and not completed until after the peak period, effectively increasing the duration of the peak period
- Fewer vehicles passing through an intersection due to the addition of construction-related heavy vehicles, which have a slower acceleration profile compared to light vehicles. This would likely result in an increase to average delay.

Increased traffic on Parramatta Road associated with Stage 1 would result in a temporary increase in southbound queue lengths at the Parramatta Road/Wentworth Street during the evening peak period.

Figure 10-16: Clyde stabling and maintenance facility construction site intersection performance (2023)

Parking

On-street parking spaces along Kay Street would be permanently removed. These parking spaces serve the properties that would form the construction site. Therefore, the impact of the lost parking spaces would be minimal.

Up to 10 parking spaces may be removed on Unwin Street and Wentworth Street where the realigned Unwin Street ties in with the existing road network. The impact of these lost parking spaces would be minimal due to the low net decrease in parking spaces, and the availability of alternative parking nearby.

10.9 Silverwater services facility construction site

10.9.1 Existing environment

The Silverwater services facility construction site is bound by Silverwater Road, Carnarvon Street, Wetherill Street North and Derby Street.

The location of the construction site and the surrounding transport network are shown on Figure 10-17.

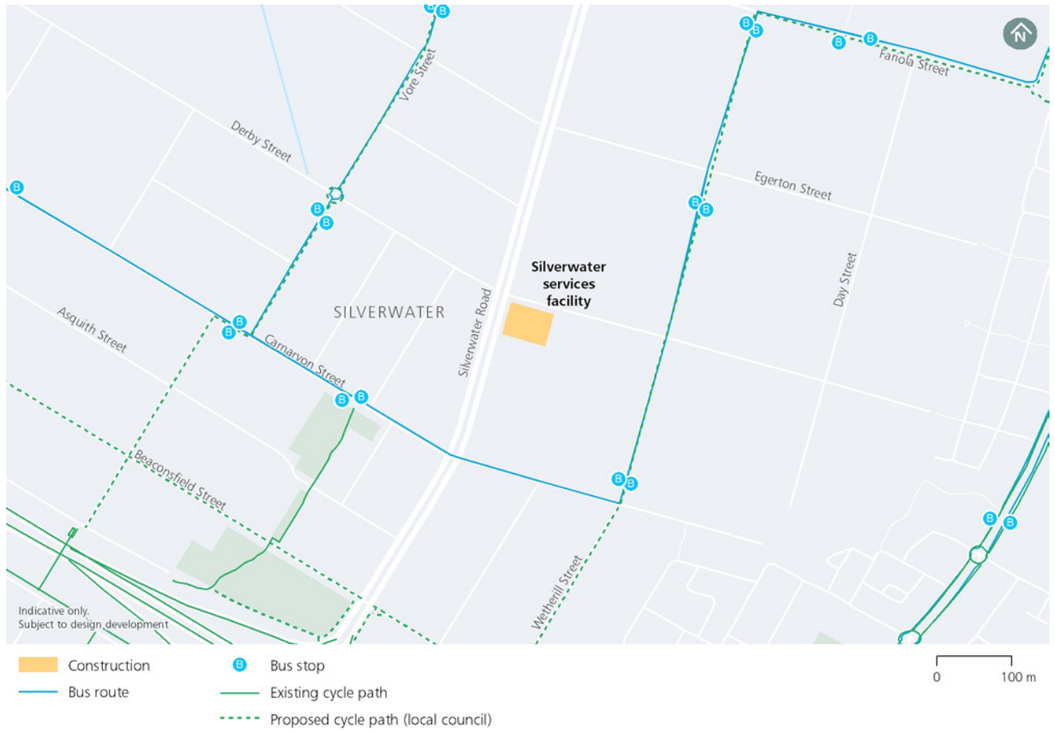


Figure 10-17: Silverwater services facility construction site transport network

Active transport network

The local road network surrounding the construction site generally has a footpath on at least one side of the road. Pedestrian activity near the construction site is low and is primarily generated by the employees of surrounding commercial and industrial businesses.

Pedestrian crossing facilities are limited and include signalised crossings at the Silverwater Road/Carnarvon Street and Silverwater Road/Fariola Street intersections.

The cycle network surrounding the construction site is limited and includes:

- A shared path on the M4 Western Motorway and through Deakin Park, shared paths through Deakin Park and between Beaconsfield Street and the Louise Sauvage Pathway
- On-road cycle routes south of the M4 Western Motorway which connect to Auburn Station and surrounding suburbs via the local road network and east of the site on Newington Boulevard and John Ian Wing Parade.

Public transport services

The public transport network around the Silverwater services facility is limited to bus services. A summary of these services is provided in Table 10-18.

Table 10-18: Silverwater services facility construction site existing public transport services

Public transport mode	Description
Bus	• Four bus routes • One public on-demand bus service • Major bus stops on Stubbs Street, Carnarvon Street, Vore Street, Parramatta Road and Wetherill Street North.

Road traffic volume and patterns

Silverwater Road is the primary arterial road near the construction site. Key local roads include Carnarvon Street, Wetherill Street North and Derby Street.

During the morning peak hour, higher traffic volumes are experienced on the following routes in the vicinity of the construction site:

- Southbound traffic on Silverwater Road
- Eastbound on Carnarvon
- Northbound on Wetherill Street North
- Westbound on Derby Street.

During the evening peak hour, higher traffic volumes are experienced on the following routes in the vicinity of the construction site:

- Southbound traffic on Silverwater Road
- Westbound on Carnarvon
- Southbound on Wetherill Street North
- Westbound on Derby Street.

The existing traffic volumes on the surrounding road network are provided in Table 10-19.

Table 10-19: Silverwater services facility construction site existing traffic volumes (2019)

Road	Direction	Morning peak hour (vehicles per hour)	Evening peak hour (vehicles per hour)
Derby Street east of Silverwater	Eastbound	30	20
	Westbound	110	40
Carnarvon Street east of Silverwater Road	Eastbound	280	130
	Westbound	160	350
Silverwater Road south of Derby Street	Northbound	1,600	1,710
	Southbound	2,110	1,890
Wetherill Street North south of Derby Street	Northbound	270	110
	Southbound	90	260

Intersection performance

Modelled intersection performance during the morning and evening peak hours for key intersections in the vicinity of the Silverwater services facility construction site is shown in Table 10-20.

Modelled intersection performance indicates that the Silverwater Road / Derby Street intersection currently performs at level of service F during the evening peak hour. This is due to the intersection not being signalised where the worst movement is reported, which is vehicles turning left from Derby Street onto Silverwater Road during the evening peak hour. Given that the intersection is restricted to left-in and left-out movements, its existing performance during the evening peak hour does not impact vehicles travelling on Silverwater Road. Southbound queues on Silverwater Road from the Carnarvon Street intersection extend past Derby Street, resulting in an increase to average delays at the Silverwater Road / Derby Street intersection.

Table 10-20: Modelled peak hour existing intersection performance – Silverwater services facility construction site (2019)

Intersection	Peak hour	Demand flow (vehicles per hour)	Average delay (second per vehicle)	Level of service
Silverwater Road/Carnarvon Street	Morning	4,283	29	B
	Evening	4,229	54	D
Silverwater Road/Derby Street	Morning	3,796	18	B
	Evening	3,684	77	F
Carnarvon Street/Wetherill Street North	Morning	474	<5	A
	Evening	494	5	A
Derby Street/Wetherill Street North	Morning	408	9	A
	Evening	355	15	A

On-street parking, loading, servicing and pick-up arrangements

Unrestricted on-street parking is provided on both sides of most local roads including Derby Street, Wetherill Street North and Carnarvon Street. However, during special events on-street parking on these roads is time restricted to two hours. Parking is prohibited on Silverwater Road, with clearways in operation seven days a week during daylight hours (6 am to 7 pm Monday to Friday, 9 am to 6 pm Saturday and Sunday).

There are no kiss and ride, loading zone or point to point transport service zones on roads immediately surrounding the construction site.

10.9.2 Potential impacts

Vehicle movement forecast and routes

The anticipated vehicle (light and heavy) one way movements at the construction site over a typical day are provided in Figure 10-18 and Figure 10-19 respectively.

The proposed primary haul routes are shown in Figure 10-20. Access to and egress from the construction site would be left-in, left-out, to and from Derby Street. Roads forming part of the construction vehicle route include the M4 Western Motorway, Silverwater Road, Carnarvon Street, Wetherill Street North and Derby Street.

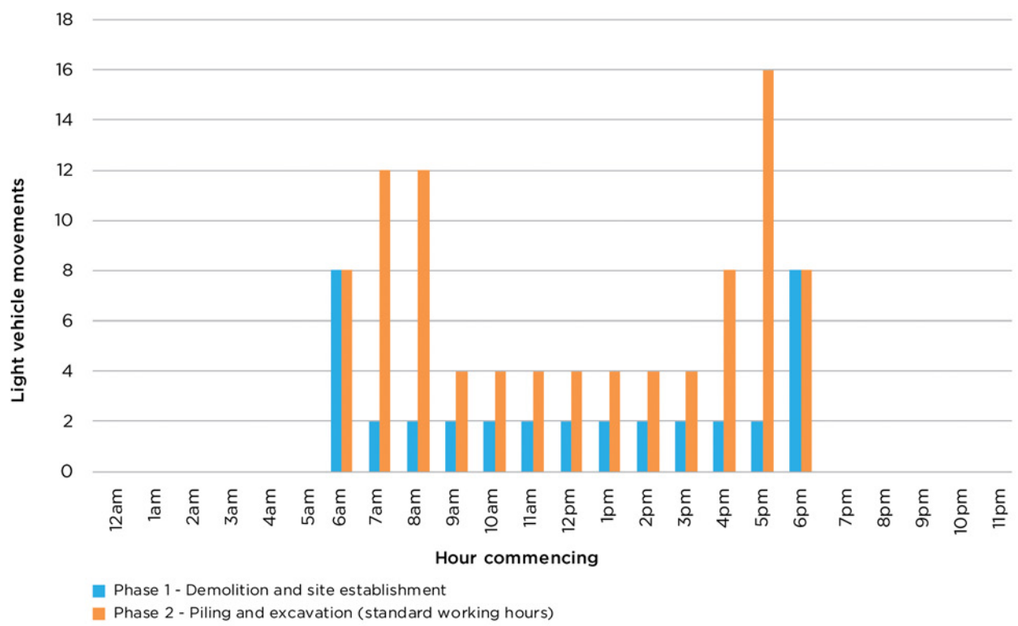


Figure 10-18: Hourly light vehicle movements at the Silverwater services facility construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

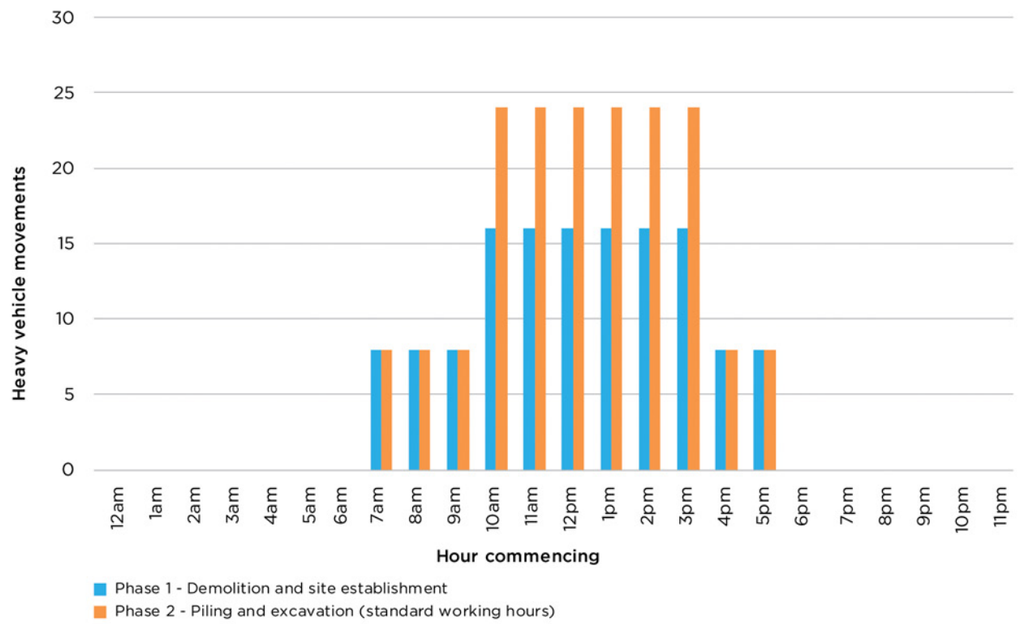


Figure 10-19: Hourly heavy vehicle movements at the Silverwater services facility construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

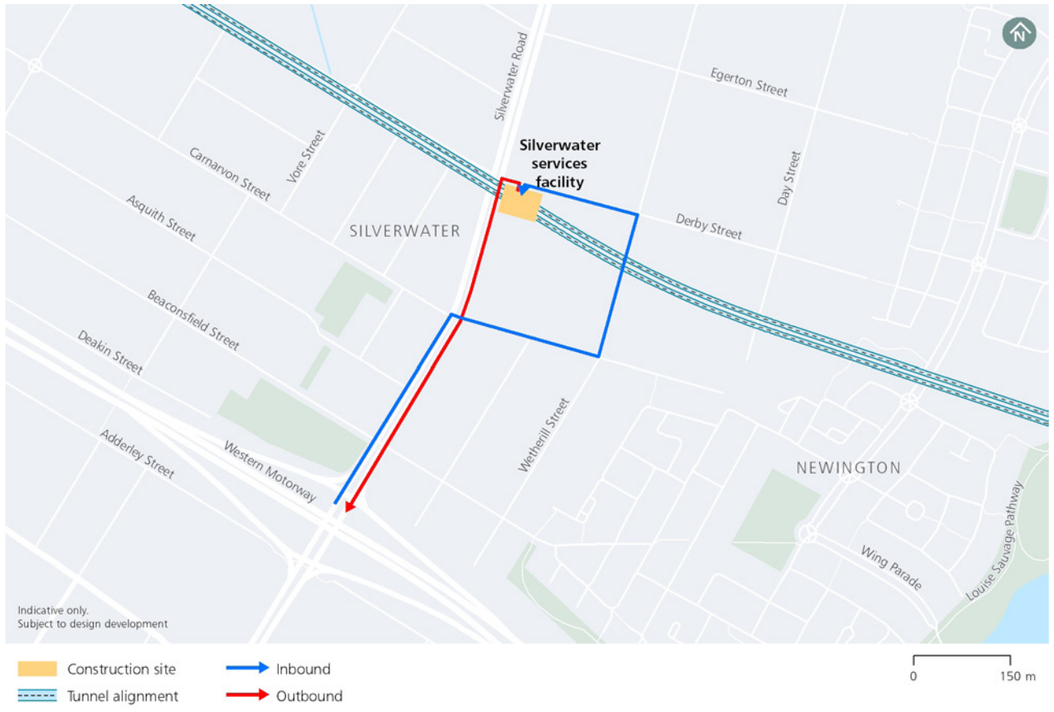


Figure 10-20: Silverwater services facility construction site haulage routes

Active transport network

No impacts to the pedestrian and cyclist networks are anticipated during construction.

Public transport network

Carnarvon Street and Wetherill Street North are used by route 544 buses and forms part of the construction vehicle route for the Silverwater services facility construction site. Route 544 operates every 30 minutes during the weekday morning and evening peak periods. The impact to this service due to additional construction vehicles on the road network would be negligible due to the limited frequency of the service. No impacts are anticipated on the operation of bus stops.

Road network performance

Potential impacts to road network performance would be minimised through the implementation of the Construction Traffic Management Framework and mitigation measures identified in Section 10.16. This includes reducing vehicle movements in network peak periods.

Figure 10-21 shows the anticipated performance of key intersections in the year 2023 with and without Stage 1. Additional intersection performance indicators are provided in Technical Paper 1 (Transport and traffic).

Modelled intersection performance with construction traffic indicates that the following intersections would experience a temporary reduction in level of service:

- Silverwater Road/Carnarvon Street during the morning peak hour. This intersection would still operate with spare capacity with the addition of construction traffic
- Silverwater Road/Derby Street during the evening peak hour. This is due to an increase in traffic volumes at the intersection, with outbound construction vehicles turning left from the westbound approach. Southbound queues on Silverwater Road from the Carnarvon Street intersection during the evening peak hour extend past Derby Street, resulting in an increase to average delays experienced by vehicles turning left from Derby Street into Silverwater Road.

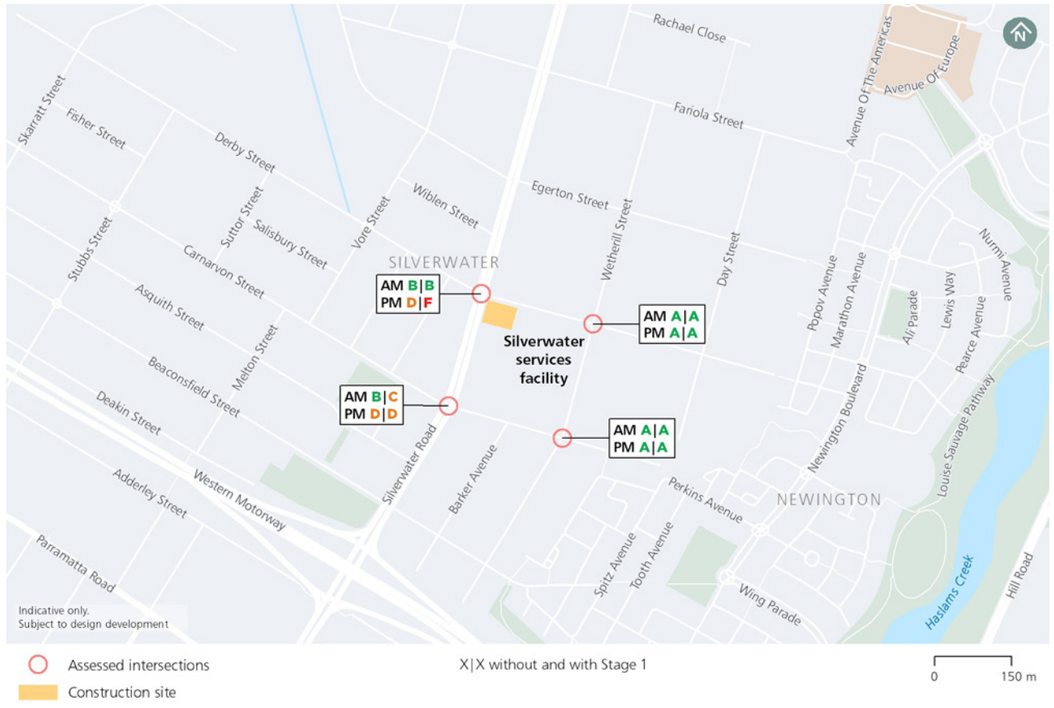


Figure 10-21: Silverwater services facility construction site intersection performance (2023)

Parking

Up to six on-street parking spaces may be temporarily removed near the site access on Derby Street to accommodate construction vehicle movements. Impacts are anticipated to be minor given the low number of potential lost parking spaces and the availability of alternative on-street parking on roads nearby.

10.10 Sydney Olympic Park metro station construction site

10.10.1 Existing environment

The Sydney Olympic Park metro station construction site would be located on Herb Elliott Avenue near Figtree Drive, Showground Road and Dawn Fraser Avenue.

The location of the construction site and the surrounding transport network are shown on Figure 10-22.

Figure 10-22: Sydney Olympic Park metro station construction site transport network

Active transport network

The pedestrian network near the Sydney Olympic Park metro station construction site is well established with wide footpaths and large, paved pedestrian areas to accommodate large crowds during major special events. There are no formal pedestrian crossing facilities immediately surrounding the construction site. However, local roads such as Herb Elliott Avenue, Showground Road and Figtree Drive carry low vehicle volumes and have a 40 kilometres per hour signposted speed limit, which provide pedestrians with generally safe road crossing conditions.

Pedestrian crossings are provided at the following locations near the construction site:

- Signalised crossings at the Sarah Durack Avenue/Olympic Boulevard intersection, the Sarah Durack Avenue/Australia Avenue intersection, the Australia Avenue/Herb Elliott Avenue intersection and the Homebush Bay Drive/Australian Avenue/Underwood Road roundabout
- A staged crossing via the central median on Olympic Boulevard.

The cycle network surrounding the construction site is well-developed and includes:

- Marked cycle lanes on both sides of Australia Avenue, Sarah Durack Avenue, Edwin Flack Avenue, Dawn Fraser Avenue and Bennelong Parkway
- On-road cycle routes along Shirley Strickland Avenue and Rod Laver Drive
- Off-road shared paths throughout the area, particularly to the west of Olympic Boulevard and east of Australia Avenue around Bicentennial Park
- Defined bicycle circuits within the Sydney Olympic Park precinct, including the Olympic Circuit, River Heritage Circuit and Parklands Circuit. These circuits comprise the above on-road and off-road cycle paths, and other cycle paths located north of Bicentennial Park and Dawn Fraser Avenue.

Public transport services

A summary of the public transport services around the Sydney Olympic Park metro station construction site is provided in Table 10-21.

Table 10-21: Sydney Olympic Park metro station construction site existing public transport services

Public transport mode	Description
Rail	• Sydney Trains network – T7 Olympic Park Line • Planned Parramatta Light Rail (Stage 2) including a planned stop on Dawn Fraser Avenue near Showground Road
Bus	• Four bus routes (including one Night Ride bus route) • Nine additional bus routes for major events • One public on-demand bus service • Two school bus routes • Major bus stops on Edwin Flack Avenue, Dawn Fraser Avenue, Park Street and Australia Avenue.

Road traffic volume and patterns

Parramatta Road and Homebush Bay Drive are the primary arterial roads near the construction site and carry the highest levels of traffic. Key local roads connecting the wider road network to Sydney Olympic Park include Australia Avenue, Sarah Durack Avenue, Edwin Flack Avenue and Birnie Avenue. Olympic Boulevard, Herb Elliott Avenue and Figtree Drive provide access to the construction site and are signposted with a 40 kilometres per hour speed limit.

During the morning peak hour, higher traffic volumes are experienced on the following routes in the vicinity of the construction site:

- Eastbound and westbound traffic on Parramatta Road
- Eastbound traffic on Homebush Bay Drive
- Northbound traffic on Australia Avenue
- Northbound traffic on Birnie Avenue.

During the evening peak hour, higher traffic volumes are experienced on the following routes in the vicinity of the construction site:

- Eastbound and westbound traffic on Parramatta Road
- Eastbound traffic on Homebush Bay Drive
- Northbound and southbound traffic on Australia Avenue
- Westbound traffic on Sarah Durack Avenue
- Northbound traffic on Edwin Flack Avenue
- Southbound traffic on Birnie Avenue.

The existing traffic volumes on the surrounding road network are provided in Table 10-22.

Table 10-22: Sydney Olympic Park metro station construction site existing traffic volumes (2019)

Road	Direction	Morning peak hour (vehicles per hour)	Evening peak hour (vehicles per hour)
Parramatta Road west of Birnie Avenue	Eastbound	1,840	1,510
	Westbound	2,070	1,760
Homebush Bay Drive ramps west of Australia Avenue	Eastbound	850	670
	Westbound	360	480
Herb Elliott Avenue west of Australia Avenue	Eastbound	160	330
	Westbound	370	90
Sarah Durack Avenue west of Olympic Boulevard	Eastbound	370	570
	Westbound	450	810
Figtree Drive west of Australia Avenue	Eastbound	40	150
	Westbound	230	20
Australia Avenue north of Homebush Bay Drive	Northbound	1,810	1,750
	Southbound	1,300	1,800
Australia Avenue north of Figtree Drive	Northbound	760	400
	Southbound	420	630
Olympic Boulevard north of Sarah Durack Avenue	Northbound	160	240
	Southbound	140	290
Edwin Flack Avenue north of Sarah Durack Avenue	Northbound	460	830
	Southbound	480	430
Birnie Avenue north of Parramatta Road	Northbound	650	600
	Southbound	500	980

Intersection performance

Modelled existing intersection performance during the morning and evening peak hours for key intersections near the Sydney Olympic Park metro station construction site is shown in Table 10-23.

Traffic congestion along Parramatta Road adjacent to Sydney Olympic Park is high during both peak hours, which is reflected in the existing performance of the Birnie Avenue/Parramatta Road intersection. Queuing on Parramatta Road impacts the ability of vehicles to turn out of Birnie Avenue. Southbound queues from the intersection reduces the capacity and impacts on the performance of the Edwin Flack Avenue/Shane Gould Avenue/Birnie Avenue intersection upstream, particularly during the evening peak hour.

The roundabout at Australia Avenue/Underwood Road/Homebush Bay Drive also currently performs at or near capacity during the morning and evening peak hour, with long queues on the Homebush Bay Drive westbound off ramp. This is due to vehicles approach from the off ramp having to yield to vehicles from Australia Avenue. The existing performance of the roundabout is further compounded as vehicles from the Underwood Road northbound approach yield to right turning vehicles from Australia Avenue and the Homebush Bay Drive westbound off ramp.

The existing performance of the Australia Avenue/Sarah Durack Avenue/Bennelong Parkway intersection in the evening peak hour can be attributed to the high number of vehicles travelling northbound into the Sydney Olympic Park precinct.

Table 10-23: Modelled peak hour existing intersection performance – Sydney Olympic Park metro station construction site (2019)

Intersection	Peak hour	Demand flow (vehicles per hour)	Average delay (second per vehicle)	Level of service
Australian Avenue/Sarah Durack Avenue/Bennelong Parkway	Morning	3,418	24	B
	Evening	3,176	57	E
Australia Avenue/Underwood Road/ Homebush Bay Drive	Morning	3,973	64	E
	Evening	3,931	>100	F
Birnie Avenue/Parramatta Road	Morning	4,617	>100	F
	Evening	4,535	79	F
Edwin Flack Avenue/Shane Gould Avenue/Birnie Avenue	Morning	1,406	30	C
	Evening	1,857	58	E
Herb Elliot Avenue/Parkview Drive/ Australian Avenue	Morning	1,263	43	D
	Evening	887	56	D
Olympic Boulevard/Herb Elliot Avenue	Morning	618	<5	A
	Evening	528	<5	A
Olympic Boulevard/Sarah Durack Avenue	Morning	1,166	17	B
	Evening	1,671	22	B
Sarah Durack Avenue/Edwin Flack Avenue	Morning	968	17	B
	Evening	1,315	6	A
Olympic Boulevard/Figtree Drive	Morning	884	<5	A
	Evening	926	<5	A

On-street parking, loading, servicing and pick-up arrangements

Free, time-limited on-street parking spaces are available along Olympic Boulevard, Murray Rose Avenue, Dawn Fraser Avenue, Figtree Drive, Herb Elliot Avenue, Showground Road, Grand Parade and Parkview Drive. There are also paid on-street parking spaces available along Herb Elliot Avenue, Dawn Fraser Avenue and Showground Road. During major special events, on-street parking may not be available due to road closures in place around the Sydney Olympic Park precinct.

A number of other on-street parking arrangements exist on Herb Elliott Avenue and include parking for motorbikes, a loading zone on the northern side about 90 metres east of Showground Road, a kiss and ride zone near Olympic Boulevard and a point to point transport service zone on the southern side near Showground Road. There is a mail zone on the western side of Showground Road and a loading zone on the southern side of Dawn Fraser Avenue between Showground Road and Park Street.

10.10.2 Potential impacts

Vehicle movement forecast and routes

The anticipated vehicle (light and heavy) one way movements at the construction site over a typical day are provided in Figure 10-23 and Figure 10-24 respectively.

The proposed primary haul routes are shown in Figure 10-25. Access to and egress from the construction site would be left in and both left and right out via Herb Elliot Avenue. Roads forming part of the construction vehicle route include the M4 Western Motorway, Homebush Bay Drive, Australia Avenue and Herb Elliott Avenue.

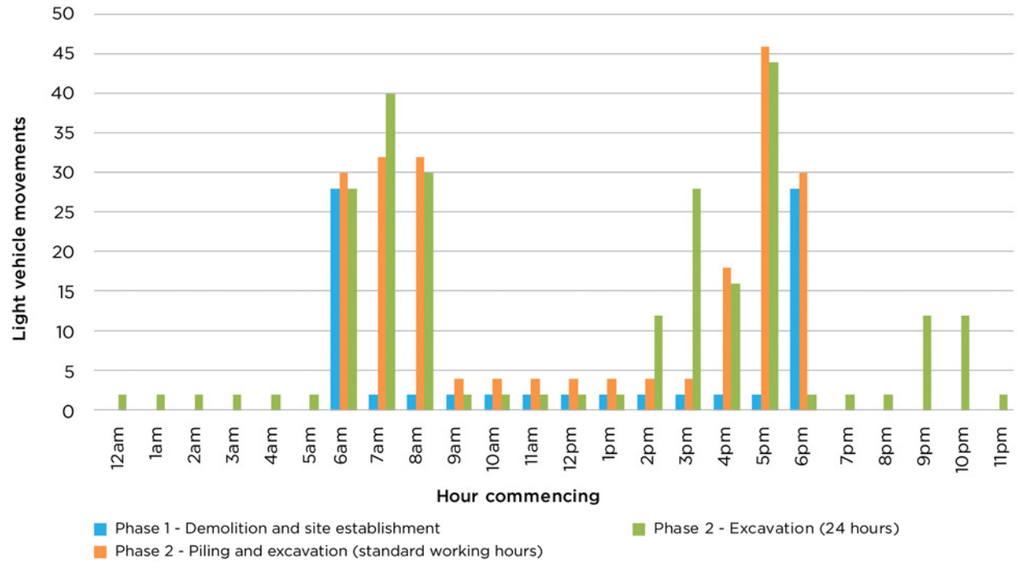


Figure 10-23: Hourly light vehicle movements at the Sydney Olympic Park metro station construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

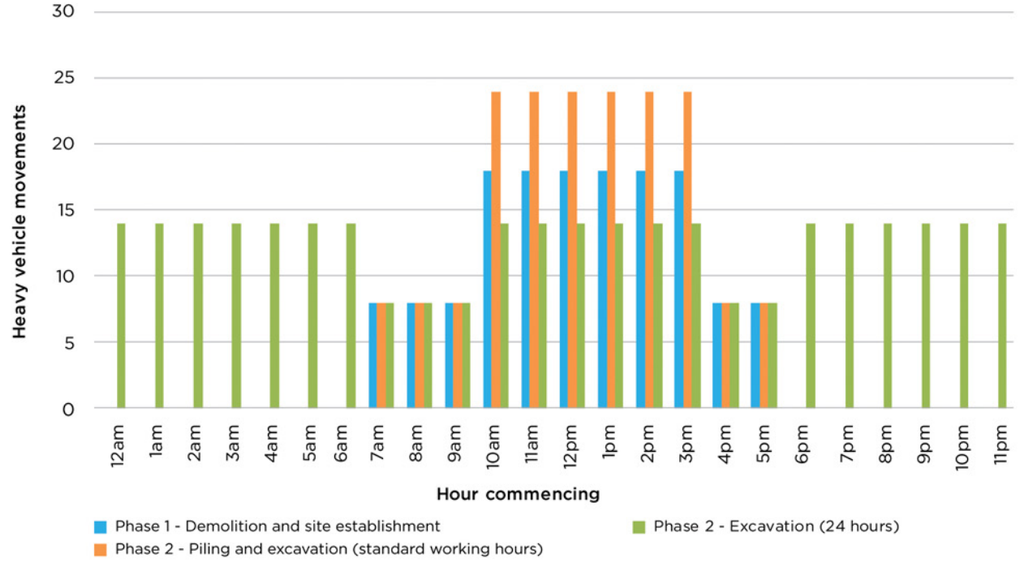


Figure 10-24: Hourly heavy vehicle movements Sydney Olympic Park metro station construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

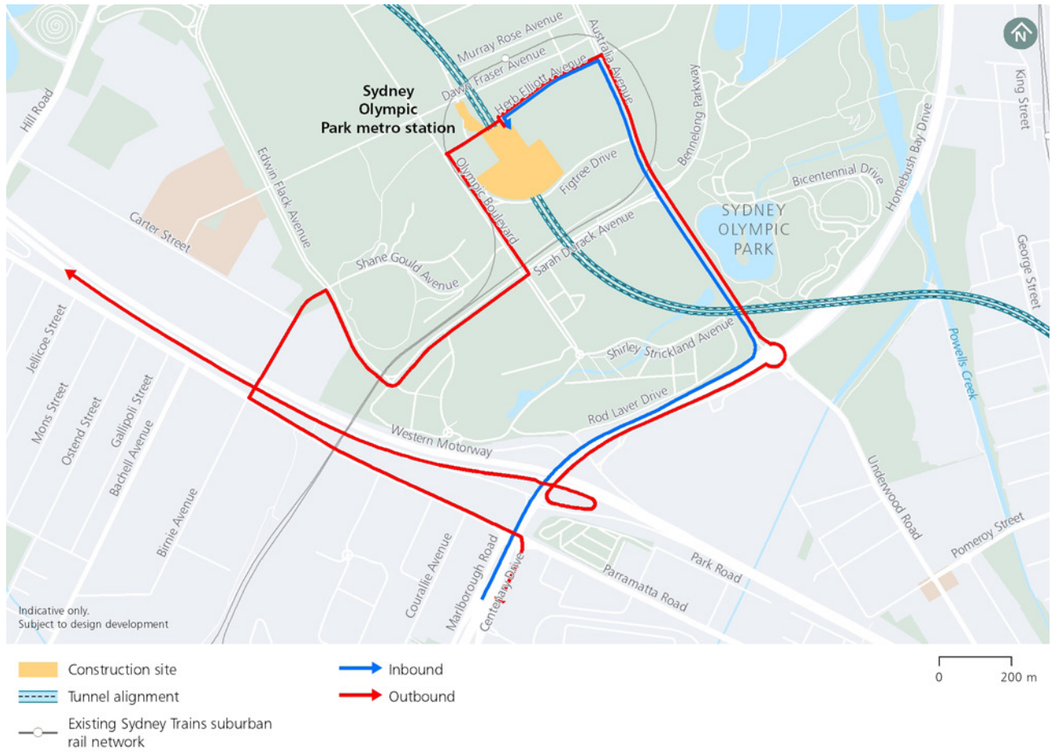


Figure 10-25: Sydney Olympic Park metro station construction site haulage routes

Active transport network

Part of Showground Road would be permanently pedestrianised as part of Stage 1 construction. This would improve the pedestrian network by removing potential existing conflicts between pedestrians and vehicles.

Australia Avenue and Edwin Flack Avenue are designated on-road cycle environments of moderate difficulty. Temporary impacts to cyclists on these roads would be minor given that cyclists would be interacting with a low number of additional heavy vehicles generated at the Sydney Olympic Park metro station construction site.

Public transport network

A summary of the potential impacts to public transport services around the construction site is provided in Table 10-24.

Table 10-24: Sydney Olympic Park metro station construction site existing public transport impacts

Public transport mode	Impact description
Rail	• No impact
Bus	• Potential temporary minor increase in travel time due to additional construction vehicles on the road network • During special events, construction vehicle movements would be limited where possible to minimise impacts on special event bus services • No impacts to the operation of regular or special event bus stops.

Road network performance

Potential impacts to road network performance would be minimised through the implementation of the Construction Traffic Management Framework and mitigation measures identified in Section 10.16. This includes reducing vehicle movements in network peak periods.

Figure 10-26 shows the anticipated performance of key intersections in the year 2023 with and without Stage 1. Additional intersection performance indicators are provided in Technical Paper 1 (Transport and traffic).

Modelled intersection performance with construction traffic indicates that the following intersections would experience a temporary reduced level of service:

- Herb Elliott Avenue/Parkview Drive/Australia Avenue during the evening peak hour – from level of service D to F. This is due to an increase in traffic volumes at the intersection, with inbound construction vehicles turning left from the northbound approach and outbound construction vehicles turning right from the eastbound approach. This temporary impact is not considered a major impact as it does not interface with the arterial road network
- Sarah Durack Avenue/Edwin Flack Avenue during the evening peak hour – from level of service A to B. This intersection would still operate with spare capacity with the addition of construction traffic.

All other intersections forming part of the construction vehicle route would perform at the same level of service compared to the scenario without construction traffic.

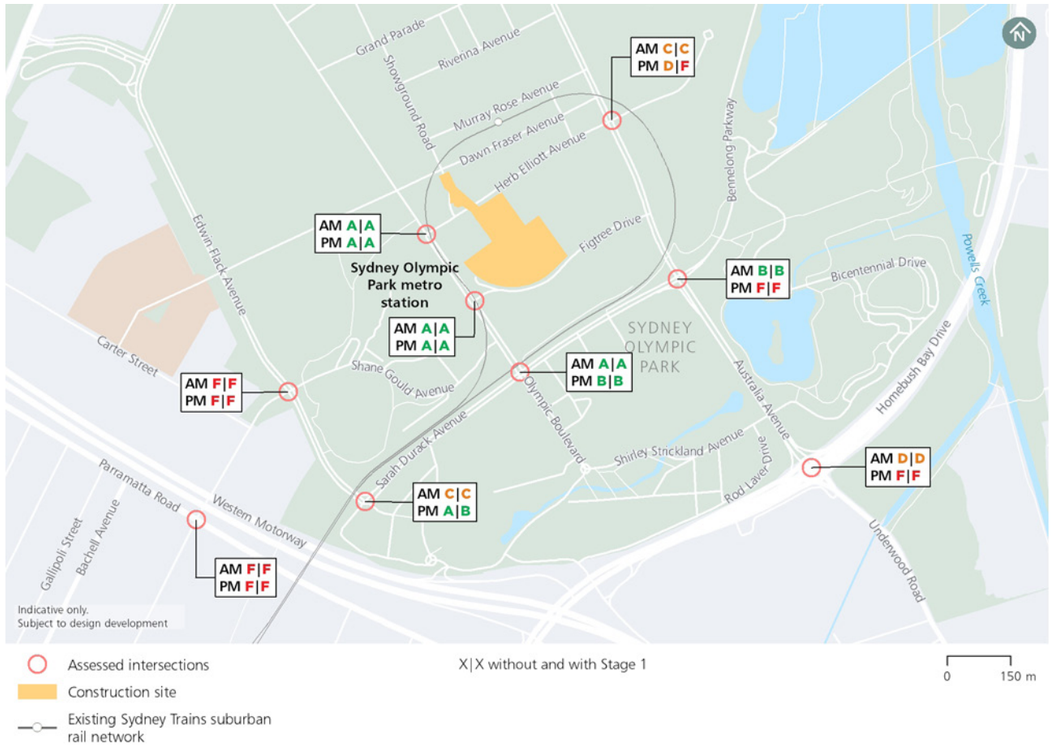


Figure 10-26: Sydney Olympic Park metro station construction site intersection performance (2023)

Parking and property access

Cut-and-cover works across Herb Elliott Avenue would require temporary closures of Herb Elliot Avenue. Options for this work are currently under investigation and may include:

- Full closure for an extended period: In this case, access to adjacent properties would be maintained from either end of Herb Elliott Avenue
- Stage partial closures: In this case, through traffic would be maintained under traffic control, although this would be likely to extend the total duration of works.

Sydney Metro is also investigating the feasibility of design and construction options to avoid cut-and-cover works across Herb Elliott Avenue.

Showground Road at its intersection with Dawn Fraser Avenue would be pedestrianised to accommodate the proposed northern station entry. Access to the Ibis, Pullman and Novotel Hotels' underground car park and driveway access (for authorised vehicles only) to the Abattoir Heritage Precinct would be maintained via Olympic Boulevard and Herb Elliott Avenue, resulting in additional travel distance of up to 220 metres. This would be a minor impact due to the small increase in travel distance and resultant small increase in travel time. There would be no other impacts to parking or private property access.

The taxi rank on the southern side of Herb Elliott Avenue adjacent to the construction site would be temporarily relocated to an alternative site close to its current location. The potential impact to taxi customers would be minor.

10.11 North Strathfield metro station construction site

10.11.1 Existing environment

The North Strathfield metro station construction site would be bound by Pomeroy Street, Queen Street and the T9 Northern Line.

The location of the construction site and the surrounding transport network are shown on Figure 10-27.

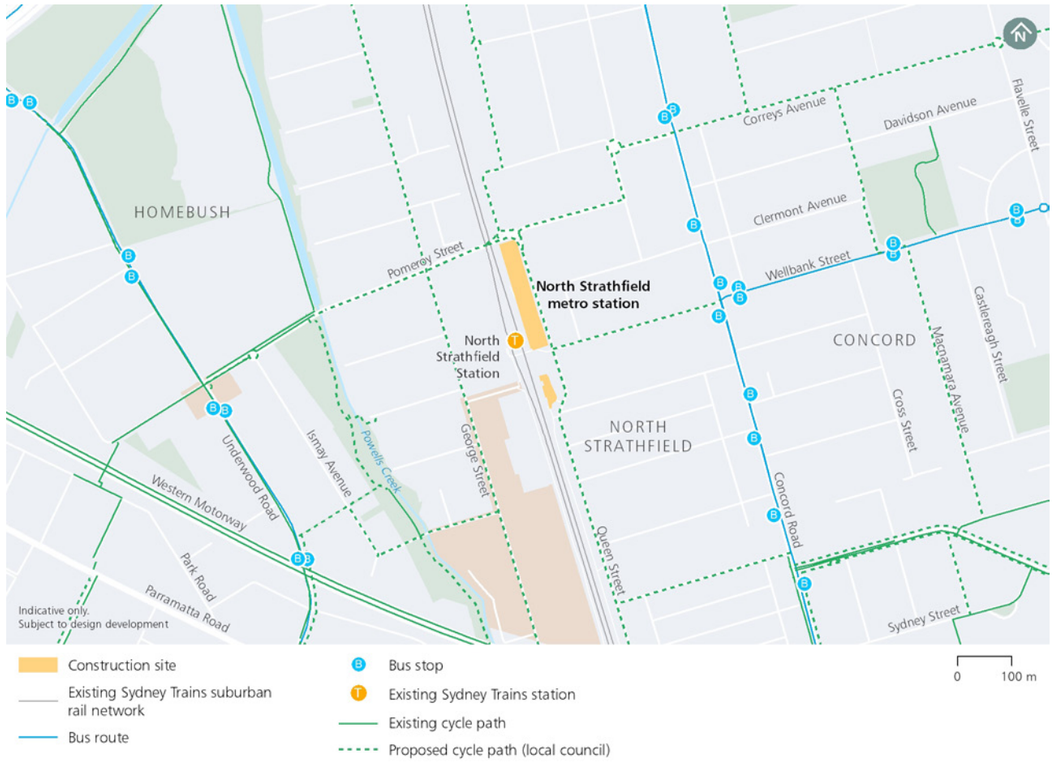


Figure 10-27: North Strathfield metro station construction site transport network

Active transport network

Footpaths exist on both sides of most streets near the North Strathfield metro station construction site. Pedestrian crossing facilities are limited and provided at the following locations:

- A pedestrian bridge across the T9 Northern Line at the existing North Strathfield Station between Queen Street and Hamilton Street East/Pomeroy Street. There are three short footpaths near the Queen Street/Wellbank Street intersection which converge at the pedestrian overbridge, providing access to the existing North Strathfield Station and the western side of the rail line
- Signalised crossing along Concord Road and at the Pomeroy Street/George Street intersection
- A raised zebra crossing at the Queen Street/Wellbank Street intersection.

The cycle network surrounding the construction site includes:

- On-road cycle routes to the west of the existing North Strathfield Station along Underwood Road, Bridge Road, Pomeroy Street and The Crescent
- Shared paths near Powells Creek to the west of the existing North Strathfield Station (including connections to the Cooks River cycleway and the Sydney Olympic Park precinct)
- On-road and off-road cycle routes to the east of the existing North Strathfield Station along Concord Road, Patterson Street and Gipps Street.

Public transport services

A summary of the public transport services around the North Strathfield metro station construction site is provided in Table 10-25.

Table 10-25: North Strathfield metro station construction site existing public transport services

Public transport mode	Description
Rail	• Sydney Trains network – T9 Northern Line.
Bus	• Six bus routes (including two NightRide bus routes) • One public on-demand bus service • 22 school bus routes • Major bus stops on Underwood Road, Concord Road and Wellbank Street.

Road traffic volume and patterns

The M4 Western Motorway, Parramatta Road and Concord Road are the major arterial roads that carry high volumes of traffic through the road network surrounding the construction site. Key collector roads near the construction site include Queen Street and Wellbank Street.

During the morning peak hour, higher traffic volumes are experienced on the following routes in the vicinity of the construction site:

- Westbound traffic on the M4 Western Motorway and Parramatta Road
- Northbound traffic on Concord Road
- Northbound and southbound traffic on Queen Street.

During the evening peak hour, higher traffic volumes are experienced on the following routes in the vicinity of the construction site:

- Eastbound traffic on the M4 Western Motorway and Parramatta Road
- Southbound traffic on Concord Road
- Eastbound and westbound traffic on Wellbank Street
- Northbound and southbound traffic on Queen Street.

The existing traffic volumes on the surrounding road network are provided in Table 10-26.

Table 10-26: North Strathfield metro station construction site existing traffic volumes (2019)

Road	Direction	Morning peak hour (vehicles per hour)	Evening peak hour (vehicles per hour)
Parramatta Road west of Concord Road	Eastbound	800	950
	Westbound	960	1,040
M4 Western Motorway north of Parramatta Road	Eastbound	2,060	2,140
	Westbound	2,500	1,990
Waratah Street west of Concord Road	Eastbound	60	50
	Westbound	60	40
Wellbank Street east of Queen Street	Eastbound	340	380
	Westbound	410	410
Concord Road north of Parramatta Road	Northbound	1,320	910
	Southbound	1,060	1,290
Concord Road south of Wellbank Street	Northbound	1,230	810
	Southbound	610	890
Queen Street north of Wellbank Street	Northbound	400	490
	Southbound	430	440

Intersection performance

Modelled intersection performance during the morning and evening peak hours for key intersections in the vicinity of the North Strathfield metro station construction site is shown in Table 10-27.

The high traffic volumes experienced on all approaches to the Concord Road/Parramatta Road/Leicester Avenue intersection result in its existing performance during the morning peak hour.

Queuing on Queen Street in the northbound direction during the evening peak hour comes from the Queen Street/Beronga Street intersection and extends past the Queen Street/Wellbank Street intersection, reducing its capacity and resulting in a deterioration in performance.

Table 10-27: Modelled peak hour existing intersection performance – North Strathfield metro station construction site (2019)

Intersection	Peak hour	Demand flow (vehicles per hour)	Average delay (second per vehicle)	Level of service
Concord Road/Parramatta Road/ Leicester Avenue	Morning	3,530	65	E
	Evening	3,756	45	D
Concord Road/Patterson Street	Morning	2,755	25	B
	Evening	2,834	23	B
Concord Road/Wellbank Street	Morning	2,626	24	B
	Evening	2,583	24	B
Queen Street/Parramatta Road	Morning	1,748	7	A
	Evening	2,010	5	A
Wellbank Street/Queen Street	Morning	740	41	C
	Evening	893	91	F
M4 Western Motorway/Concord Road	Morning	2,645	54	D
	Evening	2,804	33	C

On-street parking, loading, servicing and pick-up arrangements

A mix of time-restricted and unrestricted on-street parking is provided on roads near the construction site including Queen Street, Beronga Street, Waratah Street, Wellbank Street and Shipley Avenue. On-street parking spaces close to the existing North Strathfield Station are generally time-restricted. Weekday peak period clearways operate on Concord Road, with on-street parking available on the western side only, outside of these periods.

A kiss and ride zone is located on the western side of Queen Street near Wellbank Street and a mail zone is located on the eastern side of Queen Street near Wellbank Street. There are no loading zones on roads immediately surrounding the construction site.

10.11.2 Potential impacts

Vehicle movement forecast and routes

The anticipated vehicle (light and heavy) one way movements at the construction sites over a typical day are provided in Figure 10-28 and Figure 10-29 respectively.

The proposed primary haul routes are shown in Figure 10-30. Access to and egress from the north and south construction sites would be left in and right-out for the northern site access and right-in, left-out for the southern site access, to and from Queen Street. Roads forming part of the construction vehicle route include the M4 Western Motorway, Concord Road, Wellbank Street and Queen Street.

Adjustments to construction site access arrangements and the local road network would be explored during detailed design to minimise conflicts with heavy vehicles movements. This may include use of Waratah Street for haulage, adjustments to local traffic circulation, and/or changes to traffic control at Queen Street and Wellbank Street.

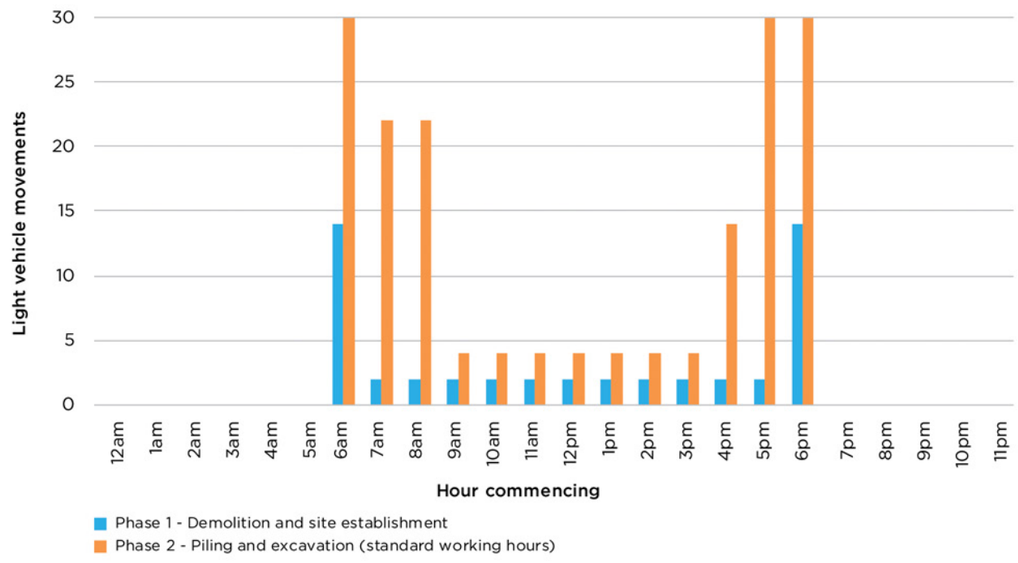


Figure 10-28: Hourly light vehicle movements at the North Strathfield metro station construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

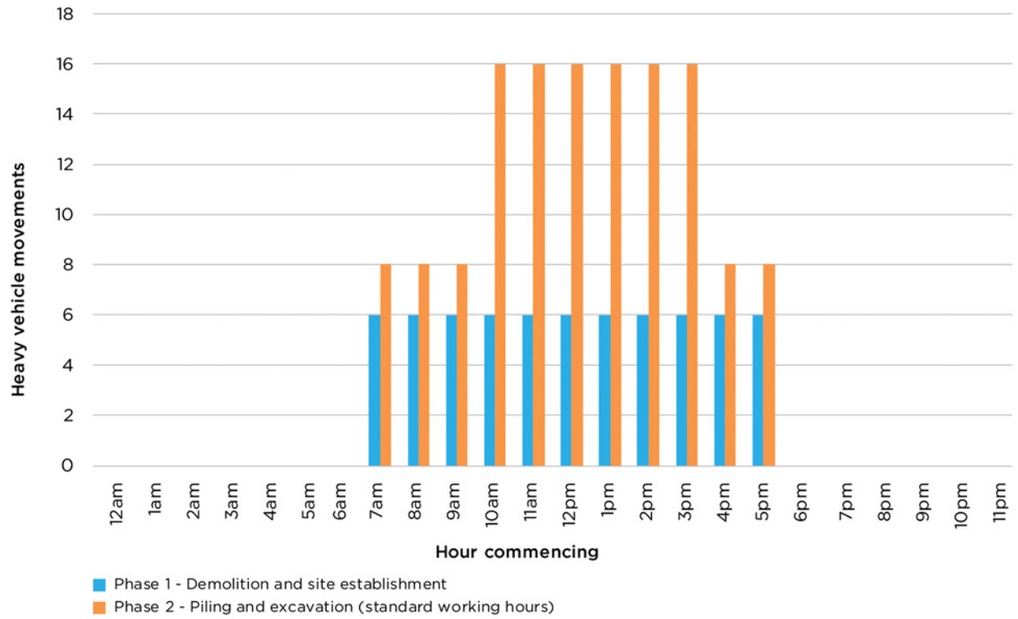


Figure 10-29: Hourly heavy vehicle movements at the North Strathfield metro station construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

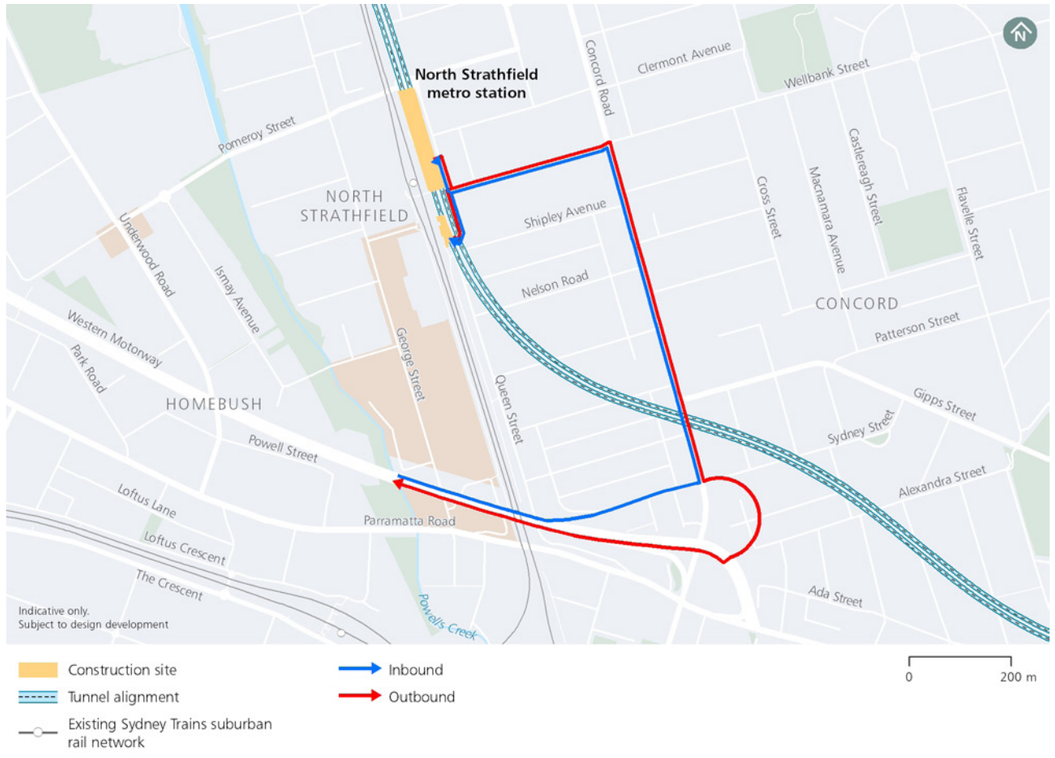


Figure 10-30: North Strathfield metro station construction site haulage routes

Active transport network

The western footpath on Queen Street adjacent to the construction site would be temporarily removed. Pedestrians would be diverted to the footpath on the eastern side of Queen Street. The Queen Street / Wellbank Street intersection would need to be modified to accommodate heavy vehicles movements and provide safe pedestrian access. Modification of the intersection may include signalisation and/or changes to zebra crossings.

There are currently three short footpaths near the Queen Street / Wellbank Street intersection which converge at the pedestrian overbridge, providing access to the existing North Strathfield Station and the western side of the rail line. During construction, some of these footpaths may be closed, however access to the existing North Strathfield Station would be maintained. There would be no impacts to the lift access provided to the existing station.

Collectively the adjustment of the pedestrian network would minimally temporarily increase the travel distance of pedestrians and therefore impacts are anticipated to be minor.

There would be no impacts to the cycle network near the construction site during Stage 1.

Public transport services

A summary of the potential impacts to public transport services around the construction site is provided in Table 10-28.

Table 10-28: North Strathfield metro station construction site existing public transport impacts

Public transport mode	Impact description
Rail	• No impact to services. If works are required within the rail corridor, these works would be carried out during rail track possessions
Bus	• Potential temporary minor increase in travel time due to additional construction vehicles on the road network • Temporary relocation of the existing bus stop on the western side of Queen Street (north of Wellbank Street). This bus stop serves nine school bus routes. Bus operators, relevant parts of Transport for NSW, the City of Canada Bay and the affected schools would be consulted about the new bus stop location. This would not impact the operation of school bus services that use this stop, however may result in some customers having to temporarily walk slightly further distances to or from the bus stop.

Road network performance

Potential impacts to road network performance would be minimised through the implementation of the Construction Traffic Management Framework and mitigation measures identified in Section 10.16. This includes reducing vehicle movements in network peak periods and during school drop off and pick up periods.

Figure 10-31 show the performance and the anticipated performance of key intersections in the year 2023 with and without Stage 1. Additional intersection performance indicators are provided in Technical Paper 1 (Transport and traffic).

Modelled intersection performance with construction traffic indicates that the following intersections would experience a temporary reduction in level of service from Stage 1:

- Concord Road/Patterson Street during the morning peak hour. Without construction traffic, average delay at the intersection is 53 seconds, which is close to the threshold between level of service D and E. With construction traffic, average delay increases by six seconds which would not substantially change the operational performance of the intersection
- M4 Western Motorway/Concord Road during the evening peak hour. Average delay at the intersection increases by 20 seconds with the addition of construction traffic. This is the result of additional construction vehicles travelling through the intersection to access and egress from the M4 Western Motorway, with increased queue lengths on the eastbound and southbound approaches.

There would be the need to modify the Queen Street/Wellbank Street intersection, which may involve changes to the zebra crossings or signalisation. This would improve pedestrian safety, accessibility and connectivity during construction, however may have impacts on traffic and pedestrian access and movements.

Sydney Metro is continuing to investigate construction site access arrangements to reduce potential impacts and minimise conflicts with heavy vehicle movements. This may include the use of Waratah Street for haulage, localised changes to traffic circulation, and / or changes to traffic control and pedestrian crossing facilities at the Queen Street / Wellbank Street intersection.

Figure 10-31: North Strathfield metro station construction site intersection performance

Parking

To enable construction works, the parking lane on the western side of Queen Street would be temporarily removed between Wellbank Street and Pomeroy Street, resulting in the temporary loss of about 20 on-street parking spaces. These parking spaces are time-restricted to one or two hours. Nearby streets have limited capacity to accommodate additional parking demand, and it is unlikely that all lost parking spaces could be accommodated. Therefore the impact to parking on the surrounding local road network would be moderate. Impacts to parking in the local road network surrounding the construction site would be minimised through the measures outlined in Section 10.17.

The kiss and ride zone on the western side of Queen Street north of Wellbank Street would also be temporarily relocated during construction. The kiss and ride zone would be relocated to the closest practical alternative to minimise disruption to users and therefore impacts are anticipated to be minor.

10.12 Burwood North Station construction site

10.12.1 Existing environment

The Burwood North Station construction site would comprise two separate sites, a northern site and a southern site on either side of Parramatta Road. The northern site is bound by Parramatta Road, Loftus Street, a part of the southern section of Burton Street, close to Burwood Road and Burwood Road. The southern site is on the corner of Parramatta Road and Burwood Road.

The location of the construction site and the surrounding transport network are shown on Figure 10-32.

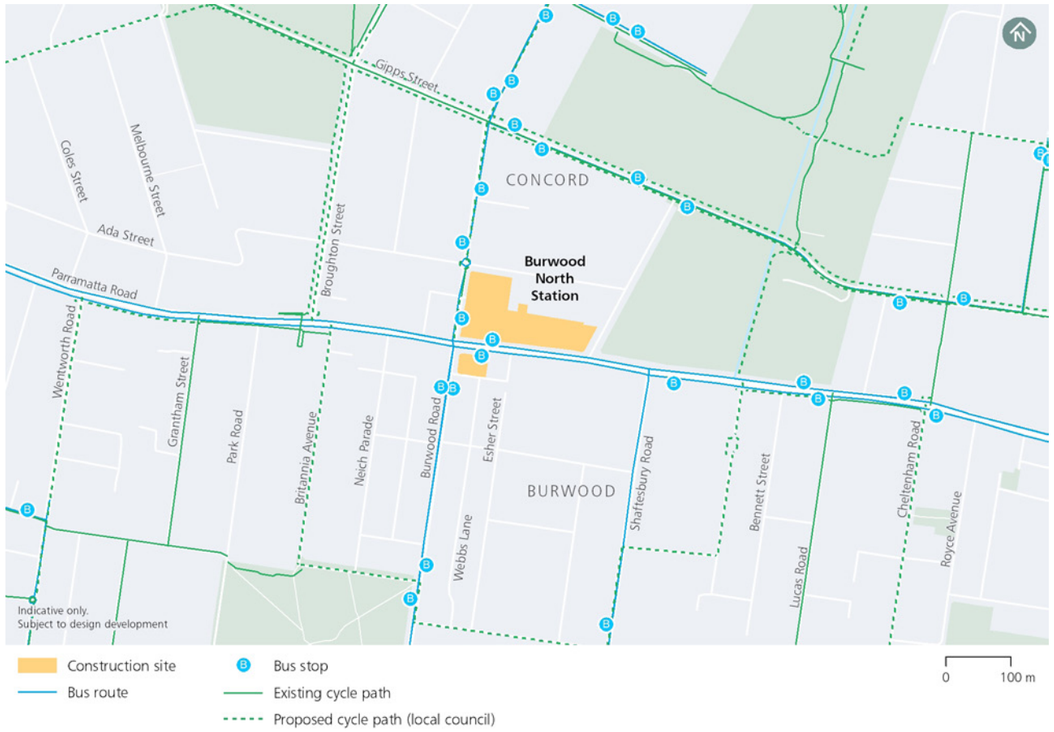


Figure 10-32: Burwood North Station construction site transport network

Active transport network

Footpaths are provided along both sides of most roads near the construction site. High levels of pedestrian activity occur along Parramatta Road and Burwood Road (south of Parramatta Road).

Pedestrian crossings are provided at the following locations:

- A pedestrian bridge over Parramatta Road near Broughton Street and Britannia Avenue
- Signalised crossings at the Parramatta Road/Burwood Road intersection, the Parramatta Road/Shaftesbury Road intersection and the Parramatta Road/Broughton Street intersection
- Staged crossing of Loftus Street via the raised central median.

The cycle network surrounding the construction site includes:

- A shared path along the southern side of Parramatta Road between the Broughton Street bridge and Grantham Street
- On-road cycle routes along Gipps Street and Stanley Street, and over the Broughton Street bridge.

Public transport services

The public transport network around Burwood North Station construction site is limited to bus services. A summary of these services is provided in Table 10-29.

Table 10-29: Burwood North Station construction site existing public transport services

Public transport mode	Description
Bus	• 27 bus routes • One public on-demand bus service • 46 school bus routes • Major bus stops on Parramatta Road, Burwood Road, Gipps Street, Crane Street and Railway Parade.

Road traffic volume and patterns

Parramatta Road is the major arterial road that carries a high volume of traffic through the road network surrounding the construction site. Key local roads in the vicinity of the construction site include Burwood Road, Broughton Street, Gipps Street and Loftus Street.

During the morning peak hour, higher traffic volumes are experienced on the following routes in the vicinity of the construction site:

- Eastbound traffic on Parramatta Road and Gipps Street
- Southbound traffic on Broughton Street, Burwood Road and Loftus Street.

During the evening peak hour, higher traffic volumes are experienced on the following routes in the vicinity of the construction site:

- Eastbound traffic on Parramatta Road
- Eastbound and westbound traffic on Gipps Street
- Southbound traffic on Broughton Street and Loftus Street
- Northbound and southbound traffic on Burwood Road.

The existing traffic volumes on the surrounding road network are provided in Table 10-30.

Table 10-30: Burwood North Station construction site existing traffic volumes (2019)

Road	Direction	Morning peak hour (vehicles per hour)	Evening peak hour (vehicles per hour)
Parramatta Road west of Broughton Street	Eastbound	2,520	2,920
	Westbound	2,260	2,280
Parramatta Road west of Loftus Street	Eastbound	2,380	2,820
	Westbound	1,840	2,010
Gipps Street west of Loftus Street	Eastbound	1,120	1,030
	Westbound	820	1,030
Broughton Street north of Parramatta Road	Northbound	250	270
	Southbound	370	410
Burwood Road south of Parramatta Road	Northbound	440	450
	Southbound	520	430
Burwood Road south of Gipps Street	Northbound	350	380
	Southbound	360	350
Loftus Street north of Parramatta Road	Northbound	<10	30
	Southbound	180	140

Intersection performance

Modelled intersection performance during the morning and evening peak hours for key intersections near the Burwood North station construction site is shown in Table 10-31.

The existing performance of the Burton Street/Broughton Street intersection during the morning peak hour is due to downstream queuing from the Parramatta Road/Broughton Street intersection.

Traffic congestion along Parramatta Road delays vehicles from Loftus Street turning into Parramatta Road, and is reflected in the existing performance of the Parramatta Road/Loftus Street intersection. This is an unsignalised intersection, where the intersection performance reported is for the worst movement (in this case, the Loftus Street southbound left-turn).

Table 10-31: Modelled peak hour existing intersection performance – Burwood North Station construction site (2019)

Intersection	Peak hour	Demand flow (vehicles per hour)	Average delay (second per vehicle)	Level of service
Broughton Street/Gipps Street	Morning	2,457	33	C
	Evening	2,698	21	B
Burton Street/Broughton Street	Morning	735	>100	F
	Evening	932	20	B
Gipps Street/Burwood Road	Morning	2,516	25	B
	Evening	2,820	22	B
Gipps Street/Loftus Street	Morning	1,868	29	B
	Evening	2,216	36	C
Loftus Street/Burton Street	Morning	263	6	A
	Evening	252	<5	A
Parramatta Road/Broughton Street	Morning	5,114	35	C
	Evening	5,155	27	B
Parramatta Road/Burwood Road	Morning	5,420	17	B
	Evening	5,506	22	B
Parramatta Road/Loftus Street	Morning	4,745	>100	F
	Evening	4,780	37	C

On-street parking, loading servicing and pick-up arrangements

On-street parking is provided on both sides of most local and collector roads including Loftus Street, Burton Street, Broughton Street and Gipps Street, east of Burwood Road. Most of these on-street parking spaces do not have any time restrictions. West of Burwood Road, on-street parking is prohibited on both sides of Gipps Street during weekday peak periods to allow for two trafficable lanes in each direction. On-street parking spaces provided on Burwood Road close to Gipps Street are not time-restricted. Near Parramatta Road, parking is prohibited on both sides of Burwood Road during weekday peak periods, with time-restricted parking available outside of these hours.

On-street parking along Parramatta Road is generally not provided with clearways in operation seven days a week during daylight hours (6 am to 7 pm Monday to Friday, 8 am to 8 pm Saturday and Sunday), and no parking or no stopping signs along most sections of the corridor.

There are no kiss and ride, loading zone or point to point transport service zones on roads immediately surrounding the construction site.

10.12.2 Potential impacts

Vehicle movement forecast and routes

The anticipated vehicle (light and heavy) one way movements over a typical day are provided in Figure 10-33 and Figure 10-34 respectively for the Burwood North Station northern construction site and in Figure 10-35 and Figure 10-36 respectively for the Burwood North Station southern construction site.

The proposed primary haul routes are shown in Figure 10-37. Access to the northern construction site would be left in from Parramatta Road (for heavy vehicles) and left in from Burton Street (for light vehicles). Egress from the northern construction site would be left out via Loftus Street (most heavy vehicles) and left out via Burton Street (light vehicles). Roads forming part of the construction vehicle route for the northern site include the M4 Western Motorway, Parramatta Road, Loftus Street, Gipps Street and Broughton Street. Access to and egress from the southern construction site would be left in from Burwood Road and left out via Parramatta Road. Roads forming part of the construction vehicle route for the southern site include the Parramatta Road, Burwood Road and the M4 Western Motorway.

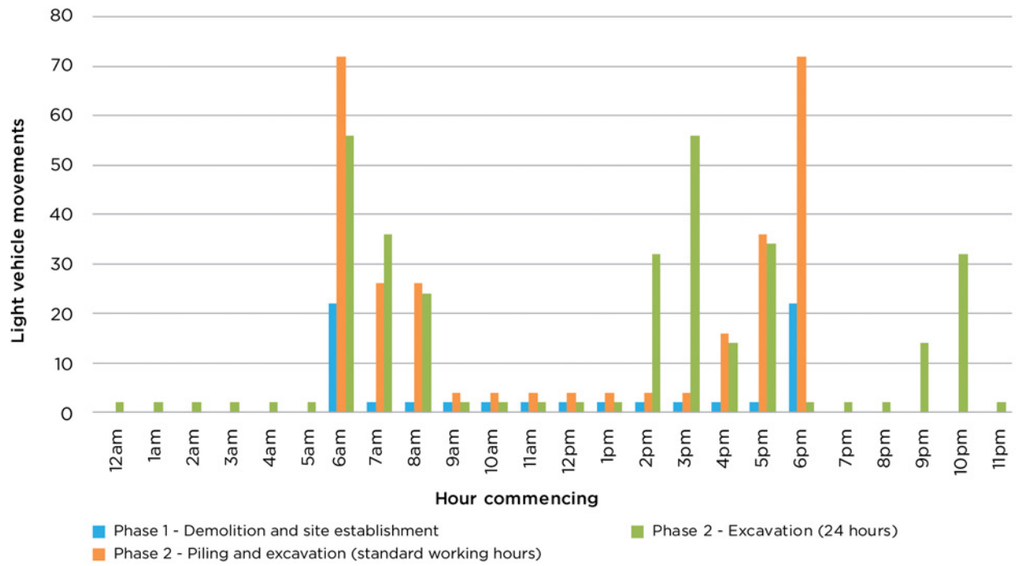


Figure 10-33: Hourly light vehicle movements at the Burwood North Station northern construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

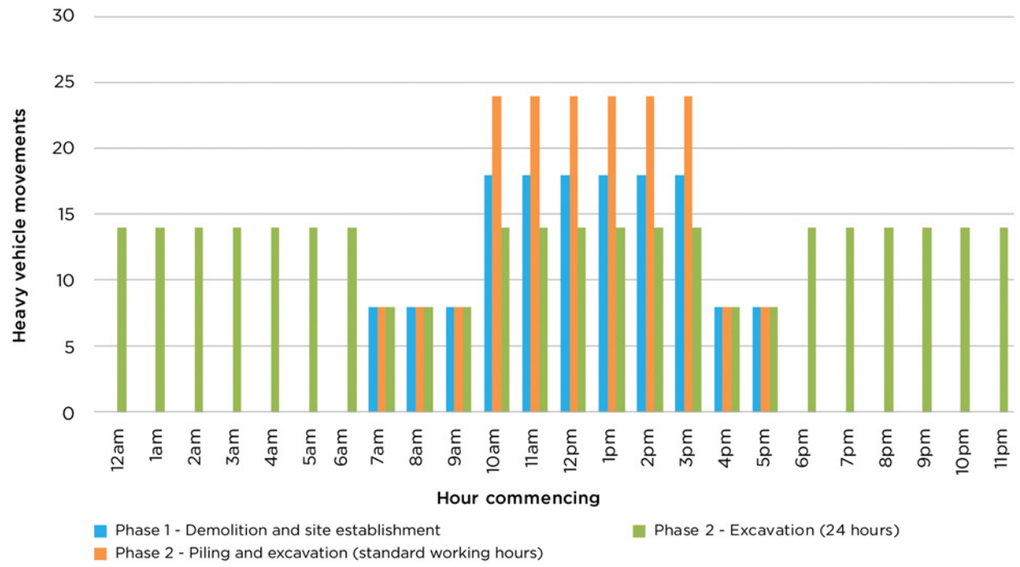


Figure 10-34: Hourly heavy vehicle movements at the Burwood North Station northern construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

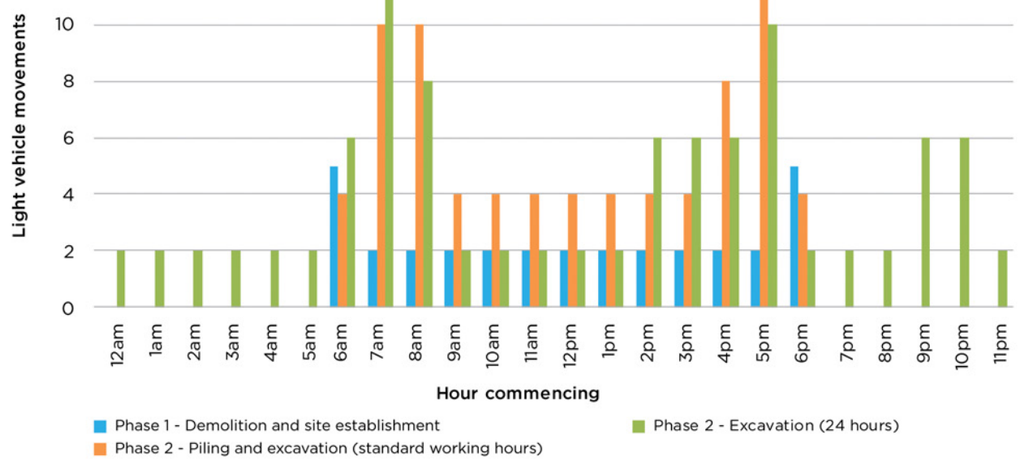


Figure 10-35: Hourly light vehicle movements at the Burwood North Station southern construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

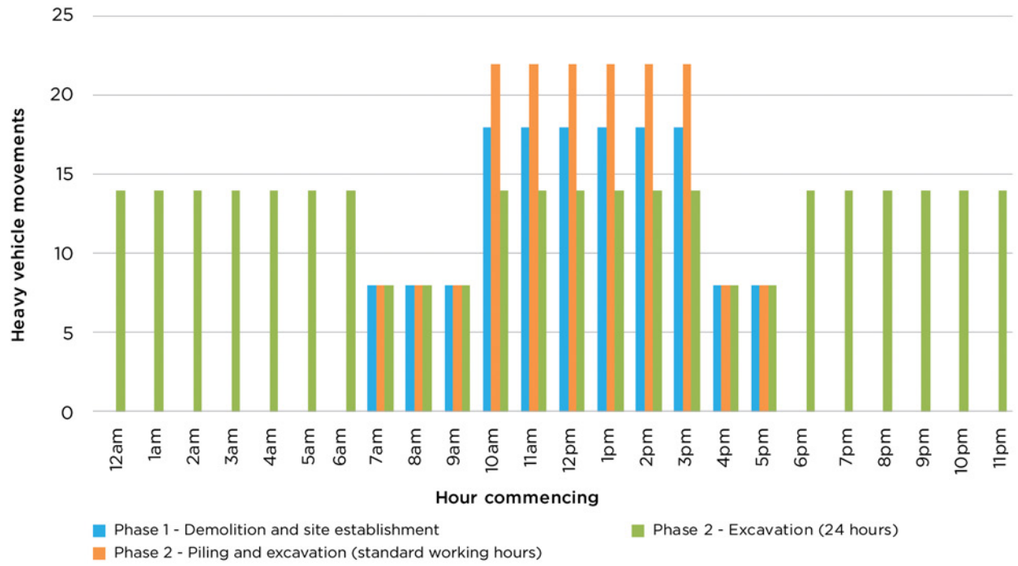


Figure 10-36: Hourly heavy vehicle movements at the Burwood North Station southern construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

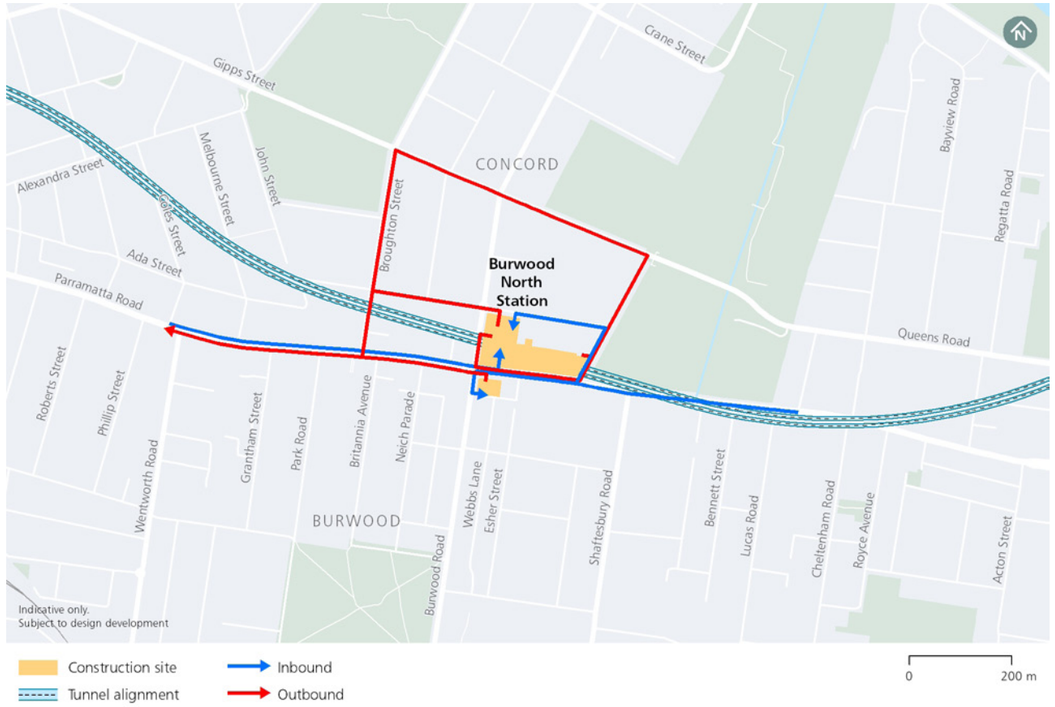


Figure 10-37: Burwood North Station construction site haulage routes

Active transport network

No impacts to pedestrians are anticipated during construction.

Gipps Street between Loftus Street and Broughton Street is designated as a moderate or high difficulty on-road cycle route. This section of Gipps Street would also be temporarily used by egressing construction vehicles generated at the northern construction site resulting in cyclists on Gipps Street temporarily interacting with a low number of additional heavy vehicles. Fencing located directly outside of the Pine Inn Hotel would be removed consistent with other sections of Parramatta Road nearby.

Public transport services

The public transport network around Burwood North Station construction site is limited to bus services. A summary of the potential impacts to bus services around the construction site is provided in Table 10-32.

Table 10-32: Burwood North station construction site existing public transport impacts

Public transport mode	Impact description

Bus	• Temporary relocation of the following bus stops:
	  • The bus stop on the northern side of Parramatta Road between Burwood Road and Loftus Street, adjacent to the Burwood North Station northern construction site
	  • The bus stop on the eastern side of Burwood Road between Neichs Lane and Parramatta Road, adjacent to the Burwood North Station northern construction site
	  • The bus stop on the southern side of Parramatta Road between Burwood Road and Esher Street, adjacent to the Burwood North Station southern construction site.
	  • Bus operators, relevant parts of Transport for NSW, the City of Canada Bay and Burwood Council (as relevant) would be consulted about the new bus stop locations.
	• Potential temporary minor increase in travel time due to additional construction vehicles on the road network.

Road network performance

Potential impacts to road network performance would be minimised through the implementation of the Construction Traffic Management Framework and mitigation measures identified in Section 10.16. This includes reducing vehicle movements in network peak periods and during school drop off and pick up periods.

Figure 10-38 shows the anticipated performance of key intersections in the year 2023 with and without Stage 1. Additional intersection performance indicators are provided in Technical Paper 1 (Transport and traffic).

Compared to existing conditions, there is a substantial decrease in demand flow at intersections along Parramatta Road. This is due to the progressive opening of WestConnex stages, where a considerable proportion of traffic that currently travels on Parramatta Road is forecast to shift onto WestConnex by 2023.

Modelled intersection performance with construction traffic indicates that the Parramatta Road/Broughton Street intersection would experience a temporary deterioration in performance from level of service B to C. However, this intersection would still operate with spare capacity.

Overall, all intersections would continue to perform satisfactorily at level of service D or better with construction traffic.

Sydney Metro is continuing to investigate opportunities to provide construction vehicle access and egress directly to Parramatta Road and minimise the use of Loftus Street by construction heavy vehicles.

Figure 10-38: Burwood North Station construction site intersection performance (2023)

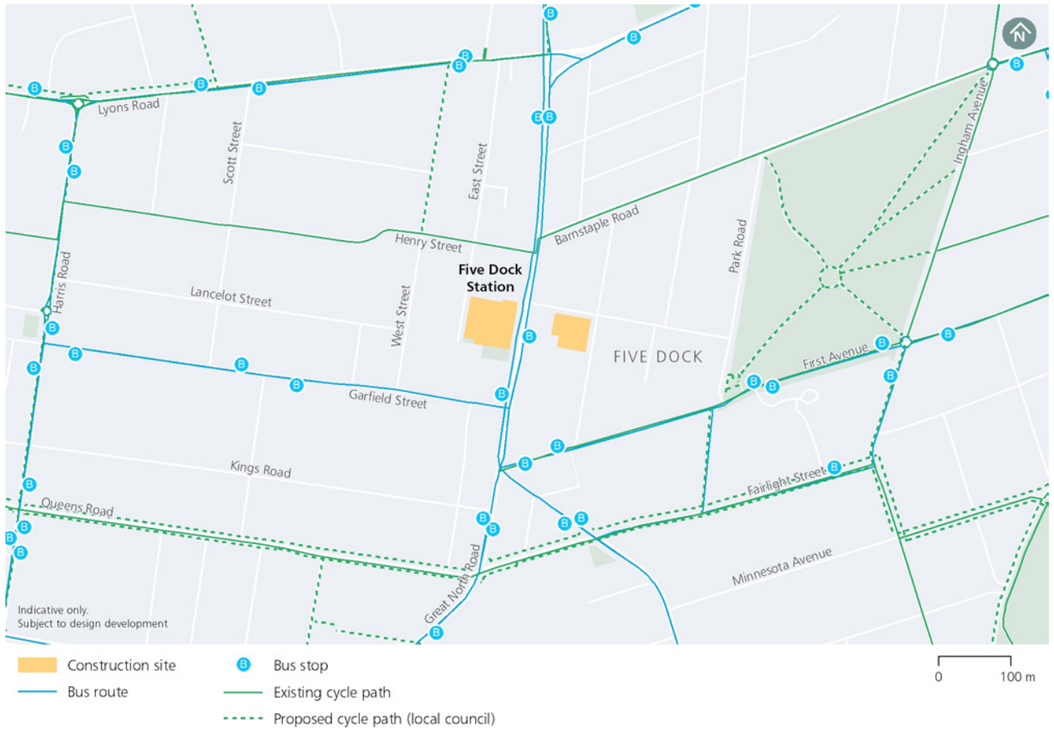


Figure 10-39: Five Dock Station construction site transport network

Parking

About four on-street parking spaces would be temporarily removed on the western side of Loftus Street adjacent to the Burwood North Station northern construction site boundary. The temporary loss of parking spaces would not have any major impacts on parking considering the proximity and availability of other spaces.

Off-street private parking for properties fronting Burwood Road and Parramatta Road within the Burwood North Station northern construction site would be permanently removed. These parking spaces serve properties that would be demolished during construction and would result in negligible parking impacts.

10.13 Five Dock Station construction site

10.13.1 Existing environment

The Five Dock Station construction site would comprise two separate sites, a western site and an eastern site on either side of Great North Road. The Five Dock Station western construction site is between Great North Road and East Street to the north of Fred Kelly Place. The Five Dock Station eastern construction site is on the corner of Waterview Street and Second Avenue.

The location of the construction site and the surrounding transport network are shown on Figure 10-39.

Active transport network

Footpaths are provided on both sides of all roads near the Five Dock Station construction site. Pedestrian activity near the construction site is concentrated around businesses and community facilities along Great North Road.

Pedestrian crossings are provided at the following locations:

- Signalised crossings at:
  - Great North Road/Ramsay Road/First Avenue intersection
  - Great North Road/Garfield Street intersection
  - Great North Road/Lyons Road intersection
  - Great North Road/Queens Road/Fairlight Street intersection
  - Great North Road at Fred Kelly Plaza
- A raised zebra crossing across Great North Road near Henry Street.

There are no controlled pedestrian crossings in the immediate vicinity of the Five Dock Station eastern construction site.

The cycle network surrounding the construction site includes:

- On-road cycle routes along Lyons Road West, Henry Street, Barnstaple Road, First Avenue and Queens Road
- An off-road cycle path on Lyons Road West
- A shared path along the southern side of Iron Cove Creek between Dobroyd Parade and Wolseley Street.

Public transport services

The public transport network around Five Dock station construction site is limited to bus services. A summary of these services is provided in Table 10-33.

Table 10-33: Five Dock station construction site existing public transport services

Public transport mode	Description
Bus	• 16 bus routes (including four NightRide bus routes) • One public on-demand bus service • 56 school bus routes • Major bus stops at Great North Road, Lyons Road, Lyons Road West, Garfield Street, Harris Road, First Avenue, Ingham Avenue, Ramsay Road and Parramatta Road.

Road traffic volume and patterns

Parramatta Road and Lyons Road are the main arterial roads that carry high volumes of traffic through the road network surrounding the construction site. Key collector roads near the construction site include Great North Road and First Avenue. Second Avenue and Waterview Street are local roads.

During the morning peak hour, higher traffic volumes are experienced on the following routes in the vicinity of the construction site:

- Eastbound traffic on Parramatta Road, Lyons Road and First Avenue
- Southbound traffic on Great North Road.

During the evening peak hour, higher traffic volumes are experienced on the following routes in the vicinity of the construction site:

- Eastbound traffic on Parramatta Road and First Avenue
- Westbound traffic on Lyons Road
- Northbound and southbound traffic on Great North Road
- Eastbound and westbound on Second Avenue
- Southbound on Waterview Street.

The existing traffic volumes on the surrounding road network are provided in Table 10-34.

Table 10-34: Five Dock Station construction site existing traffic volumes (2019)

Road	Direction	Morning peak hour (vehicles per hour)	Evening peak hour (vehicles per hour)
Lyons Road east of Great North Road	Eastbound	1,050	770
	Westbound	620	1,080
Parramatta Road west of Great North Road	Eastbound	2,430	2,560
	Westbound	2,150	2,270
Parramatta Road east of Great North Road	Eastbound	2,540	2,620
	Westbound	2,310	2,400
Second Avenue east of Great North Road	Eastbound	70	90
	Westbound	30	80
First Avenue east of Great North Road	Eastbound	290	270
	Westbound	100	160
Great North Road south of Lyons Road	Northbound	450	590
	Southbound	500	500
Great North Road north of Garfield Street	Northbound	490	570
	Southbound	540	600
Waterview Street north of First Avenue	Northbound	20	80
	Southbound	20	110

Intersection performance

Modelled existing intersection performance during the morning and evening peak hours for key intersections near the Five Dock Station construction site is shown in Table 10-35.

The existing performance of some intersections on Great North Road in the evening peak hour is due to the conflict between local traffic with their end destinations in Five Dock and regional traffic travelling between Lyons Road and Parramatta Road via Great North Road.

Table 10-35: Modelled peak hour existing intersection performance – Five Dock Station construction site (2019)

Intersection	Peak hour	Demand flow (vehicles per hour)	Average delay (second per vehicle)	Level of service
Great North Road/Garfield Street	Morning	1,308	21	B
	Evening	1,422	32	C
Great North Road/Lyons Road	Morning	2,748	47	D
	Evening	3,124	66	E
Great North Road/Queens Road/ Fairlight Street	Morning	2,507	27	B
	Evening	2,520	30	C
Great North Road/Ramsay Road/First Avenue	Morning	1,418	16	B
	Evening	1,484	28	B
Parramatta Road/Great North Road	Morning	5,335	34	C
	Evening	5,193	62	E
Great North Road/Second Avenue	Morning	1,018	9	A
	Evening	1,121	15	A
First Avenue/Waterview Street	Morning	387	<5	A
	Evening	437	<5	A
Second Avenue/Waterview Street	Morning	98	7	A
	Evening	195	8	A

On-street parking, loading, servicing and pick-up arrangements

On-street parking is provided on both sides of Great North Road. Near the Five Dock town centre, parking spaces on the western side of Great North Road are time-restricted while parking spaces on the eastern side of Great North Road are not time-restricted. On-street parking is also available on both sides of local roads such as First Avenue, Waterview Street and Second Avenue, consisting of time-restricted and unrestricted spaces.

A loading zone is located on the northern side of Henry Street near Great North Road and a mail zone is on the northern side of Garfield Street near Great North Road. There are no kiss and ride zones on roads immediately surrounding the construction site.

10.13.2 Potential impacts

Vehicle movement forecast and routes

The anticipated vehicle (light and heavy) one way movements over a typical day are provided in Figure 10-40 and Figure 10-41 respectively for the Five Dock Station northern construction site and in Figure 10-42 and Figure 10-43 respectively for the Five Dock Station southern construction site.

The proposed primary haul routes are shown in Figure 10-44. Access to and egress from the Five Dock Station western construction site would be left in and left out via Great North Road. Roads forming part of the construction vehicle route for the Five Dock Station west construction site include Parramatta Road, Great North Road and Lyons Road. Access to and egress from the Five Dock Station eastern construction site would be left in from Waterview Street and left out to Second Avenue. Roads forming part of the construction vehicle route for the Five Dock Station eastern construction site include Parramatta Road, Great North Road, First Avenue, Waterview Street and Second Avenue.

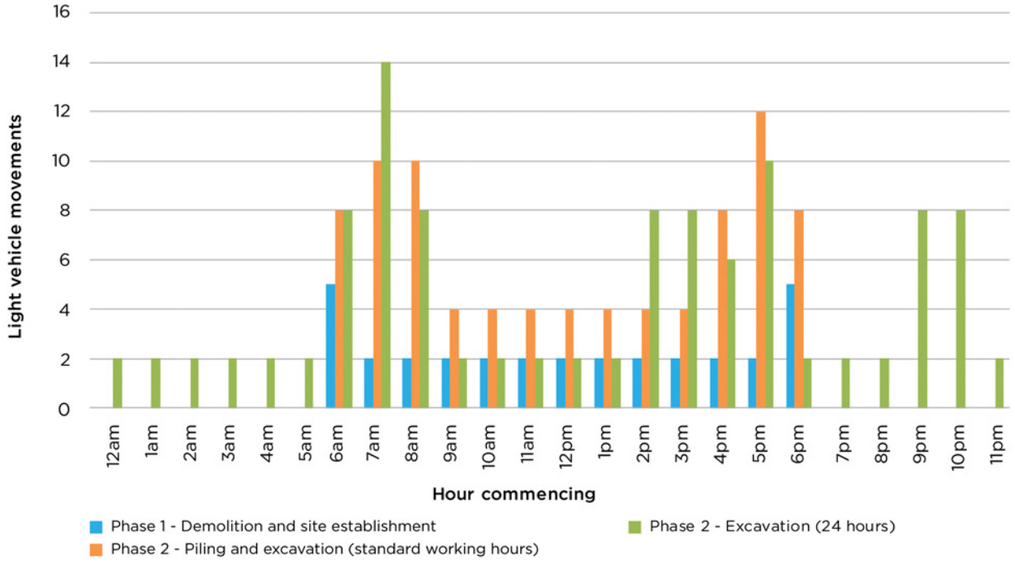


Figure 10-40: Hourly light vehicle movements at the Five Dock Station western construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

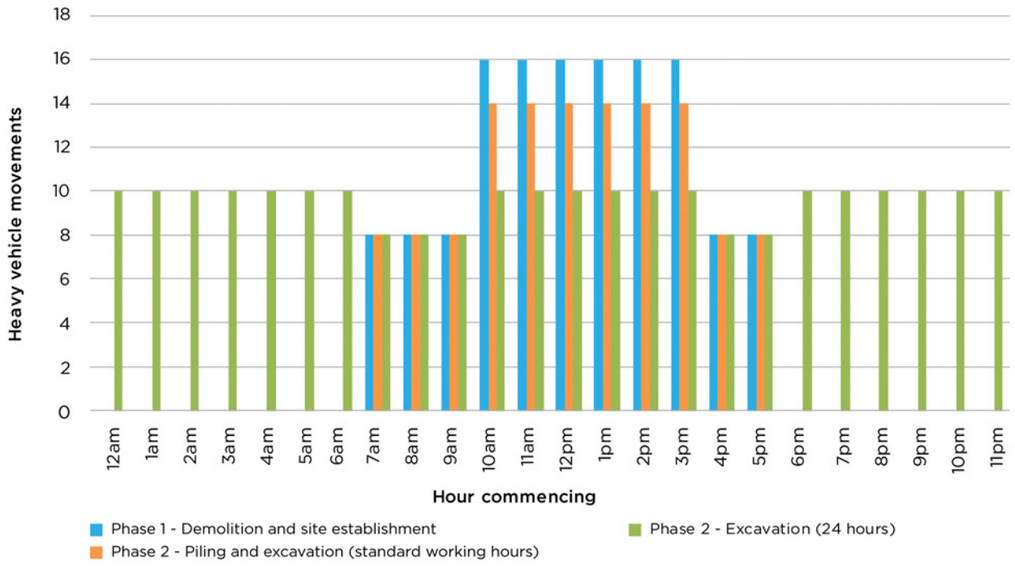


Figure 10-41: Hourly heavy vehicle movements at the Five Dock Station western construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

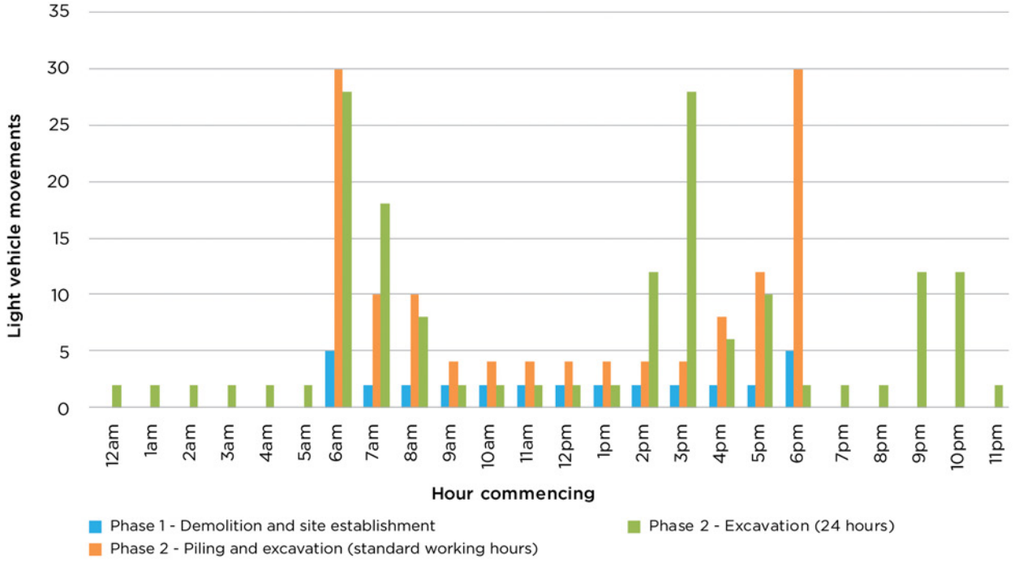


Figure 10-42: Hourly light vehicle movements at the Five Dock Station eastern construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

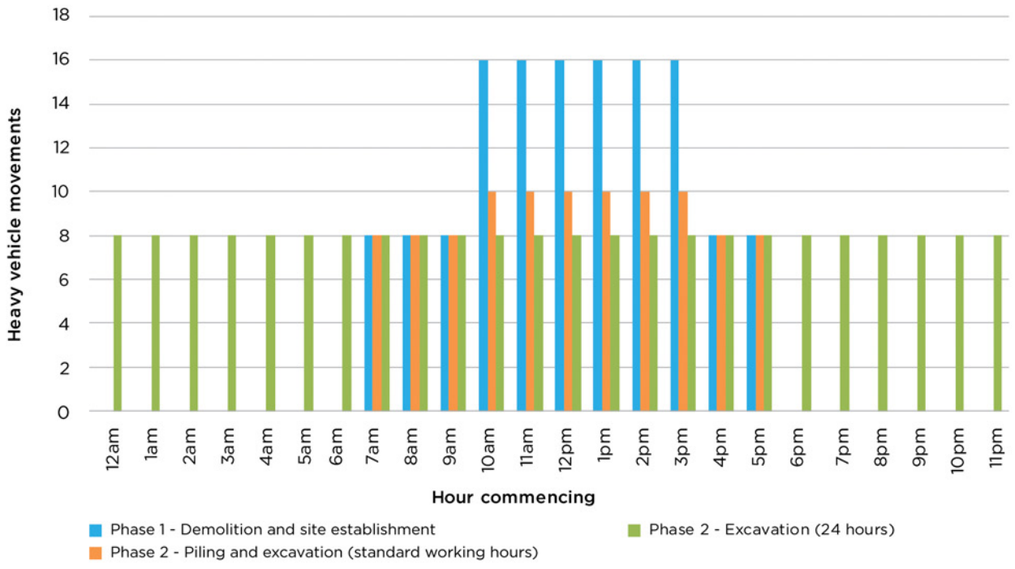


Figure 10-43: Hourly heavy vehicle movements at the Five Dock Station eastern construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

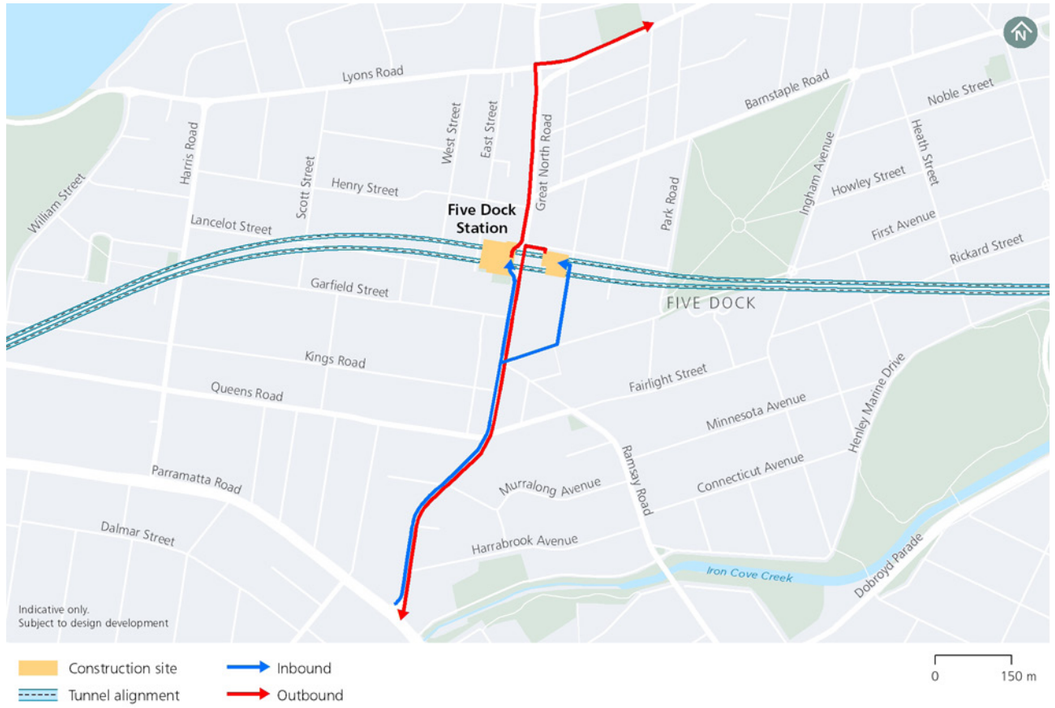


Figure 10-44: Five Dock Station construction site haulage routes

Active transport network

The Five Dock Station western construction site is located adjacent to Fred Kelly Place, which generates a substantial amount of pedestrian activity. Establishment of the construction site would require temporary changes to some pedestrian footpaths. No other impacts to pedestrians are anticipated.

Cyclists using First Avenue would be subject to temporary minor increases in additional heavy vehicles (four heavy vehicle movements per hour during peak periods).

Public transport services

The public transport network around Five Dock Station construction site is limited to bus services. Potential impacts to the bus services around the construction site would include a temporary minor increase in travel time due to additional construction vehicles on the road network.

Road network performance

Potential impacts to road network performance would be minimised through the implementation of the Construction Traffic Management Framework and mitigation measures identified in Section 10.16. This includes reducing vehicle movements in network peak periods and during school drop off and pick up periods.

Figure 10-45 shows the anticipated performance of key intersections in the year 2023 with and without Stage 1. Additional intersection performance indicators are provided in Technical Paper 1 (Transport and traffic).

Compared to the existing conditions, there is a substantial decrease in demand flow at intersections along Parramatta Road. This is due to the progressive opening of WestConnex stages, where a considerable proportion of traffic that currently travels on Parramatta Road is forecast to shift onto WestConnex by 2023.

Modelled intersection performance with construction traffic indicates that several intersections near the Five Dock station construction site would experience a temporary deterioration in level of service. The temporary impacts of construction traffic on intersection performance in the evening peak hour in an already congested network are considered major due to the following:

- A number of intersections would experience a substantial temporary increase in average delay
- A number of intersections that operate with spare capacity prior to construction would be temporarily at or over-capacity during construction
- Construction vehicles would be travelling within a constrained environment, with Great North Road generally limited to a single lane in each direction.
- The temporary increase in vehicles on Great North Road during construction results in increased congestion at the Great North Road / Garfield Street intersection, which also impacts the operational performance of the Great North Road / Second Avenue intersection
- Great North Road / Second Avenue is an unsignalised intersection, with the worst movement reported as the overall performance of the intersection. This movement is the westbound approach along Second Avenue where construction vehicles turning left would experience difficulty finding a suitable gap in traffic due to queueing along Great North Road in the southbound direction.

Sydney Metro is continuing to investigate construction site access arrangement to reduce potential impacts and minimise conflicts with heavy vehicle movements. This includes the potential conversion of Waterview Street (north of the car park) to one-way northbound circulation.

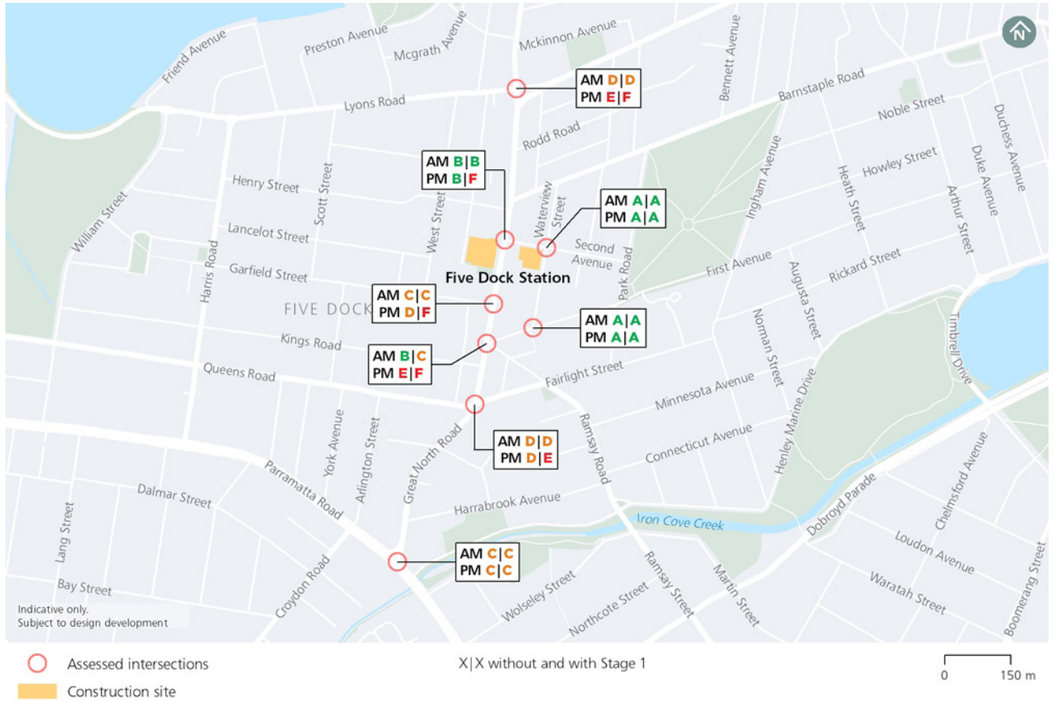


Figure 10-45: Five Dock Station construction site intersection performance (2023)

Parking and property access

Western construction site

About 12 on-street parking spaces may be temporarily removed along the western side of Great North Road between East Street and Second Avenue, adjacent to the Five Dock Station western construction site. These parking spaces are time-restricted to 30 minutes.

There is the potential for conflict between vehicles exiting the Five Dock Station western construction site and vehicles exiting the St Albans Anglican Church driveway. Construction vehicle movements would be managed during church service times so that the potential for conflict with church patrons is minimised.

Eastern construction site

About 12 off-street restricted parking spaces that are accessible from Second Avenue between Great North Road and Waterview Street would be permanently removed. In addition, up to 10 on-street parking spaces may be temporarily removed near the site access and egress points along Waterview Street (unrestricted parking) and Second Avenue (time-restricted parking), respectively, to accommodate construction vehicle movements.

There is limited spare parking capacity available on the local road network in Five Dock.

10.14 The Bays Station construction site

10.14.1 Existing environment

The Bays Station construction site would be located on Port Access Road near Victoria Road, Robert Street and Solomons Way.

The location of the construction site and the surrounding transport network are shown on Figure 10-46.

Figure 10-46: The Bays Station construction site transport network

Active transport network

Pedestrian activity within the immediate vicinity of the construction site is low given the industrial land uses present. Footpaths are provided on both sides of Victoria Road, James Craig Road and Robert Street. Footpaths are provided on one side of Solomons Way and Sommerville Road, however sections of these roads are not open to the general public. The surrounding suburbs of Rozelle, Balmain, Glebe and Annandale have well-developed pedestrian networks.

Pedestrian crossings are provided at the following locations:

- Pedestrian overpasses across Victoria Road and The Crescent near the Victoria Road/The Crescent intersection and near Lilyfield Road
- Signalised crossings at the Victoria Road/Robert Street intersection, the Victoria Road/The Crescent intersection and the James Craig Road/The Crescent intersection
- Staged crossing via the median at the roundabout on James Craig Road (east of The Crescent).

The cycle network surrounding the construction site includes:

- Off-road shared paths on Victoria Road, James Craig Road, ANZAC Bridge, The Crescent, Robert Street (east of Buchanan Street), Railway Parade, and throughout Jubilee Park and on the western side of White Creek
- On-road cycle routes along Balmain Road, Darling Street, Lilyfield Road, Robert Street, Crescent Street, Gordon Street, Denison Street and Cecily Street.

The future active transport network within the vicinity of The Bay Station construction site will be modified to accommodate WestConnex M4-M5 Link, which is part of the WestConnex program of works. These changes will be implemented by the time construction of Stage 1 commences.

Public transport services

A summary of the public transport services around The Bays Station construction site is provided in Table 10-36.

Table 10-36: The Bays Station construction site existing public transport services

Public transport mode	Description
Rail	No suburban, intercity train or light rail services near the construction site
Bus	• 23 bus routes • 20 school bus routes • Major bus stops on Victoria Road, The Crescent and Lilyfield Road. • Bus lanes on Victoria Road and The Crescent.
Ferry	• Ferry service between the White Bay Cruise Terminal and Barangaroo when cruise ships are docked at the White Bay Cruise Terminal (Captain Cook Cruises).

Road traffic volume and patterns

City West Link, The Crescent and Victoria Road are the major arterial roads that carry high volumes of traffic through the road network surrounding the construction site. Key collector roads near the construction site include James Craig Road, Robert Street and Solomons Way.

During the morning peak, higher traffic volumes are experienced on the following routes near the construction site:

- Eastbound on City West Link and The Crescent
- Southbound on Victoria Road.

During the evening peak, higher traffic volumes are experienced on the following routes in the vicinity of the construction site:

- Eastbound and westbound on City West Link and The Crescent
- Northbound on Victoria Road.

The future road network within the vicinity of The Bay Station construction site will be modified to accommodate WestConnex M4-M5 Link. These changes will be implemented by 2023. Additional road network changes are proposed as part of Western Harbour Tunnel and Beaches Link. This project is currently in its planning stages and if approved, would connect to WestConnex M4-M5 Link and the surface road network in Rozelle. Port Access Road is proposed to be relocated prior to commencement of site establishment for Stage 1. This project is subject to a separate planning pathway.

The existing traffic volumes on the surrounding road network are provided in Table 10-37.

Table 10-37: The Bays Station construction site existing traffic volumes (2016)

Road	Direction	Morning peak hour (vehicles per hour)	Evening peak hour (vehicles per hour)
The Crescent west of James Craig Road	Eastbound	2,630	2,990
	Westbound	2,240	2,990
City West Link west of The Crescent	Eastbound	1,830	2,260
	Westbound	1,500	2,250
James Craig Road east of The Crescent	Eastbound	330	130
	Westbound	160	210
Victoria Road north of The Crescent	Northbound	1,920	3,690
	Southbound	3,940	2,930

Intersection performance

Modelled existing intersection performance during the morning and evening peak hours for key intersections near The Bays Station construction site is shown in Table 10-38.

Existing performance of these intersections is a result of high volumes of through traffic conflicting with right turning and cross-street traffic, in conjunction with substantial queuing along City West Link in the eastbound direction.

Table 10-38: Modelled peak hour existing intersection performance – The Bays Station construction site (2016)

Intersection	Peak hour	Demand flow (vehicles per hour)	Average delay (second per vehicle)	Level of service
Victoria Road/Robert Street	Morning	5,876	48	D
	Evening	6,721	39	C
Victoria Road/The Crescent	Morning	9,741	32	C
	Evening	11,551	36	C
The Crescent/James Craig Road	Morning	5,190	29	C
	Evening	6,521	9	A
City West Link/The Crescent	Morning	5,076	>100	F
	Evening	6,699	32	C
City West Link/Catherine Street	Morning	3,926	73	F
	Evening	5,174	32	C

On-street parking, loading, servicing and pick-up arrangements

Parking is prohibited in both directions along City West Link and The Crescent east of City West Link with clearways in operation at all times. Also, on-street parking is not available along James Craig Road and The Crescent south of City West Link.

There are no kiss and ride, loading zone or point to point transport service zones on roads immediately surrounding the construction site.

10.14.2 Potential impacts

Vehicle movement forecast and routes

The anticipated vehicle (light and heavy) one way movements at the construction site over a typical day are provided in Figure 10-47 and Figure 10-48 respectively.

The proposed primary haul routes are shown in Figure 10-49. Access to and egress from the construction site would be right in and left out via Solomons Way. Roads forming part of the construction vehicle route include City West Link, The Crescent, James Craig Road, Sommerville Road and Solomons Way.

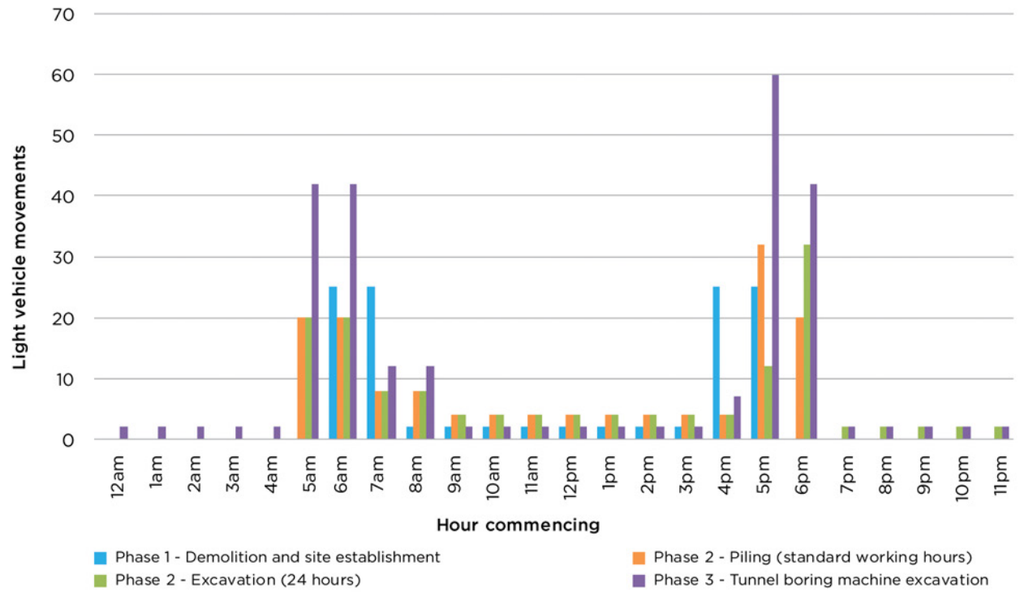


Figure 10-47: Hourly light vehicle movements at The Bays Station construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

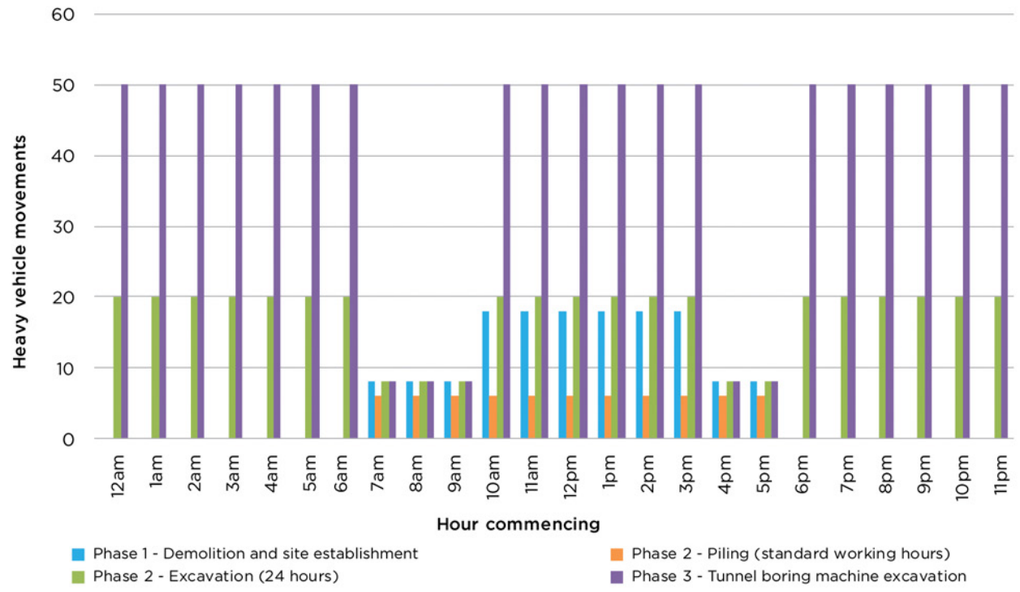


Figure 10-48: Hourly heavy vehicle movements at The Bays Station construction site

Note: Movement means a one way movement. A truck entering and then leaving a work site represents 2 movements.

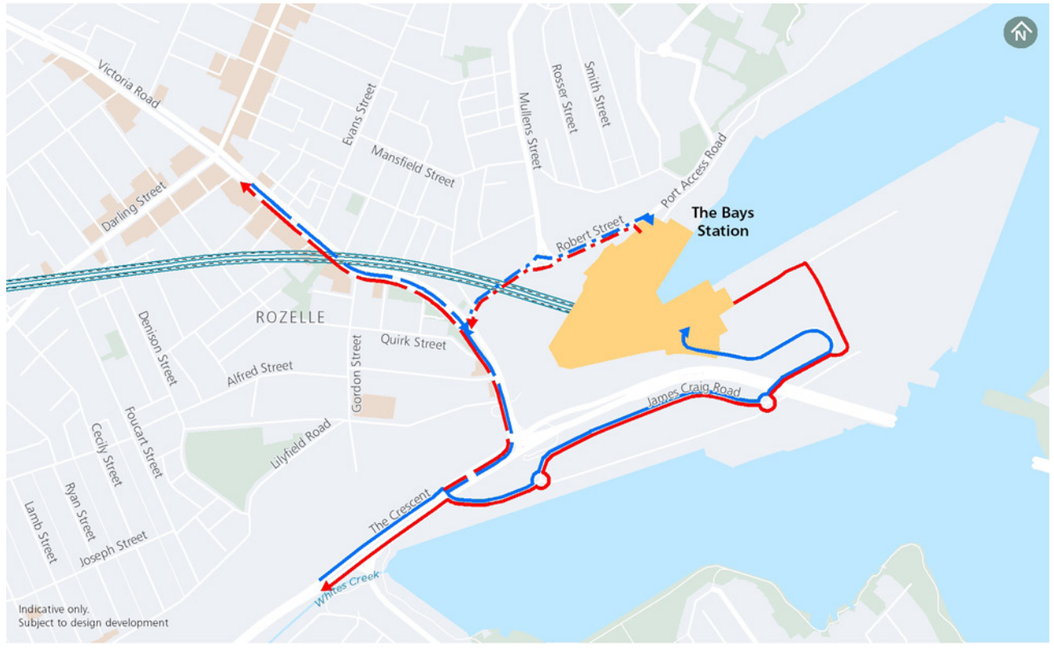


Figure 10-49: The Bays Station construction site haulage routes

Active transport network

The construction site is not anticipated to result in any impacts to the active transport network given that shared paths adjacent to James Craig Road and The Crescent would remain open.

Public transport services

There is potential for a minor temporary increase in bus travel time due to additional construction vehicles on the road network. There would be no other impacts to public transport services.

Road network performance

Potential impacts to road network performance would be minimised through the implementation of the Construction Traffic Management Framework and mitigation measures identified in Section 10.16. This includes reducing vehicle movements in network peak periods.

Figure 10-50 shows the anticipated performance of key intersections in the year 2023 with and without Stage 1. Additional intersection performance indicators are provided in Technical Paper 1 (Transport and traffic).

From an operational perspective, the performance of an intersection where the modelling results show a small reduction in demand flow and/or average delay would remain very similar with and without construction traffic.

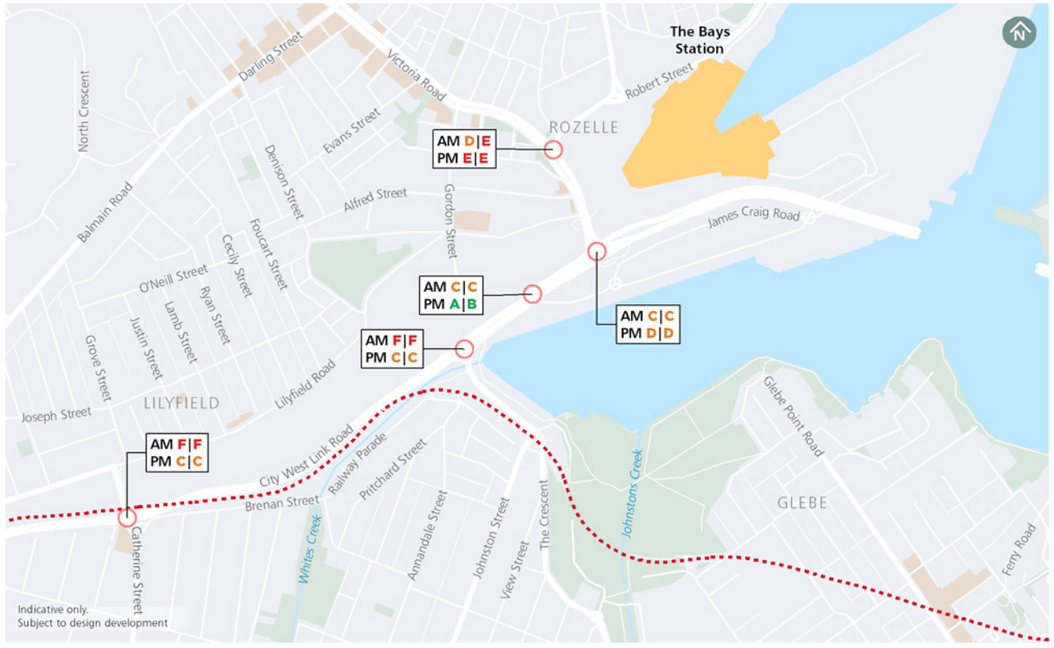


Figure 10-50: The Bays Station construction site intersection performance (2023)

Parking and property access

No impacts to parking or property access are anticipated during construction.

10.15 Cumulative impacts

Potential cumulative impacts were considered for assessment based on the likely interactions of Stage 1 with other projects and plans that met the adopted screening criteria. The approach to assessment and the other projects considered are described further in Appendix G (Cumulative impacts assessment methodology – Stage 1).

Projects which have been considered for the cumulative construction traffic assessment are those which fall within the construction footprint of Stage 1, as well as construction vehicle routes that use roads near the Stage 1 construction sites.

The future Parramatta Light Rail (Stage 1) is being constructed near to the Westmead and Parramatta metro station construction sites. The construction vehicle routes in Westmead for the two projects are not anticipated to interact. However, in Parramatta construction vehicles for both projects are anticipated to use many of the same roads including Great Western Highway, O'Connell Street and Pitt Street.

Construction of the future Parramatta Light Rail (Stage 1) commenced in late-2018 and is scheduled for completion in 2023. The program for the future Parramatta Light Rail (Stage 1) indicates that the main construction works would be completed in 2022, with testing and commissioning completed in 2023.

Given that a low number of construction vehicles would be generated during the testing and commissioning phase in 2023, and that the future Parramatta Light Rail (Stage 1) construction vehicle routes do not directly interface with Stage 1 construction vehicle routes in Westmead, cumulative construction impacts at the Westmead metro station construction site are anticipated to be minimal. Cumulative construction impacts at the Parramatta metro station construction site are anticipated to be minor.

Stage 1 construction works at The Bays Station construction site would occur simultaneously with WestConnex M4-M5 Link and Western Harbour Tunnel. Cumulative impacts could occur associated with a temporary increase in construction vehicles on the road networks resulting in a reduction in intersection performance. The number of temporary construction vehicle movements generated by Stage 1, WestConnex M4-M5 Link and Western Harbour Tunnel during the morning and evening peak hour is provided in Table 10-39.

Table 10-39: Number of cumulative construction vehicle movements

Project	Construction site	Morning peak hour (vehicles per hour)		Evening peak hour (vehicles per hour)	
		Light vehicle	Heavy vehicle	Light vehicle	Heavy vehicle
Stage 1	The Bays Station construction site	2	8	60	8
WestConnex M4-M5 Link	Rozelle civil and tunnel site	100	46	350	46
	Iron Cove Link civil site	15	4	140	4
Western Harbour Tunnel	Rozelle Rail Yards construction support site	45	14	30	14
	Victoria Road construction support site	41	37	71	37
	White Bay construction support site	40	63	140	63

Figure 10-51 shows the anticipated performance of key intersections in the year 2023 with and without Stage 1. Additional intersection performance indicators are provided in Technical Paper 1 (Transport and traffic).

From an operational perspective, this means that the road network is already operating at capacity and the cumulative impact of construction vehicles would result in temporary increased intersection delays and queue lengths.

Co-ordination of traffic management arrangements between major construction projects would occur in consultation with Transport for NSW including Transport Coordination.

The temporary impacts of cumulative construction traffic on intersection performance in the evening peak hour in an already congested network are considered major due to the following:

- A number of intersections would experience a substantial increase in average delay as indicated by a level of service E or F during construction
- A number of intersections that already operate close to or at capacity would deteriorate even further with cumulative construction
- Cumulative construction vehicles would be travelling within an already congested environment.

WestConnex M4-M5 Link is expected to be operational in 2023 and should provide some improvement to the operational performance of the road network near The Bays Station construction site. Additional mitigation measures would also be adopted to reduce the anticipated impacts.

Figure 10-51: The Bays Station construction site cumulative intersection performance

10.16 Management and mitigation measures

10.16.1 Approach to management and mitigation

The approach to transport and traffic management during the construction phase, including the process for the development of all Traffic Management Plans, is outlined in Appendix F (Construction Traffic Management Framework).

The Construction Traffic Management Framework provides the overall strategy and approach for construction traffic management for Sydney Metro West, and an outline of the traffic management requirements and processes that will be common to each of the proposed construction sites. It establishes the traffic management processes (including the use of directional signage and variable message signs), emergency services consultation requirements for access impacts and acceptable criteria to be considered and followed in managing roads and footpaths adjacent to construction sites.

10.16.2 Mitigation measures

The mitigation measures that would be implemented to address potential temporary transport and traffic impacts are listed in Table 10-40.

Table 10-40: Mitigation measures – Transport and traffic Stage 1

Reference	Impact/issue	Mitigation measure	Application location(s)[1]
TT1	Changes to the network	The community would be notified in advance of proposed road and pedestrian network changes through appropriate forms of community liaison.	All
TT2	Traffic incidents	In the event of a traffic related incident, coordination would be carried out with Transport Coordination and/or the Transport Management Centre's Operations Manager.	All
TT3	Emergency vehicles access	Access to properties for emergency vehicles would be provided at all times.	All
TT4	Road safety	Vehicle access to and from construction sites would be managed to maintain pedestrian, cyclist and motorist safety. Depending on the location, this may require manual supervision, physical barriers, temporary traffic signals and modifications to existing signals or, on occasions, police presence.	All
TT5	Road safety	Additional enhancements for pedestrian, cyclist and motorist safety near the construction sites would be implemented during construction. This would include measures such as: • Assessing the suitability of construction haulage routes through sensitive land use areas with respect to road safety • Deployment of speed awareness signs in conjunction with variable message signs near construction sites to provide alerts to drivers • Providing community education and awareness about sharing the road safely with heavy vehicles • Specific construction driver training to understand route constraints, safety and environmental considerations such as sharing the road safely with other road users and limiting the use of compression braking • Requiring technology and equipment to improve vehicle safety, eliminate heavy vehicle blind spots, and monitor vehicle location and driver behaviour.	All
TT6	Road safety	All trucks would enter and exit construction sites in a forward direction, where feasible and reasonable.	All
TT7	Congestion	Construction site traffic would be managed to minimise movements during peak periods.	All
TT8	Congestion	Construction site traffic immediately around construction sites would be managed to minimise vehicle movements through school zones during pick up and drop off times.	WMS, PMS, BNS, FDS
TT9	Congestion	Opportunities to minimise impacts at the Alexandra Avenue/Bridge Road intersection would be determined in consultation with Transport for NSW.	WMS
TT10	Loss of parking	Where existing parking is removed to facilitate construction activities, consultation would occur with the relevant local council to investigate opportunities to provide alternative parking facilities.	All
TT11	Loss of parking	Construction sites would be managed to minimise the number of construction workers parking on surrounding streets by: • Encouraging workers to use public or active transport • Encouraging ride sharing • Provision of alternative parking locations and shuttle bus transfers where feasible and reasonable.	All
TT12	Change of bus stop locations	Any relocation of bus stops and kiss-and-ride facilities would be carried out in consultation with Transport for NSW including Transport Coordination (for relevant locations), the relevant local council and bus operators. Wayfinding and customer information would be provided to notify customers of relocated bus stops.	WMS, NSMS, BNS
TT13	Bus priority	Opportunities to improve bus priority along the temporary detour at Westmead metro station construction site would be investigated during detailed design.	WMS
TT14	Active transport	Pedestrian and cyclist access would be maintained during the temporary closure of Alexandra Avenue. Wayfinding and customer information would be provided to guide pedestrians and cyclists to alternative routes.	WMS
TT15	Impacts on active transport	Where existing cyclist facilities (e.g. bicycle parking) would be temporarily unavailable to facilitate construction activities, suitable replacement facilities would be provided for this duration.	WMS, PMS
TT16	Taxi relocation	Any relocation of taxi ranks would be carried out in consultation with Transport for NSW, the relevant local council and taxi operators. Wayfinding and customer information would be provided to notify customers of relocated taxi ranks.	SOPMS
TT17	Impacts on special events	During major special events, impacts to the transport and traffic network would be reduced by (as necessary): • Minimising the level of construction activity, and if necessary, ceasing all construction activity • Maintaining appropriate access to all areas within the event precinct • Erection of hoardings, site fencing and gates at key locations within the construction site boundary to permit pedestrian movements adjacent to the construction site and separate pedestrians from construction vehicles • Scheduling deliveries to the construction site outside of event periods. For special events that require specific traffic measures, those measures would be developed in consultation with Transport for NSW including Transport Coordination (for relevant locations), and the organisers of the event.	PMS, CSMF, SOPMS

Reference	Impact/issue	Mitigation measure	Application location(s)[1]
TT18	Property access	Access to existing properties and buildings would be maintained in consultation with property owners.	All
TT19	Construction vehicle impacts	Traffic control measures required at the Parramatta metro station construction site access on George Street would be determined in consultation with Transport for NSW.	PMS
TT20	Construction vehicle impacts	Adjustments to site access arrangements and the local road network would be explored during detailed design to minimise conflicts with heavy vehicle movements.	NSMS, FDS
TT21	Construction vehicle impacts	Construction site traffic generated at the Five Dock Station construction site would be managed to avoid or minimise travel during the evening peak period.	FDS
TT22	Construction vehicle impacts	Construction site traffic generated at the Five Dock Station construction site would be managed to minimise movements during church service times at St Albans Anglican Church.	FDS
TT23	Construction vehicle impacts	Opportunities to provide vehicle access and egress directly to Parramatta Road and minimise the use of Loftus Street at the Burwood North Station construction site would be explored during detailed design.	BNS
TT24	Cumulative construction traffic impacts	Co-ordination of traffic management arrangements between major construction projects would occur in consultation with Transport for NSW including Transport Coordination.	TBS

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (eg tunnel boring machine works); PSR: Power supply routes.

10.16.3 Interactions between mitigation measures

There are no mitigation measures in other chapters that are directly relevant to the management of potential transport and traffic impacts.

There are no mitigation measures identified in the assessment of other environmental aspects that are likely to affect the assessment of transport and traffic.

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11 Noise and vibration – Stage 1

11 Noise and vibration – Stage 1

This chapter provides an assessment of the potential noise and vibration impacts as a result of Stage 1 and identifies mitigation measures to address these impacts. This chapter draws on information provided in Technical Paper 2 (Noise and vibration).

11.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to noise and vibration and where they have been addressed in the Environmental Impact Statement are outlined in Table 11-1.

Table 11-1: Secretary's Environmental Assessment Requirements – Noise and vibration Stage 1

Reference	Secretary's Environmental Assessment Requirements	Where addressed
4. Noise and Vibration		
4.1	Commitments made in Section 9.2.2 of the Scoping Report.	Section 11.5 to 11.14
4.2	An assessment of construction noise and vibration impacts must address: a. the nature of construction activities and related noise characteristics;	Section 11.3
	b. the intensity and duration of noise (both air and ground borne) and vibration impacts. This must include consideration of extended construction impacts associated with ancillary facilities (and the like) and construction fatigue;	Section 11.5 to 11.14
	c. the identification and nature of receivers, existing and proposed, during the construction period;	
	d. the nature of the impact and the sensitivity of receivers and level of impact including for out of hours works;	
	e. the need to balance timely conclusion of noise and vibration-generating works with periods of receiver respite, and other factors that may influence the timing and duration of construction activities (such as traffic management);	Section 11.3
	f. noise impacts of out-of-hours works (including utility works and works associated with the SSI including those undertaken under another assessment pathway), possible locations where out-of-hours works would be undertaken, the activities that would be undertaken, the estimated duration of those activities and justification for these activities in terms of the Interim Construction Noise Guideline (DECCW, 2009);	Section 11.5 to 11.14
	g. sleep disturbance (including the number of noise-awakening events);	
	h. a cumulative noise and vibration assessment inclusive of impacts from Stage 1, including concurrent construction activities within Stage 1 and the construction of other relevant development in the vicinity of Stage 1;	Section 11.15
	i. details and analysis of the predicted effectiveness of mitigation measures to adequately manage identified impacts, including impacts as identified in (h);	Section 11.5 to 11.14 Section 11.16
	j. any potential residual noise and vibration impacts following application of mitigation measures; and	
	k. a description of how receiver feedback received would be taken into account in the design of mitigation measures, including any tailored mitigation, management and communication strategies for sensitive receivers.	Section 11.16.2
4.3	The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage).	Section 11.5 Section 11.6 to 11.14
4.4	Blast impacts (if required) can comply with current guidelines.	Section 11.3.9 Section 11.16.2

11.2 Legislative and policy context

The guidelines used to assess noise and vibration impacts from Stage 1 are listed in Table 11-2.

Table 11-2: Noise and vibration guidelines

Guideline/policy name	Where guideline has been used
Interim Construction Noise Guideline (ICNG) (Department of Environment and Climate Change, 2009)	Assessment of airborne noise and ground-borne noise impacts on sensitive receivers.
Assessing Vibration: a technical guideline (Department of Environment and Conservation, 2006)	Assessment of vibration impacts on sensitive receivers.
AS2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors	Provides recommended design sound levels for internal areas of occupied spaces.
NSW Road Noise Policy (Department of Environment, Climate Change and Water, 2011)	Assessment of construction traffic impacts.
BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2, (British Standards Institute, 1993)	Screening trigger levels for vibration (cosmetic damage) to sensitive buildings and structures.
DIN 4150:Part 3-2016 Structural vibration – Effects of vibration on structures (Deutsches Institute fur Normung, 1999)	Screening assessment of vibration impacts (cosmetic damage) to heritage sensitive structures, where the structure is found to be unsound.
Sydney Metro Construction Noise and Vibration Standard (Sydney Metro, 2020)	Assessment and management protocols for construction of Sydney Metro projects. This standard is based on the requirements of the ICNG, as appropriate to Sydney Metro and is the guiding document for Stage 1.
Guideline for Child Care Centre Acoustic Assessment Version 2.0, (Association of Australasian Acoustical Consultants, 2013)	Contains the reference criteria for child care centres.
Noise Policy for Industry (Environment Protection Authority, 2017a)	Establishment of Rated Background Levels and procedure for noise monitoring.

11.3 Assessment approach

11.3.1 Overview

The assessment methodology for noise and vibration impacts generally involved:

- Identifying and classifying sensitive receivers relevant to Stage 1 construction sites
- Characterising the existing noise environment based on attended and unattended noise measurements at specific locations across Stage 1
- Determining noise and vibration management levels in accordance with relevant guidelines
- Modelling to quantify potential noise and vibration impacts
- Assessing the significance of potential impacts identified
- Examining the proposed construction methodologies and identifying mitigation measures that are likely to be required to minimise construction noise and vibration impacts
- Consultation with the Environment Protection Authority to discuss the approach to the noise and vibration assessment.

The noise and vibration assessment considered the following components of Stage 1:

- Tunnelling construction activities, construction road traffic noise (i.e. spoil and material transport) and utility works – refer to Section 11.5
- All surface construction sites (i.e. metro station construction sites, Clyde stabling and maintenance facility and services facility construction sites), including associated activities such as tunnel boring machine launch/retrieval, concrete batching plants and segment production facility – refer to sections 11.6 to 11.14
- Operational aspects associated with road network changes at Westmead and Clyde – refer to sections 11.6 and 11.8 respectively
- Cumulative construction impacts including any interaction with nearby major projects – refer to Section 11.15.

11.3.2 Construction site work scenarios

Representative scenarios have been developed to assess the likely impacts from the various construction phases of Stage 1. These scenarios are listed in Table 11-3 for the required construction sites and for the remaining construction activities, which include tunnelling and ancillary works.

Table 11-3: Construction scenario descriptions

Scenario	Description
Construction site activities	
Enabling and site establishment works	These works are required to demolish existing buildings and structures, clear or protect trees, establish access points and erect hoarding. Relocation of services or third-party assets may also be required. Includes provision of high voltage power supplies for excavation equipment, which is required early in the program. The works are split into: • 'Typical' works which would include operation of supporting equipment such as generators, cranes, compressors, etc., and loading of heavy vehicles with equipment such as excavators • 'Peak' works which would include the use of noise intensive equipment such as rock breakers and concrete saws at times, especially during demolition of existing structures. The number of construction faces would double during 'peak' works for most construction sites.
Piling	Piling is required at all construction sites for the foundations of future structures and to support linings for the stations and shafts. The works are split into: • 'Typical' works which would include operation of supporting equipment such as excavators and cranes, as well as concreting equipment such as concrete mixer heavy vehicles and concrete pumps • 'Peak' works which would use all supporting equipment and the use of piling rigs. The number of piling faces would double during 'peak' works with most construction sites requiring up to four piling faces where there is sufficient space.
Surface construction	Following site establishment and piling works, civil works and surface structures such as abutments, roads, hardstand areas, and facilities such as water treatment equipment and site offices would be constructed. Acoustic shed(s) (or other acoustic measures) would be constructed over excavation and spoil handling areas as early as possible for sites where excavation and tunnelling works are proposed 24 hours per day seven days a week.
Excavation	All Sydney Metro West stations would be underground. Stations, service facility shafts and tunnel boring machine launch shafts would need to be excavated from the surface down. Excavation would begin immediately after the piling works and would be separated into two phases – 'initial excavation' and 'main excavation'. These two phases are explained below. **Initial excavation** Initial excavation involves removal of the upper layers of soil and rock to a depth suitable for the construction of an acoustic shed or acoustic panels (which are covers placed over the top of the excavation pit to minimise noise emissions). Initial excavation would take around two months to complete at each site and would be performed during standard construction hours. Initial excavation of soil and soft rock can be undertaken using 'ripping' where the earth is separated using a manual pick attachment on an excavator. Initial excavation of hard rock would require rock breaking, which is noise intensive. The time required for ripping versus rock breaking would vary at each site depending on the depth of rock. The works are split into: • 'Typical' initial excavation works which would include the use of support equipment for spoil handling and a process called 'mucking out' which is described below • 'Peak' works which would involve the concurrent use of support equipment and noise intensive rock breakers. The number of construction faces would double during 'peak' works for most construction sites. Initial excavation works are not assessed for construction sites without acoustic sheds (or other acoustic measures). At these sites only 'main excavation' would occur. **Main excavation** Main excavation (referred to as 'excavation' below) involves excavation to a depth where blasting can be performed, if it is suitable for that site. Excavation would be completed within acoustic sheds (or other acoustic measures) at most sites except for the Parramatta metro station construction site, North Strathfield metro station construction site, service facilities sites at Silverwater and Rosehill, and the tunnel dive structure at Rosehill. At sites without acoustic sheds (or other acoustic measures), excavation works would be restricted to standard construction hours. Once acoustic sheds (or other acoustic measures) are in place, excavation works would occur 24 hours per day, seven days a week. The works are split into: • 'Typical' excavation works which would include the use of supporting equipment for spoil handling and a process called 'mucking out' which is described below • 'Peak' works which would involve the concurrent operation of supporting works and rock breakers. The number of construction faces would double during 'peak' works for most construction sites with most sites requiring concurrent use of two rock breaking faces. Construction equipment outside the acoustic sheds (or other acoustic measures) would include heavy vehicles and fixed ancillary equipment such as temporary ventilation systems and water treatment facilities.
Mucking out	At times during excavation, works would pause so the loose spoil can be removed using excavators and transferred to heavy vehicles. This is referred to as 'mucking out'. Mucking out is the 'typical' works activity for the initial excavation and excavation works scenarios.

Scenario	Description
Mined caverns	Once the shafts have been excavated, areas of the underground station caverns can be mined using road headers. These works would be required at Burwood North and Five Dock Station construction sites. The works are split into: • 'Typical' works which would include operation of supporting equipment associated with spoil removal • 'Peak' works include the concurrent use of road headers and supporting equipment. The number of construction faces would double during 'peak' works for some construction sites with up to two road headers operating at the same time. Excavation of stub tunnels, connecting tunnels, and crossover and turnback caverns have been included in the assessment of tunnelling activities.
Tunnel boring machine launch, extraction, and support	Tunnel boring machines would be launched and supported from the Westmead metro station and The Bays Station construction sites. At each site, support activities would be needed to provide tunnel ventilation, supply high voltage power and extract/stockpile spoil for removal. Tunnel boring machines would be extracted at the Sydney Olympic Park Metro Station construction sites. Tunnel boring machine assembly, launch and extraction would occur 24 hours per day, seven days a week, however the majority of these works would be completed inside acoustic sheds (or other acoustic measures). Some less noisy works would be required outside the shed, such as loading and unloading of heavy vehicles. Once the tunnel boring machines are operational, spoil handling and removal would occur 24 hours per day, seven days a week at launch and support sites. The works require heavy vehicles, spoil conveyors, loading activities, tunnel ventilation fans, dust collectors, and materials and equipment deliveries. Where 24 hours per day, seven day a week tunnelling or excavation works are required near sensitive receivers, an acoustic shed (or other acoustic measures) would be erected to mitigate the noise emissions.
Concrete batching plant and segment production facility	A concrete segment production facility would be established at the Clyde stabling and maintenance facility construction site. This would include a concrete batching plant, a pre-cast production facility and storage yard. 'Typical' and 'peak' works scenarios for the concrete batching plant and pre-cast facility would generally include operation of concrete processing equipment such as concrete pumps, agitators, and vibrators, as well as the loading of heavy vehicles and stockpiles with concrete and tunnel lining segments. The facility is assumed to operate as follows: • 50 per cent capacity during the 'typical' scenario • 100 per cent capacity during the 'peak' scenario. The concrete batching plant and segment production facility would operate 24 hours per day, seven days a week. The use of the concrete batching plant and segment production facility has been included in the assessment of Clyde earthworks and civil works.
Clyde earthworks and civil works	The Clyde stabling and maintenance facility construction site would include earthwork and civil works needed to prepare the site for construction of stabling and maintenance facility facilities. The works are split into: • 'Typical' works which would include operation of supporting equipment such as excavators and trucks • 'Peak' works which would use all supporting equipment and noise intensive equipment such as concrete saws and jackhammers. The number of working faces would double during 'peak' works.
Tunneling and ancillary activities	
Tunnelling – excavation and construction	The tunnelling works would occur 24 hours per day, seven days a week. Depending on the rate of progress, noise and vibration impacts from tunnelling would likely only be apparent for relatively short periods at most locations. At this stage, tunnel boring machines are proposed to be used for most of the alignment, with roadheaders and rockbreakers proposed to be used at stations, stub tunnels, cross passages and crossover and turnback caverns. Roadheaders would also be used to excavate the tunnels that connect the stabling and maintenance facility to the main alignment.
Tunnelling – work trains	Consistent with the tunnelling methodology used on other Sydney Metro projects, work trains would be used to supply materials, such as precast tunnel lining segments, and workers to the workface. Spoil would be removed via conveyor. Work trains are anticipated to operate on a temporary narrow gauge rail with resilient mounts and/or use rubber wheels. The work trains would be loaded at the tunnel boring machine launch site and unloaded at the tunnel boring machine. The operating speed of work trains is around 10 kilometres per hour and they would be required 24 hours per day seven days a week to support tunnelling. On the basis of the above, work trains are not expected to result in any significant noise and vibration impacts.
Spoil and materials transport	Spoil and materials transport would be required to and from all construction sites. Spoil and materials transport would be via heavy vehicles. The possibility of bulk removal of spoil from The Bays Station construction site via barge is being investigated as an alternative option that may reduce the need for road transportation.
Road intersection modification	Road works would be required to modify intersections near the Westmead metro station construction site. These works would likely occur during the night-time period to minimise disruption on the road network. The works are split into: • 'Typical' works which would include operation of supporting equipment such as lighting towers, excavators and trucks • 'Peak' works which would use all supporting equipment plus noise intensive equipment like concrete saws and rockbreakers at times.
Utility works	Construction associated with utility relocation and diversion works would likely be required in various areas near most construction sites, however at this early stage the required locations are unknown. Works would likely be required along various streets to allow access and modification to underground utilities.

11.3.3 Noise impact assessment scenarios

The noise levels presented in the assessment are based on a realistic worst-case assessment of each works scenario, where construction equipment is at the closest point to each receiver. Stage 1 includes a number of base case mitigation measures to minimise the potential airborne noise impacts. These measures are considered as part of the design or construction methodology in the impact assessment. These are listed in Table 11-4.

Table 11-4: Stage 1 specific base case noise mitigation measures

Included mitigation measures	Description
Bored piling	The construction activities assume that bored piling would be used as opposed to impact piling, wherever possible. Bored piling is significantly less noise intensive than impact piling.
Acoustic perimeter hoardings	For construction concentrated in a single area, such as at the station and service facility construction sites, temporary acoustic hoardings around the site perimeter would be used where receivers are potentially affected and where feasible and reasonable. On this basis, three metre high acoustic hoardings of solid construction (as opposed to standard wire mesh fence) have been included in the assessment although other means of achieving the same noise outcome may be applied.
Acoustic sheds	Acoustic sheds have been assumed to be used for all construction sites where construction activities would regularly occur on a 24 hours per day, seven days per week basis near sensitive receivers. Typically, the sheds are designed to cover all excavation and spoil handling activities. At this stage, detailed designs for sheds have not been developed and a typical shed construction based on those used on previous stages of Sydney Metro have been used, with indicative shed dimensions. Shed ventilation would be designed to maintain the integrity of the shed, which indicatively would require attenuators for supply and return air ducting. When the main doors of the acoustic shed are opened to allow heavy vehicle access, noise emissions would potentially increase. The assessment presents predicted noise levels for doors open and doors closed. Where opening the shed doors during the night-time is predicted to result in noise management level exceedances, a two-stage 'airlock' door may be required to provide additional mitigation. The specific noise mitigation measures would be determined during detailed construction planning and would take into account the construction program, construction working hours and construction traffic management in accordance with the Sydney Metro Construction Noise and Vibration Standard.
Acoustic panels	Where acoustic sheds are constructed over part of a cut and cover station, the excavated section between the sheds would be covered by acoustic panels to minimise noise emissions. This assessment assumes that such panels would be consistent with those used in previous stages of Sydney Metro and would not allow a significant transfer of construction noise.

For most construction activities, it is expected the construction noise levels during less intensive activities would frequently be lower than predicted.

The noise impact assessment scenarios have been categorised into 'peak' and 'typical' works which have been used to define the likely range of potential noise impacts:

- 'Peak' works represent the noisiest stages and can require the use of noise intensive equipment such as rockbreakers or concrete saws for some construction scenarios. While 'peak' works would be required at times in most locations, the noisiest activities would not occur over the full duration of construction. The 'peak' scenarios also include the maximum anticipated number of construction faces at each of the various construction sites. The assessment is generally considered conservative as the calculations assume several items of equipment at each construction face are in use at the same time within individual scenarios
- 'Typical' works represent typical noise emissions from Stage 1 when noise intensive equipment is not in use. The 'typical' works includes all items of equipment for a given activity except for the loudest item. These items of equipment generally support the 'peak' works activity and are referred to as 'supporting equipment'.

Certain construction scenarios would require the concurrent operation of several construction teams (or 'construction faces') performing the same works in different areas of the site.

11.3.4 Construction program and hours

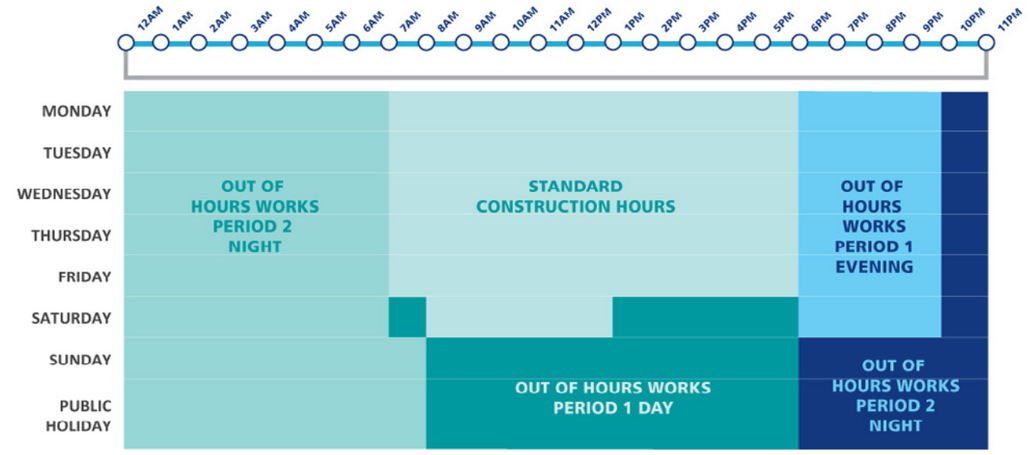
Subject to planning approval, construction of Stage 1 is planned to commence in 2021, with completion of Stage 1 works planned for 2026. The total duration of Stage 1 construction works is expected to be around five years. An indicative construction program for Stage 1 is provided in Chapter 8 (Stage 1 description).

Construction of Stage 1 would be carried out during standard construction hours where possible although evening and night-time work would be required during some periods. Standard construction hours for normal construction activities are:

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

Standard construction hours and other works periods are identified in the ICNG. These are further defined in the Sydney Metro Construction Noise and Vibration Standard, shown in Table 11-5.

Table 11-5: Standard construction hours



Note 1: Work outside of standard construction hours is defined as out-of-hours work and can be divided into 2 periods of sensitivity. Out-of-hours work period 1 is defined as Monday to Saturday 6pm to 10pm (evenings), Saturday 7am to 8am and 1pm to 6pm (day) and Sunday and public holidays 8am to 6pm (days). Out-of-hours work period 2 is defined as Monday to Saturday 10pm to 7am (nights) and Sundays and public holidays 6pm to 8am (nights).

A summary of the proposed construction hours for Stage 1 is shown in Table 11-6.

As the tunnel boring machines operate continuously, tunnelling and associated support activities would need to be carried out on a 24 hour per day, seven day a week basis. Most surface construction works, however, would be carried out during the standard construction hours.

Acoustic sheds (or other acoustic measures) would be constructed prior to commencing evening and night-time works at all sites where works outside of standard construction hours could have the potential to impact nearby receivers.

Table 11-6: Proposed construction hours

Activity	Construction hours	Comments or exceptions
Aboveground construction activities		
Enabling works	ICNG standard construction hours and daytime OOHW Period 1 at some sites	Works restricted to standard construction hours with the exception of Parramatta, Silverwater and The Bays construction sites (refer Table 11-7). Non-disruptive preparatory work, repairs or maintenance may be carried out on Saturday afternoons between 1pm and 5pm or Sundays between 8am and 5pm.
Piling		
Surface construction		
Initial excavation		
Tunnel boring machine launch, extraction, and support	24 hours per day, seven days per week	Restrictions would be in place during peak hours.
Concrete batching plant		
Segment production facility		
Construction traffic for material supply to and spoil removal from tunnelling and underground excavation (station and ancillary facility sites)		
Westmead intersection modification works		
Utility works		
Underground construction activities		
Controlled blasting	ICNG standard construction hours	Drill and blast, if required, would be carried out during periods anticipated to have the least impact on receivers. This is expected to be during standard construction hours.
Tunnelling works	24 hours per day, seven days per week. ICNG standard construction hours (Parramatta and North Strathfield only)	Activities that support tunnelling may need to occur 24 hours per day, up to seven days per week. Rockbreaking in the tunnel and cross-passages between 10pm and 7am would not occur except where appropriate noise impact management measures have been established.
Underground excavation at station and ancillary sites		

The Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009) identifies the following categories of work that might be carried out outside the recommended standard hours:

- The delivery of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads
- Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
- Maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
- Public infrastructure works that shorten the length of the project and are supported by the affected community
- Works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

It is anticipated that in addition to the delivery of oversize plant/structures, the activities listed in Table 11-7 would need to be completed out of hours. Justification for these requirements is provided in the table.

Table 11-7: Works outside of standard construction hours

Activity	Justification for Out-of-hours activities
Tunnelling (including cross passages) and tunnelling support activities (including tunnel boring machine launch/retrieval and spoil handling).	Tunnelling and excavation works would define the overall Stage 1 duration. Earlier completion would bring considerable benefits to the community and would reduce the duration of construction related disruption. Other aspects of the justification for out-of-hours tunnelling and support operations include the need to: • Install ground support systems immediately following excavation • Construct cross passages closely following the progress of the tunnel boring machines to provide a critical secondary egress for people to evacuate and access for emergency services in the event of an incident • Reduce peak demand on the electricity network • Handle the spoil produced by the 24 hour per day, 7 days a week operation of the tunnel boring machines and the proposed out of hours transport of spoil.
Precast concrete segment production	The production of precast concrete tunnel segments is needed to support the tunnel following the tunnel boring excavation. The production facility needs to operate outside standard hours to achieve the precast segment production rates required by 24 hour per day, 7 days a week tunnel boring machine operation.
Construction traffic for material supply to and spoil removal from tunnelling and underground excavation (station and ancillary facility sites)	Tunnelling and excavation works would require materials deliveries and the transport by road of substantial quantities of spoil. To avoid further impacting the operation of the road network, construction vehicle movements during the AM and PM peak periods need to be minimised. Given the volumes of spoil and space constraints at construction sites, which limit the extent of on-site spoil storage, transport of materials and spoil cannot be limited to the hours between 10am and 3pm. Night-time vehicle movements are therefore necessary.
Underground excavation at station and ancillary sites	For mined excavations, temporary support in the form of shotcrete, steel sets and rockbolts must be installed immediately to ensure stability of the works and to minimise any potential ground movement or settlement. Grouting is required to transfer load directly to the adjacent rock and needs to occur immediately after bolt installation for safety and quality reasons. Out-of-hours works would allow for the completion of the entire support system immediately following excavation.
Intersection modifications at Westmead	These works would require lane closures and, in some cases, total closure of roads. Intersection modification works would, therefore, likely be required to occur during the evening and night-time period when traffic volumes are lower to minimise disruption to local traffic.
Daytime out-of-hours works (Period 1 Saturday only)	Enabling works, pilling, surface construction, and initial excavation works are proposed during the Saturday daytime out-of-hours works period 1 at Parramatta, Silverwater and The Bays construction sites. Residential receivers are generally around 100 metres or further away from these construction sites and are screened from view by intervening non-residential buildings, meaning impacts would be low.

Further detail on the approach to out of hours work is provided in the Sydney Metro Construction Noise and Vibration Standard.

11.3.5 Construction noise metrics

Noise parameters most relevant to construction noise are described below and were evaluated for daytime (7am-6pm), evening (6-10pm) and night-time (10pm-7am) periods:

- Rating background level (RBL) or L_{A90} – the background noise level in the absence of proposed construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods and is used to set the $L_{Aeq(15\ minute)}$ noise management levels (NMLs) for residential receivers
- $L_{Aeq\ (period)}$ – the 'energy average noise level' evaluated over a defined measurement period (typically 15 minutes for construction noise or the relevant daytime, evening or night-time period for ambient noise monitoring)
- L_{Amax} or $L_{A1(1min)}$ – the 'typical maximum noise level' for an event, used in the assessment of potential sleep disturbance during night-time periods.

11.3.6 Noise catchment areas and sensitive receivers

The area surrounding each construction site is divided into one or more Noise Catchment Areas (NCAs) that reflect the ambient noise environment of that area, as well as the noise and vibration sensitivity of the surrounding land uses.

The sensitivity of occupants to noise and vibration varies according to the nature of the occupancy and the activities performed within the affected premises. For example, premises with sensitive equipment or uses are more likely to be sensitive to vibration and ground-borne noise than residential premises, which in turn are more sensitive than typical commercial premises.

Receivers potentially sensitive to noise and vibration have been categorised into the following receiver categories:

- Residential buildings
- Commercial/industrial buildings
- 'Other sensitive' land uses, which includes educational institutions, childcare centres, medical facilities, places of worship, outdoor recreation areas.

A description of each of the NCAs is provided for each of the construction sites (beginning in Section 11.6).

New developments

A review of recently approved developments in the study area has been completed and those that would be categorised as sensitive have been included in the assessment.

11.3.7 Construction noise management levels

Airborne construction noise

Noise management levels

The Construction Noise and Vibration Standard references the ICNG for assessing and managing construction noise impacts from Sydney Metro works.

The ICNG contains procedures for determining project specific Noise Management Levels (NMLs) for sensitive receivers. The 'worst-case' noise levels from construction of a project are predicted and then compared to the NMLs in a 15 minute assessment period to determine the likely impact of Stage 1.

The NMLs are not mandatory limits, however where construction noise levels are predicted or measured to be above the NMLs, feasible and reasonable work practices to minimise noise emissions are to be investigated.

Residential receivers

The ICNG provides an approach for determining $L_{Aeq(15minute)}$ NMLs at residential receivers by applying the measured $L_{A90(15minute)}$ background noise levels, as described in Table 11-8.

Table 11-8: Determination of NMLs for residential receivers

Time of day	NML $L_{Aeq(15minute)}$	How to apply
Standard construction hours: **Monday to Friday** **7am-6pm** **Saturday** **8am-1pm** **No work on Sundays or public holidays**	Noise affected RBL + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent would apply all feasible and reasonable work practices to meet the noise affected level • The proponent would also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restructuring the hours that the very noisy activities can occur, taking into account: • Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools or mid-morning or mid-afternoon for works near residences) • If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dBA	• A strong justification would typically be required for works outside the recommended standard hours • The proponent would apply all feasible and reasonable work practices to meet the noise affected level • Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent would negotiate with the community.

Other sensitive land uses and commercial receivers

The Stage 1 specific $L_{Aeq(15minute)}$ NMLs for other non-residential noise sensitive receivers from the ICNG are provided in Table 11-9.

Table 11-9: NMLs for other sensitive receivers

Land use	NML $L_{Aeq(15minute)}$ (applied when the land use is in use)
Classrooms at schools and other education institutions	Internal noise level 45 dBA
Hospital wards and operation theatres	Internal noise level 45 dBA
Places of worship	Internal noise level 45 dBA
Active recreation areas **(characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)**	External noise level 65 dBA
Passive recreation areas **(characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion e.g. reading, meditation)**	External noise level 60 dBA
Commercial	External noise level 70 dBA
Industrial	External noise level of 75 dBA

Rosehill Gardens racecourse stables have been included in the assessment and are assessed as 'other sensitive' active recreation areas. This is consistent with the CBD and South East Light Rail Environmental Impact Statement (Transport for NSW, 2013).

Other noise-sensitive receivers require separate Stage 1 specific noise goals. The ICNG recommends that the internal construction noise levels at these premises are determined based on the 'maximum' internal levels presented in AS 2107. These recommended 'maximum' internal noise levels are provided in Table 11-10.

Table 11-10: NMLs for other receivers

Description	Time period	NML derived from	Noise management level (dBA) $L_{Aeq(15minute)}$	
			Internal	External
Hotel	Daytime and evening	AS2107: Bars and lounges	50	70[1]
	Night-time	AS2107: Sleeping areas: Hotels near major roads	40	60[1]
Childcare centres	Daytime	GCCCAA: Outdoor play areas	-	55
		GCCCAA: Sleeping areas	40	50[2]
Public building	When in use	AS2107: Public space	50	60[2]
Recording studio	When in use	AS2107: Music recording studios	25	45[1]
Theatre/auditorium	When in use	AS2107: Drama theatres	30	50[1]
Stables	When in use	ICNG: Outdoor passive recreation	-	60

Note 1: The criteria are specified as an internal noise level for this receiver category. As the noise model predicts external noise levels, it has been assumed that these receivers have fixed windows with a conservative 20 dB reduction for external to internal noise levels.

Note 2: Receiver conservatively assumed to have openable windows and a 10 dB reduction from outside to inside facade levels.

Assessing airborne construction noise impacts

The assessment of predicted airborne noise impacts around construction sites is based on the exceedance of the NMLs as per the construction scenarios identified in Section 11.3.2. The likely subjective response of people affected by the impacts is shown in Table 11-11 and is used at all construction sites to describe the level of impact during standard construction hours.

Table 11-11: Exceedance bands and corresponding subjective response to impacts

Exceedance of management level	Likely subjective response	Impact colouring
No exceedance	Negligible to low	
1 to 10 dB	Minor to marginal	
11 dB to 20 dB	Moderate	
>20 dB	High	

Ground-borne construction noise

Construction works can cause ground-borne noise impacts in nearby buildings when vibration intensive equipment is in use, such as during tunnelling works using tunnel boring machines, roadheaders or rockbreakers. Ground-borne noise NMLs are defined in the ICNG for residential receivers and in the Sydney Metro Construction Noise and Vibration Standard for commercial receivers.

The NMLs are applicable to tunnelling works and also where ground-borne noise levels are higher than airborne noise levels, which can occur during rockbreaking for example, where airborne noise levels are shielded by noise barriers or other such structures.

Ground-borne NMLs for residential and commercial receivers, based on levels provided in the ICNG, are presented in Table 11-12.

Table 11-12: Internal ground-borne NMLs for residential and commercial receivers

Time of day	Ground-borne NMLs $L_{Aeq(15\ minute)}$
Daytime 7am-6pm	• Residential 45 dBA • Commercial 50 dBA
Evening 6-10pm	• Residential 40 dBA
Night-time 10pm-7am	• Residential 35 dBA

At locations where the construction noise levels are predicted to exceed the NMLs, consideration must be given to applying all feasible and reasonable work practices for each site and activity to minimise potential noise impacts.

For 'other sensitive' receivers such as education institutions, hospital wards, operating theatres and places of worship, neither the ICNG nor Sydney Metro Construction Noise and Vibration Standard provide guidance in relation to acceptable ground-borne noise levels. For these receivers, the ICNG internal airborne NMLs listed in Table 11-9 and Table 11-10 have been used to identify potential ground-borne noise impacts.

11.3.8 Ground-borne construction vibration

The effects of vibration in buildings can be divided into three main categories:

- Those in which the occupants of buildings are disturbed (human comfort)
- Those where the building contents may be affected (building contents)
- Those where the integrity of the building may be compromised (structural or cosmetic damage).

These are discussed further in the following sections.

Human comfort and building contents

People can sometimes perceive vibration impacts when vibration generating construction works are located close to occupied buildings. Vibration from construction works tends to be intermittent in nature and the EPA's Assessing Vibration: a technical guideline (2006) provides criteria for intermittent vibration based on the Vibration Dose Value (VDV). The VDV provides a measurement of the presence of 'jolts and jars' experienced and combines the magnitude of vibration with the time for which it occurs. The 'preferred' and 'maximum' VDVs for human comfort impacts are shown in Table 11-13.

People perceive vibration at levels well below those likely to cause damage to building contents. For most receivers, the human comfort vibration criteria are the most stringent and it is generally not necessary to set separate criteria for vibration effects on typical building contents.

Table 11-13: Vibration dose values for intermittent vibration

Building type	Assessment period	Vibration Dose Value[1] ($m/s^{1.75}$)	
		Preferred	Maximum
Critical Working Areas (e.g. operating theatres or laboratories)	Day or night-time	0.10	0.20
Residential	Daytime	0.20	0.40
	Night-time	0.13	0.26
Offices, schools, educational institutions and places of worship	Day or night-time	0.40	0.80
Workshops	Day or night-time	0.80	1.60

Note 1: The vibration dose value accumulates vibration energy over the daytime and night-time assessment periods, and is dependent on the level of vibration as well as the duration.

Exceptions to this can occur when vibration sensitive equipment, such as electron microscopes are located in buildings near to construction works. Criteria for vibration sensitive equipment are discussed below.

Cosmetic damage

If vibration from construction works is sufficiently high it could potentially cause cosmetic damage to elements of affected buildings. Examples of potential damage include cracking or loosening of drywall surfaces, cracks in supporting columns and loosening of joints. The levels of vibration required to cause cosmetic damage tends to be at least an order of magnitude (10 times) higher than those at which people can perceive vibration (human comfort VDVs).

Industry standard cosmetic damage vibration limits are contained in Australian Standard AS 2187-2, British Standard BS 7385 and German Standard DIN 4150, which are referenced in the Sydney Metro Construction Noise and Vibration Standard. The Sydney Metro Construction Noise and Vibration Standard recommends limits for transient vibration which correspond to minimal risk of cosmetic damage for residential and industrial buildings.

The Sydney Metro Construction Noise and Vibration Standard notes that where dynamic loading caused by continuous vibration may give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in British Standard BS 7385:2 – 1993 may need to reduce by up to 50 per cent. On this basis, the Sydney Metro Construction Noise and Vibration Standard recommends the adoption of conservative cosmetic damage screening limits shown in Table 11-14.

Table 11-14: Transient vibration values for minimal risk of cosmetic damage

Type of building	Peak component particle velocity
Reinforced or framed structures **Industrial and heavy commercial buildings**	25 mm/s
Unreinforced or light framed structures **Residential or light commercial type buildings**	7.5 mm/s

Heritage buildings and structures

The Sydney Metro Construction Noise and Vibration Standard states that heritage buildings and structures should be assessed according to the cosmetic damage screening criteria outlined in Table 11-14 and should not be assumed to be more sensitive to vibration unless found to be structurally unsound.

Sydney Metro West would complete condition surveys of potentially affected buildings and structures near to the tunnel and excavations prior to the commencement of excavation, where appropriate. Where heritage buildings and structures are found to be structurally unsound, a more conservative cosmetic damage screening level of 2.5 millimetres per second peak particle velocity (PPV) (from DIN 4150) would be adopted prior to more specific consideration of appropriate levels for each building or structure.

Utilities and other vibration sensitive assets

Construction of Stage 1 could potentially affect other utilities and assets which may be particularly sensitive to vibration. Examples include pipelines, tunnels, fibre optic cables and high pressure gas pipelines.

German Standard DIN 4150 provides the guideline vibration limits for buried pipework shown in Table 11-15. For other potentially affected assets, specific vibration limits should be determined on a case-by-case basis in consultation with the asset owner.

Table 11-15: Transient vibration values for minimal risk of cosmetic damage

Pipe material	Guideline values vibration velocity at the pipe
Steel, welded	100 mm/s
Vitrified clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80 mm/s
Masonry, plastic	50 mm/s

Sensitive scientific equipment

Some scientific equipment, such as electron microscopes and microelectronics manufacturing equipment can require more stringent vibration limits. Other equipment used for various business requirements as well as medical equipment may also have specific vibration goals. Vibration sensitive equipment is however often housed in buildings/rooms specifically designed and constructed for that purpose. Vibration criterion for vibration sensitive equipment is provided in Table 13 of Technical Paper 2 (Noise and vibration).

11.3.9 Controlled blasting

Controlled blasting is often used where deep excavation of rock is required and can be used as an alternative to rockbreaking. Controlled blasting events have the potential to result in brief ground vibration and air overpressure impacts at nearby receivers. Where controlled blasting is used to substitute or complement the operation of construction equipment to break rock, blasting can substantially reduce the length of time that noise and vibration impacts occur when compared to rockbreaking alone.

The ICNG recommends blasting occur between Monday to Friday (9am to 5pm) and Saturday (9am to 1pm) with no blasting on Sundays or public holidays.

Consistent with recent approvals for NSW infrastructure projects, the Sydney Metro Construction Noise and Vibration Standard defines the vibration and overpressure limits for blasting applied to Stage 1:

- Vibration (PPV): 25 millimetres per second
- Overpressure: 125 dBL.

As noted above, heritage buildings and structures should not be assumed to be more sensitive to vibration unless they are found to be structurally unsound. Where heritage buildings and structures are found to be structurally unsound, a more conservative cosmetic damage objective of 2.5 mm/s PPV (from DIN 4150) would be adopted.

11.3.10 Construction traffic noise

The potential impacts from construction traffic associated with Stage 1 when travelling on public roads are assessed under the NSW Road Noise Policy (Department of Environment, Climate Change and Water, 2011a).

An initial screening test is first applied to evaluate if existing road traffic noise levels are expected to increase by more than 2 dB due to construction traffic. Where this is considered likely, further assessment is required using the following relevant road traffic noise criteria:

- Existing freeway/arterial/sub-arterial roads:
  - $L_{Aeq(15hour)}$ 60 dBA day
  - $L_{Aeq(9hour)}$ 55 dBA night
- Existing local roads:
  - $L_{Aeq(1hour)}$ 55 dBA day
  - $L_{Aeq(1hour)}$ 50 dBA night.

Where the criteria are exceeded Sydney Metro would consider the use of all feasible and reasonable mitigation and management measures to minimise the impacts.

11.3.11 Sleep disturbance

Where night works are located close to residential receivers there is potential for sleep disturbance impacts.

The ICNG lists five categories of works that might be undertaken outside the standard construction hours:

- The delivery of oversized equipment or structures that require special arrangements to transport on public roads
- Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
- Maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
- Public infrastructure works that shorten the length of the project and are supported by the affected community
- Works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

Where construction works are planned to extend over more than two consecutive nights, the ICNG recommends an assessment of sleep disturbance impacts should be completed.

The most current method for assessing sleep disturbance from NSW transport infrastructure projects is contained in the EPA's Noise Policy for Industry (NPfI) (EPA, 2017). The NPfI defines sleep disturbance criteria as being 52 dBA L_{AFmax} or a maximum level of 15 dB above the RBL, whichever is the greater.

Where this criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.

11.4 Avoidance and minimisation of impacts

The design development of Stage 1 has aimed to avoid or minimise potential construction noise and vibration impacts. This included:

- Positioning Westmead metro station south of the existing rail corridor to minimise construction noise and vibration impacts to sensitive receivers (medical equipment) within the hospital precinct located north of the station
- Locating the stabling and maintenance facility at Clyde within an industrial area to minimise potential construction noise impacts on sensitive receivers
- Locating the services facility at Silverwater within an industrial area to minimise potential construction noise impacts on sensitive receivers
- Retrieval of tunnel boring machines at Sydney Olympic Park which provides ready access to the arterial road network (and the M4 Motorway) and minimises potential road traffic noise impacts.

11.5 Project-wide impacts

Potential construction noise and vibration impacts would be managed in accordance with the Sydney Metro Construction Noise and Vibration Standard (Appendix E), which aims to manage noise and vibration levels through feasible and reasonable measures. The Standard provides a process for the development of site or activity specific Construction Noise and Vibration Impact Statements, standard mitigation measures and additional mitigation measures to be implemented based on noise and vibration trigger levels.

11.5.1 Ground-borne noise impacts from tunnel boring machines

The assessment of ground-borne noise is based on the worst-case predicted ground borne noise levels for sensitive receivers located above the proposed tunnel alignment. The predictions represent the likely highest noise level inside sensitive receivers when the tunnelling works are directly below each receiver.

The tunnel boring machines are expected to progress at a rate of around 20 metres per day. This means the worst-case ground-borne noise impacts from tunnelling at individual receivers would likely only be apparent for a few days for each tunnel boring machine, when the tunnelling works are directly beneath. As the works progress and move away, a particular receiver's exposure to ground-borne noise would reduce accordingly.

A summary of the predicted ground-borne noise levels from tunnelling in each Noise Catchment Area is shown in Table 11-16. Each Noise Catchment Area is identified in Section 11.6 to 11.14.

Table 11-16: Summary of tunnelling ground-borne NML exceedances – all receiver types

Location	Noise Catchment Area	Number of receivers									
		Total	With NML exceedance[1, 2]								
			Tunnelling with tunnel boring machine								
			Standard daytime			Evening			Night-time		
			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
Westmead	NCA01	340	-	-	-	-	-	-	2	-	-
	NCA02	806	15	-	-	24	3	-	23	15	-
Parramatta	NCA03	509	13	-	-	8	-	-	4	5	-
Clyde	NCA04	392	51	-	-	91	1	-	80	49	-
	NCA05	477	-	-	-	-	-	-	-	-	-
	NCA06	207	-	-	-	-	-	-	-	-	-
	NCA07	553	-	-	-	-	-	-	-	-	-
Silverwater	NCA07	1,389	-	-	-	-	-	-	8	-	-
Olympic Park	NCA08	95	4	-	-	-	-	-	-	-	-
	NCA09	32	-	-	-	-	-	-	-	-	-
North Strathfield	NCA10	614	20	1	-	13	13	-	19	20	-
	NCA11	1,280	39	11	-	57	27	-	69	39	11
Burwood	NCA12	1,200	14	-	-	94	-	-	168	11	-
	NCA13	957	-	-	-	1	-	-	3	-	-
Five Dock	NCA14	1,242	71	-	-	93	-	-	54	61	-
	NCA15	966	14	-	-	43	-	-	47	14	-
Between Five Dock and The Bays	NCA16	389	-	-	-	-	-	-	-	-	-
	NCA17	679	-	-	-	41	-	-	60	-	-
	NCA18	921	-	-	-	-	-	-	-	-	-
	NCA19	962	-	-	-	-	-	-	-	-	-
The Bays	NCA20	873	-	-	-	-	-	-	-	-	-
	NCA21	844	-	-	-	6	-	-	12	-	-
	NCA22	46	-	-	-	-	-	-	-	-	-

Note 1: Based on worst-case predicted noise levels in each NCA

Note 2: Noise management levels for standard daytime, evening and night-time works are outlined in Section 11.3.7

The above assessment shows that:

- The worst-case ground-borne noise impacts from tunnelling during the daytime are predicted to generally be compliant with the NML or result in only 'minor' impacts. 'Moderate' impacts are predicted at 12 receivers near to North Strathfield (in Noise Catchment Area NCA10, NCA11), which is due to the tunnel being at its most shallow point in this location. These 'moderate' impacts are generally at residential receivers on Queen Street, to the north of the North Strathfield metro station construction site
- During the night-time, the impacts are more wide-spread due to a lower NML. The worst-case impacts are predicted to be 'high' to the north of the North Strathfield metro station construction site (NCA11), with 'moderate' impacts also predicted at certain receivers in Westmead, Parramatta, Clyde, North Strathfield and Five Dock. These impacts are typically at receivers which surround the construction sites, as this is where the tunnel depth is shallowest
- The ground-borne noise predictions are based on the nearest sensitive receivers and most exposed floor (i.e. ground floor for commercial and lowest habitable floor for residential). The ground-borne noise impacts would reduce for sensitive receivers which are further away from the alignment or for receivers with a higher ground floor, or on a higher storey in buildings.

11.5.2 Vibration impacts from tunnel boring machines

The assessment of ground-borne vibration is based on the worst-case predicted ground-borne vibration levels for sensitive receivers located above the proposed tunnel alignment. The predictions represent the likely highest vibration level when the tunnelling works are directly below each receiver. Similar to ground-borne noise, worst-case vibration impacts from tunnelling at individual receivers would likely only be apparent for a few days for each tunnel boring machine, when the tunnelling works are directly beneath. As the works progress and move away, a particular receiver's exposure to vibration would reduce accordingly.

A summary of the predicted ground-borne vibration levels from tunnelling in each NCA where an exceedance is predicted is shown in Table 11-17. Exceedances are predicted in NCA02, NCA03, NCA04, NCA10, NCA11 and NCA14. No exceedances are predicted in other NCAs.

Table 11-17: Summary of vibration criteria exceedances – all receiver types

Location	Noise Catchment Area[2]	Number of receivers				
		Total	With vibration criteria exceedance[1]			
			Tunnelling with tunnel boring machine			
			Cosmetic damage	Human comfort		Sensitive equipment
			Day / Night	Day	Night	Day / Night
Westmead	NCA02	806	-	2	8	-
Parramatta	NCA03	509	-	-	5	-
Clyde	NCA04	392	-	-	17	-
North Strathfield	NCA10	614	-	11	19	-
	NCA11	1,280	-	26	45	-
Burwood	NCA12	1,200	-	-	6	-
Five Dock	NCA14	1,242	-	-	43	-
	NCA15	966	-	-	9	-

Note 1: Based on worst-case predicted vibration levels

Note 2: Noise catchment areas where exceedances are not predicted are not included in the table.

The above shows the following:

- No receivers are predicted to be subject to tunnelling vibration levels which exceed the cosmetic damage criteria
- Potential exceedances of the human comfort criteria are predicted in Westmead, Parramatta, Clyde, North Strathfield and Five Dock, meaning perceptible levels of vibration may occur when tunnelling works are below certain areas. These impacts are typically at receivers which surround the construction sites, as this is where the tunnel depth is shallowest
- Potential exceedances of the relevant sensitive equipment criteria is predicted at one building in Parramatta (Cryo Australia) which is anticipated to contain sensitive equipment with a VC-A criterion.

11.5.3 Cross passages

Ground-borne noise

Ground-borne noise levels during rockbreaking are expected to be around 3 dB higher than during tunnelling. The night-time NML is likely to be exceeded during excavation of cross passages at the distances shown in Table 11-18.

'Moderate' exceedances of the night-time NML are expected where residential receivers have a slant distance of around 30 metres or less from the nearest cross passage.

'High' exceedances at residential receivers are likely where the slant distance is less than around 17 metres. The tunnel alignment depth is less than 17 metres from the surface elevation near the Olympic Park and North Strathfield metro station construction sites.

The duration of excavation for each cross passage is expected to vary between sites but may take up to several months in some areas.

Table 11-18: Minimum slant distance which results in exceedance of night-time NML

Receiver type	Criteria (dBA)	Minimum slant distance which results in exceedance of NML		
		Minor (1-10 dB)	Moderate (11-20 dB)	High (> 20 dB)
Residential (daytime)	45	30	17	10
Residential (night-time)	35	52	30	17
Educational	45	30	17	10
Medical	45	30	17	10
Place of worship	45	30	17	10
Child care	40	39	23	13
Commercial	50	23	13	7

Vibration impacts

Vibration levels from the excavation of cross passages using roadheaders and rockbreakers would be similar to the levels from excavation of the tunnels using tunnel boring machines. The tunnel alignment is sufficiently distant from nearby buildings for the risk of exceedances of the cosmetic damage criteria to be low.

Exceedances of the daytime human comfort criteria are, however, likely at residential receivers with a slant distance of less than 20 metres from cross passages and at commercial receivers with a slant distance of less than 15 metres.

Exceedances of the night-time human comfort criteria are likely at residential receivers with a slant distance of less than 30 metres from cross passages.

No identified vibration sensitive receivers are predicted to be subject to cross passage excavation vibration levels which exceed the appropriate sensitive equipment criteria.

11.5.4 Work trains

Work trains would be required in the tunnels to move equipment. The speed of these trains is typically limited to 10 kilometres per hour for safety reasons and it is assumed they would have some form of resilient rubber tyres. The work trains would be used 24 hours per day, seven days a week.

Given the slow speeds and assumed rubber tyres, the potential ground-borne noise and vibration impacts from work trains are expected to be minimal. The potential impacts should be reviewed as Stage 1 progresses and detailed information regarding work trains becomes available.

11.5.5 Utility works

An assessment of the potential noise levels from the likely plant items associated with utility works is provided in Table 11-19. Noise levels have been predicted at various offset distances (15 to 70 metres) to give an indication of the possible impacts.

During construction, noise impacts associated with utility works would be temporary and would move progressively along the utility service corridor resulting in impacts at particular receivers for only a limited period of time. For example, the excavation work along power supply routes is anticipated to progress at about 30 metres per day and it is therefore likely that any individual receiver would be affected by the highest noise levels for up to two consecutive days at most.

Table 11-19: Potential noise levels from utility works

Equipment	Predicted Noise Level at Distance ($L_{Aeq(15minute)}$ dBA)			
	15 m	30 m	50 m	70 m
Asphalt milling machine	79	73	69	66
Concrete saw[1]	80	74	70	67
Excavator	77	71	67	64
Excavator (breaker)[1]	86	80	76	73
Hand tools	65	59	55	52

Note 1: Assumed to be working for 7.5 minutes in worst-case 15 minute period.

Relatively high noise impacts are likely where noise intensive plant items are required near adjacent receivers. On typical streets where the closest receivers are about 15 metres from the road, noise levels between 80 to 86 dBA are possible when noise intensive plant items are in use.

Where night-time works are required, worst-case exceedances of greater than 25 to 30 dB above NML are possible where noise intensive plant items are in use.

11.6 Westmead metro station construction site

11.6.1 Existing environment

Existing noise levels surrounding the Westmead metro station construction site are controlled by transportation noise (i.e. road and rail) and general background noise in an urban location. The area surrounding the construction site is mainly residential and the nearest receivers are near the boundary of the site. The Westmead health precinct is to the north of the site and educational facilities are also located relatively close by.

The area surrounding Westmead metro station construction site includes two Noise Catchment Areas (NCA01 and NCA02) which are separated by the existing rail corridor. The construction site is located to the south of the existing rail station. The Westmead noise catchment areas are shown in Figure 11-1.

NCA01 is north of the existing rail corridor in Westmead and is mainly residential. 'Other sensitive' receivers include Westmead Hospital, Western Sydney University – Westmead, and Parramatta Marist High School. A child care centre and a number of medical facilities are to the north of the existing Westmead Station.

NCA02 south of the existing rail corridor and is mainly residential. Westmead Primary School is in the north of the catchment on Hawksbury Road.

Figure 11-1: Location of sensitive receivers near Westmead metro station construction site

Unattended noise monitoring was undertaken at two sensitive receivers located in the vicinity of Westmead metro station construction site between March and July 2019. The results of the unattended noise surveys are summarised in Table 11-20.

Table 11-20: Summary of unattended noise monitoring – Westmead metro station construction site

Location ID	Address	Noise level (dBA)[1]					
		Background noise (RBL)			Average noise level (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.01	8-12 Alexandra Avenue, Westmead[2]	49	47	37	67	67	62
L.02	8 Ashley Lane, Westmead	48	46	41	58	53	51

Note 1: The RBL and L_{Aeq} noise levels have been obtained using the calculation procedures documented in the Noise Policy for Industry.
Note 2: Data measured on other recent project (Parramatta Light Rail (Stage1)).

11.6.2 Construction impacts

The construction scenarios at the Westmead metro station construction site, and the anticipated working hours are shown in Table 11-21. The estimated duration of each activity is also provided, noting that most activities would be intermittent during this period and would not be expected to be undertaken on a continual basis during every day of the activity.

Stage 1 works at Westmead metro station construction site are anticipated to have a total duration of about five years. The turnback cavern at Westmead is assessed as part of the tunnelling assessment in Section 11.5.1.

Temporary construction noise and vibration impacts would be managed through the implementation of standard and additional mitigation measures in accordance with the Sydney Metro Construction Noise and Vibration Standard.

Table 11-21: Construction activities and period of works at Westmead metro station construction site

Scenario	Activity	Total indicative duration (weeks)[3]	Maximum number of working faces	Hours of works[1]				Comments
				Std. Day	Out-of-hours works			
					Day OOH[2]	Eve	Night	
Enabling works	Supporting and loading	15	1	✓	-	-	-	
	Demolition using a rockbreaker	15	2	✓	-	-	-	
Piling	Supporting works	36	2	✓	-	-	-	
	Bored piling with support plant	36	4	✓	-	-	-	
Surface construction	General works	12	1	✓	-	-	-	
	Noise intensive works	12	1	✓	-	-	-	
Initial excavation	Mucking out	8	1	✓	-	-	-	
	Through soft soil/ rock	4	2	✓	-	-	-	Excavation through soil and soft rock using excavator ripper attachment. No noise attenuation from an acoustic shed (or other acoustic measures) is included for these works.

Scenario	Activity	Total indicative duration (weeks)[3]	Maximum number of working faces	Hours of works[1]				Comments
				Std. Day	Out-of-hours works			
					Day OOH[2]	Eve	Night	
Initial excavation cont.	Through rock using rockbreaker	4	2	✓	-	-	-	Excavation through rock using rockbreaker. Works restricted to daytime hours only. No noise attenuation from an acoustic shed (or other acoustic measures) is included for these works.
Excavation within shed	Mucking out	23	1	✓				Out-of-hours works would only be conducted once the acoustic shed (or other acoustic measures) have been fully installed.
	Through rock using rockbreaker	23	2	✓				
Tunnel boring machine launch and support site	Tunnel boring machine support and spoil removal	78	1	✓	✓	✓	✓	The majority of works would be completed in the acoustic shed (or other acoustic measures). Loading of tunnel boring machine components and other less noisy works would occasionally occur outside the shed.
	Tunnel boring machine assembly and launch	2	1	✓	✓	✓	✓	
Intersection modifications	Supporting works	2	1	✓	✓	✓	✓	
	Intensive works	2	1	✓	✓	✓	✓	

Note 1: Noise intensive works outside of standard construction hours would only be undertaken within the acoustic shed (or other acoustic measures).

Note 2: OOH is Out-of-hours. During the daytime, this refers to the period on Saturday between 7am - 8am, and 1pm - 6pm.

Note 3: Durations are indicative and represent the total estimated duration of works at a typical construction site over the entire Stage 1 construction period.

Airborne construction noise

The predicted airborne NML exceedances for residential receivers around the Westmead metro station construction site are summarised in Table 11-22. The predicted airborne NML exceedances for commercial and other sensitive receiver types are summarised in Table 11-23. The predictions are representative of the highest noise levels that would be experienced when the works are nearest to the sensitive receivers.

The number of receivers predicted to experience exceedances of the NMLs are summarised in bands of 10 dB and are separated into day, evening and night-time periods, as appropriate.

'High' worst-case impacts are generally associated with early activities such as enabling works, intersection modifications and initial excavation. These works are typically of short duration and undertaken during standard daytime construction hours (unless required to be undertaken outside these times such as for traffic management and safety reasons). The majority of works out of standard hours would only be undertaken after the establishment of the acoustic shed (or other acoustic measures).

Table 11-22: Overview of NML exceedances (residential receivers) – Westmead metro station construction site

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Supporting and loading	15	Day	10	-	-
	'Peak'	Demolition using a rockbreaker with supporting plant	15	Day	130	27	8
Piling	'Typical'	Supporting works	36	Day	9	-	-
	'Peak'	Bored piling with support plant	36	Day	22	-	-
Surface construction	'Typical'	General works	12	Day	1	-	-
	'Peak'	Noise intensive works	12	Day	11	-	-
Initial excavation	'Typical'	Mucking out	8	Day	14	-	-
	'Peak'	Through soft soil/rock	4	Day	30	1	-
		Through rock using rockbreaker	4	Day	136	30	1
Excavation within shed	'Typical'	Mucking out	23	Day	-	-	-
				Day OOH	-	-	-
				Evening	1	-	-
				Night	12	1	-
				Sleep disturbance	38	10	2
	Peak	Through rock using rockbreaker (Doors Closed)	23	Day	-	-	-
				Day OOH	2	-	-
				Evening	3	-	-
				Night	22	3	-
				Sleep disturbance	38	10	2
	Peak	Through rock using rockbreaker (Doors Open)	23	Day	7	-	-
				Day OOH	13	1	-
				Evening	16	1	-
				Night	63	16	1
				Sleep disturbance	39	10	2
Tunnel boring machine launch and support	'Typical'	Tunnel boring machine support and spoil removal	78	Day	-	-	-
				Day OOH	2	-	-
				Evening	2	-	-
				Night	14	2	-
				Sleep disturbance	38	10	2
	'Peak'	Tunnel boring machine assembly and launch	2	Day	2	-	-
				Day OOH	6	-	-
				Evening	11	-	-
				Night	48	11	-
				Sleep disturbance	38	10	2

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2] With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Intersection modifications	'Typical'	Supporting works	2	Day	10	5	-
				Day OOH	16	8	-
				Evening	24	10	-
				Night	68	22	10
				Sleep disturbance	51	12	7
	'Peak'	Noise intensive works	2	Day	146	37	15
				Day OOH	329	83	24
				Evening	406	98	34
				Night	347	376	100
				Sleep disturbance	449	89	43

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 2: Total number of receivers: 941

Note 3: Based on worst-case predicted noise levels.

Table 11-23: Overview of NML exceedances ('other' sensitive receivers) – Westmead metro station construction site

Scenario	Activity	Receiver type	Number of receivers With NML exceedance		
			1-10 dB	11-20 dB	>20 dB
Enabling works	Supporting and loading	Childcare	1	-	-
		Educational	3	-	-
	Demolition using a rockbreaker with supporting plant	Commercial	1	-	-
		Childcare	-	-	1
		Educational	3	4	1
		Public building	1	-	-
		Place of worship	2	-	-
		Passive recreation	1	-	-
		Medical (daytime)	3	-	-
Piling	Supporting works	Childcare	1	-	-
		Educational	2	-	-
	Bored piling with support plant	Childcare	-	1	-
		Educational	4	-	-
Surface construction	General works	Educational	1	-	-
	Noise intensive works	Childcare	1	-	-
		Educational	4	-	-
Initial excavation	Mucking out	Childcare	1	-	-
		Educational	4	-	-
	Through soft soil/rock	Childcare	-	1	-
		Educational	4	1	-
Initial excavation cont.	Through rock using rockbreaker	Commercial	1	-	-
		Childcare	-	-	1
		Educational	6	4	1
		Public building	2	-	-
		Place of worship	2	-	-
		Passive recreation	1	-	-
		Medical (daytime)	3	-	-
Excavation within shed	Mucking out (doors closed)	No receiver types impacted	-	-	-
	Through rock using rockbreakers (doors closed)	No receiver types impacted	-	-	-
	Through rock using rockbreaker (doors open)	Educational	1	-	-
Tunnel boring machine launch and support	Tunnel boring machine support and spoil removal	No receiver types impacted	-	-	-
	Tunnel boring machine assembly and launch	Educational	1	-	-
Intersection modification	Supporting works	Child care	1	-	-
		Educational	3	1	-
	Noise intensive works	Commercial	4	-	-
		Child care	-	-	1
		Educational	5	1	4
		Public building	-	1	-
		Place of worship	4	-	-
		Passive recreation	1	-	-
		Medical (daytime)	4	-	-
		Medical (night-time)	4	-	-

The preliminary findings of the construction noise impact assessment around the Westmead metro station construction site indicate:

- Stage 1 is predicted to result in 'high' worst-case noise impacts at the nearest receivers during higher noise generating activities. The nearest receivers to the site are generally residential and educational buildings. Some of the worst-case impacts are predicted during enabling works and initial excavation which would occur before the acoustic shed (or other acoustic measures) is constructed. These works are, however, limited to standard construction hours and would not occur during the evening or night-time
- The highest impacts are during 'peak' scenarios which use noise intensive equipment such as rockbreakers. Rockbreakers would, however, only be used outdoors intermittently and the duration is around 10 days during enabling works and four weeks during Initial excavation works. When noise intensive equipment is not in use during 'typical' works, the worst-case impacts are predicted to generally be reduced to 'minor' or 'moderate' at the nearest receivers
- Piling and surface construction works generate less noise and the worst-case impacts at the nearest receivers are predicted to be 'minor'. These works would also be completed during standard construction hours, prior to the acoustic shed (or other acoustic measures) being built
- Noise intensive works outside of standard construction hours would only be completed in the acoustic shed (or other acoustic measures) once it is built (except for intersection modification works). The worst-case impacts from works in the shed during the night-time are generally predicted to be 'minor' or 'moderate' during excavation with shed when rockbreakers are in use and the shed doors are closed. When rockbreakers are in use and the doors are open the impacts are increased for receivers near to the doors of the shed

- 'High' impacts are also predicted during intersection modifications which are required on certain roads surrounding the construction site. These works are required during all periods, including some works during the evening and night-time period, however, they are only expected to last for two weeks.

Highly affected residential receivers

Residential receivers that are subject to noise levels of 75 dBA or greater are considered highly Noise Affected by the ICNG. Receivers can be highly noise affected when noisy works are occurring close to residents.

The receivers which could potentially be highly noise affected during the worst-case impacts from Stage 1 are summarised in Table 11-24 and shown by Figure 11-2. The table shows the activity and number of residential receivers affected in each NCA.

Table 11-24: Predicted number of highly noise affected residential receivers – Westmead metro station construction site

Scenario	Activity	NCA01			NCA02		
		Day	Eve	Night	Day	Eve	Night
Enabling works	Supporting and loading	-	n/a[1]	n/a	-	n/a	n/a
	Demolition using a rockbreaker	1	n/a	n/a	11	n/a	n/a
Piling	Supporting works	-	n/a	n/a	-	n/a	n/a
	Bored piling with support plant	-	n/a	n/a	-	n/a	n/a
Surface construction	General works	-	n/a	n/a	-	n/a	n/a
	Noise intensive works	-	n/a	n/a	-	n/a	n/a
Initial excavation	Mucking out	-	n/a	n/a	-	n/a	n/a
	Through soft soil/rock	-	n/a	n/a	-	n/a	n/a
	Through rock using rockbreaker	2	n/a	n/a	8	n/a	n/a
Excavation within shed	Mucking out (doors closed)	-	-	-	-	-	-
	Through rock using rockbreaker (doors closed)	-	-	-	-	-	-
	Through rock using rockbreaker (doors open)	-	-	-	-	-	-
TBM retrieval	Supporting works	-	-	-	-	-	-
	Intensive works	-	-	-	-	-	-
Intersection modifications	Supporting works	-	-	-	-	-	-
	Intensive works	1	1	1	23	23	23

Note 1: 'n/a' represents where works would not be performed during the evening or night-time periods

Figure 11-2: Predicted highly noise affected residential receivers – Westmead metro station construction site

Sleep disturbance

A sleep disturbance screening assessment has been completed for the construction works and is summarised in Table 11-22. 'High' sleep disturbance impacts are predicted at the nearest residential during noisy works as part of excavation with shed, tunnel boring machine launch and support, and intersection modifications.

Sleep disturbance impacts from within the construction site are generally controlled by heavy vehicle movements in the outdoor areas of the site as part of the excavation within shed and tunnel boring machine launch and support. Night-time truck movements at this construction site are expected to be around 25 trucks per hour.

Sleep disturbance impacts associated with intersection modifications are generally from use of noise intensive equipment such as concrete saws and rockbreakers. The number of night-time awakenings during Intersection modifications would depend on several factors, including the type of equipment being used, the duration of the noisy works and the distance of the works to nearest residential receivers.

Further investigation of awakenings would be completed during the next stages of Stage 1 when detailed construction planning information becomes available.

Ground-borne construction noise

The predicted ground-borne impacts from vibration intensive station shaft excavation works inside the acoustic shed (or other acoustic measures) are shown in Figure 11-3 and Figure 11-4 for the daytime and night-time, respectively. The predictions are representative of the highest ground-borne noise levels that would likely be experienced by the nearest receivers when excavation works are at their closest.

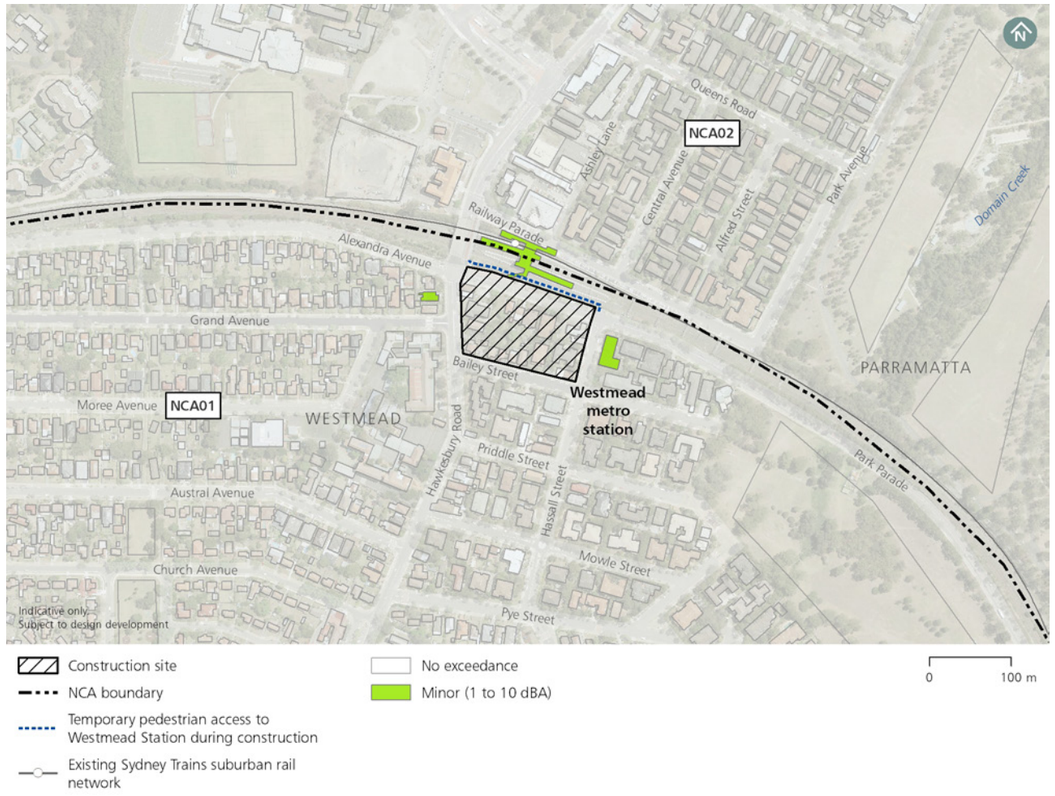


Figure 11-3: Ground-borne noise impacts (daytime construction hours) – Westmead metro station construction site

Figure 11-4: Ground-borne noise impacts (night-time construction hours) – Westmead metro station construction site

Vibration impacts

The predicted impacts during vibration intensive works are shown in Figure 11-5. The predictions are representative of the highest vibration levels that would likely be experienced by the nearest receivers when works are at their closest.

There are no predicted exceedances of the cosmetic damage screening criteria or the sensitive equipment screening criteria at this site. The human comfort criteria are predicted to be exceeded at one residential receiver to the east of the site, meaning occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use nearby.

Figure 11-5: Worst case vibration impacts – Westmead metro station construction site

Construction traffic noise

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers adjacent to construction haul routes. The forecast construction traffic volumes in the study area have been used to determine where potentially noticeable increases in road traffic noise (i.e. a greater than 2 dB increase above the existing noise level) is likely. Roads anticipated to have a greater than 2 dB increase would include Hawkesbury Road to the south of the construction site, Grand Avenue to the west of the construction site, Hassall Street and Bailey Street. Temporary road reconfigurations in the Westmead study area that divert traffic from Alexandra Avenue through Hassall Street, Bailey Street and Grand Avenue are likely to result in noticeable increases on these roads. The increase represents the worst-case predicted increase in any period.

11.6.3 Operational impacts of permanent road network changes

The predicted operational road noise levels at residential receivers are summarised in Table 11-25. The table shows the worst-case impacts in each NCA, which typically correspond to receivers nearest the roadworks.

In total, 71 residential receivers are predicted to experience exceedances of the operational road traffic noise criteria. Noise levels at one 'other' sensitive receiver, Westmead Public School, are predicted to experience noise impacts which exceed the trigger level. The locations of the receivers experience noise impacts above the noise trigger levels and, as such, are eligible for consideration of mitigation, are shown in Figure 11-6.

Residential receivers are predicted to experience noise impacts above the trigger levels adjacent to the realignment of Alexandra Avenue and also along Grand Avenue. The triggers near Bailey Street are due to Alexandra Avenue moving closer to these receivers. The triggers along Grand Avenue are due to the functional class change of Grand Avenue. This means the impacts here are required to be assessed against 'new' road criteria.

Noise levels at residential receivers to the south on Bailey Street are predicted to increase by around 3 dB due to the realigned section of Alexandra Avenue. Noise levels along Grand Avenue are predicted to increase by around 5 to 6 dB which is due to the increased volume of traffic on this road.

Exceedances of the NCG cumulative limit criteria (i.e. 5 dB or more above the NCG controlling criterion) are predicted at the receivers which have noticeable increases in noise.

While average noise levels are expected to increase at receivers on Grand Avenue during the night-time due to increased traffic, the road reconfigurations are not expected to result in any noticeable change to the maximum noise levels. The frequency of the maximum noise level event on Grand Avenue is likely to increase in line with the general increase in night-time traffic.

The works are predicted to result in acute noise levels (i.e. daytime noise levels are 65 dBA or higher, or night-time noise levels are 60 dBA or higher) at four residential receivers.

Table 11-25: Predicted road traffic noise levels at most affected residential receivers – Westmead metro station construction site

NCA	Predicted Noise Level (dBA)				Number of triggered buildings			
	At opening (2023)							
	Without project		With project		Triggers			
	Day	Night	Day	Night	>2 dB	Cumulative	Acute	Total
NCA01	70	64	70	63	-	-	-	-
NCA02	68	63	70	65	68	69	4	71

Figure 11-6: Operational traffic noise impacts – Westmead metro station construction site

11.7 Parramatta metro station construction site

11.7.1 Existing environment

Existing noise levels around the Parramatta metro station construction site are dominated by road traffic noise and the general urban noise associated with the Parramatta CBD. The area surrounding the construction site is mainly commercial, typically general office or retail use and includes one noise catchment area: NCA03 (refer to Figure 11-7).

NCA03 covers Parramatta CBD and is mainly commercial. Residential receivers are generally on the outskirts of the catchment. There are many 'other sensitive' receivers in this catchment, including Western Sydney University – Parramatta, Arthur Phillip High School, Parramatta Public School, and a number of nearby hotels and places of worship.

The nearest residential receiver is located about 20 metres to the north of the construction site on the corner of George Street and Horwood Place.

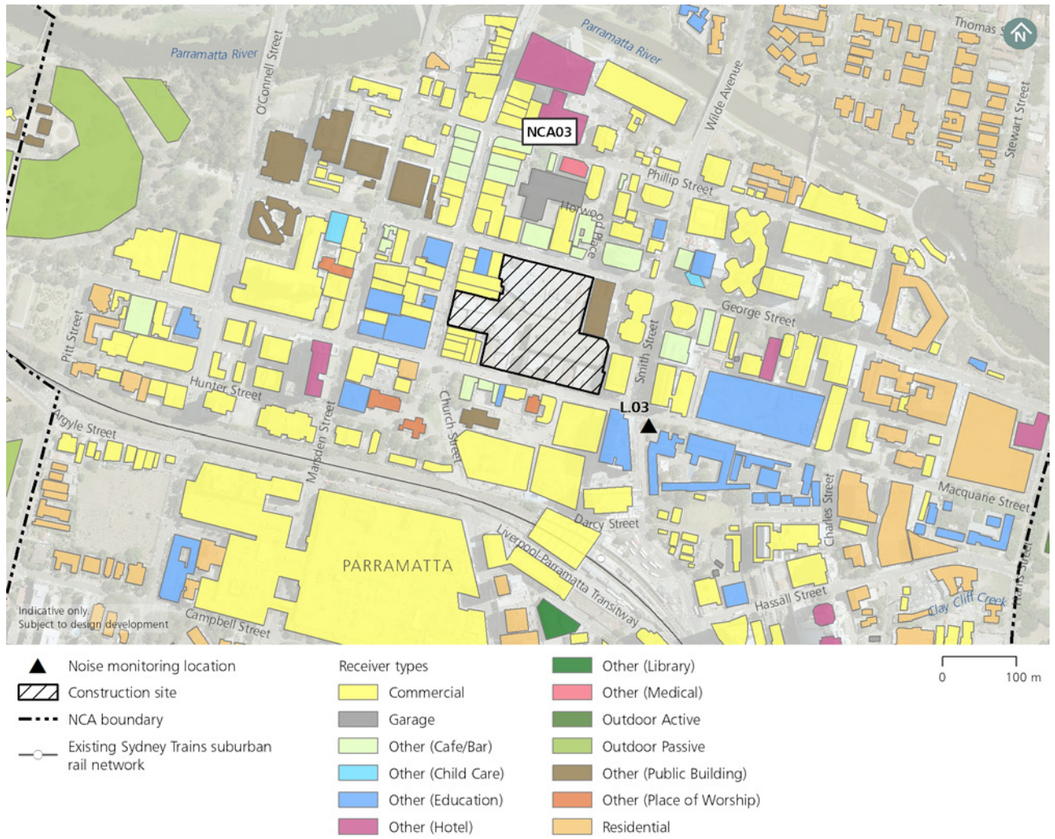


Figure 11-7: Location of sensitive receivers near Parramatta metro station construction site

Unattended noise monitoring was undertaken at one sensitive receiver located in the vicinity of Parramatta metro station construction site between March and July 2019.

The results of the unattended noise surveys are summarised in Table 11-26.

Table 11-26: Summary of unattended noise monitoring– Parramatta metro station construction site

Location ID	Address	Noise level (dBA)[1]					
		Background noise (RBL)			Average noise level (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.03	Arthur Phillip High School, Parramatta[2]	58	53	43	69	67	62

Note 1: The RBL and L_{Aeq} noise levels have been obtained using the calculation procedures documented in the Noise Policy for Industry.
Note 2: Data measured on other recent project (Parramatta Light Rail (Stage1)).

11.7.2 Construction impacts

The construction scenarios at the Parramatta metro station construction site, and the anticipated working hours are shown in Table 11-27. The estimated duration of each activity is also provided, noting that most activities would be intermittent during this period and would not be expected to be undertaken on a continual basis during every day of the activity.

Stage 1 works within the Parramatta metro station construction site are anticipated to have a total duration of about two years.

Temporary construction noise and vibration impacts would be managed through the implementation of standard and additional mitigation measures in accordance with the Sydney Metro Construction Noise and Vibration Standard.

Table 11-27: Construction activities and period of works at Parramatta metro station construction site

Scenario	Activity	Total indicative duration (weeks)[2]	Maximum number of working faces	Hours of works				Comments
				Std. Day	Out-of-hours works			
					Day OOH[1]	Eve	Night	
Enabling works	Supporting and loading	24	1	✓	✓	-	-	
	Demolition using a rockbreaker	24	2	✓	✓	-	-	Would occur intermittently. Estimated total duration of about 20 days.
Piling	Supporting works	36	2	✓	✓	-	-	
	Bored piling with support plant	36	4	✓	✓	-	-	Would occur intermittently. Estimated total duration of about 36 weeks.
Surface construction	General works	12	1	✓	✓	-	-	
	Noise intensive works	12	2	✓	✓	-	-	
Excavation	Mucking out	30	1	✓	✓	✓	✓	Mucking out would occur through standard daytime and out-of-hours daytime periods only. Spoil haulage would occur during all periods.
	Through soft soil/rock	6	2	✓	✓	-	-	
	Through rock using rockbreaker	24	2	✓	✓	-	-	Excavation through rock using rockbreaker. Works restricted to standard construction hours only and Saturday out-of-hours Period 1.

Note 1: Day OOH is Out-of-hours. During the daytime, this refers to the period on Saturday between 7am - 8am, and 1pm - 6pm.
Note 2: Durations should be regarded as indicative and represent the total estimated duration of works at a typical worksite over the entire construction period.

Airborne construction noise

The predicted airborne NML exceedances from site works in the Parramatta metro station construction site are summarised in Table 11-28 for all residential receivers. The predicted airborne NML exceedances for commercial and other sensitive receiver types are summarised in Table 11-29. The predictions are representative of the highest noise levels that would be experienced when the works are nearest to sensitive receivers.

The number of receivers predicted to experience exceedances of the NMLs are summarised in bands of 10 dB and are separated into day, evening and night-time periods.

Works at Parramatta metro station construction site would typically be restricted to standard daytime construction hours, plus extended hours on Saturday afternoons. Spoil removal is proposed out of standard construction hours to reduce potential transport and traffic impacts in a busy CBD environment. This is not predicted to result in exceedances of noise management levels due to the limited number of residential receivers in the vicinity.

Table 11-28: Overview of NML exceedances (residential receivers) – Parramatta metro station construction site

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Supporting and loading	24	No impact during any period	-	-	-
	'Peak'	Demolition using a rockbreaker	24	Day	1	-	-
				Day OOH	1	-	-
Piling	'Typical'	Supporting works	36	No impact during any period	-	-	-
	'Peak'	Bored piling with support plan	36	No impact during any period	-	-	-
Surface construction	'Typical'	General works	12	No impact during any period	-	-	-
	'Peak'	Noise intensive works	12	No impact during any period	-	-	-
Excavation	'Typical'	Mucking out	30	No impact during any period	-	-	-
	'Peak'	Through soft soil / rock	6	No impact during any period	-	-	-
		Through rock using rockbreaker	24	Day	1	-	-
				Day OOH	1	-	-

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 2: Total number of receivers: 478

Note 3: Based on worst-case predicted noise levels.

Table 11-29: Overview of NML exceedances ('other' sensitive receiver types) – Parramatta metro station construction site

Scenario	Activity		Duration (weeks)	Receiver type	Number of receivers		
					With NML exceedance		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Supporting and loading	24	Commercial	5	-	-
				Educational	4	1	5
				Public building	-	1	-
				Place of worship	-	1	-
	'Peak'	Demolition using a rockbreaker	24	Commercial	20	13	3
				Café/bar	2	5	-
				Childcare	-	2	-
				Educational	16	5	20
				Public building	6	1	1
				Place of worship	2	2	6
				Passive recreation	1	1	-
				Medical (daytime)	5	1	-
Piling	'Typical'	Supporting works	36	Commercial	3	-	-
				Educational	6	-	3
				Public building	-	1	-
				Place of worship	1	-	-
	'Peak'	Bored piling with support plant	36	Commercial	4	1	-
				Childcare	1	-	-
				Educational	5	3	4
				Public building	1	-	1
				Place of worship	2	1	1
Surface construction	'Typical'	General works	12	Commercial	1	-	-
				Educational	4	-	1
				Public building	1	-	-
				Place of worship	1	-	1
	'Peak'	Noise intensive works	12	Commercial	3	-	-
				Educational	5	2	3
				Public building	-	1	-
				Place of worship	-	1	-
Excavation	'Typical'	Mucking out	30	Commercial	4	-	-
				Educational	5	1	4
				Public building	-	1	-
				Place of worship	-	1	-

Scenario	Activity		Duration (weeks)	Receiver type	Number of receivers		
					With NML exceedance		
					1-10 dB	11-20 dB	>20 dB
Excavation cont.	'Peak'	Through soft soil/ rock	6	Commercial	7	1	-
				Childcare	1	-	-
				Educational	4	4	7
				Public building	1	-	1
				Place of worship	2	1	1
		Through rock using rockbreaker	24	Commercial	24	7	1
				Café/bar	6	-	-
				Childcare	1	1	-
				Educational	14	4	24
				Public building	4	1	1
				Place of worship	2	2	4
				Passive recreation	2	-	-
				Medical (daytime)	4	1	-

The preliminary findings of the construction noise impact assessment at Parramatta metro station construction site indicate:

- Stage 1 is predicted to result in 'high' worst-case noise impacts at the nearest receivers during higher noise generating activities. The nearest receivers to the site are generally commercial. The worst-case impacts are predicted during enabling works and excavation. These works are, however, limited to the daytime and would not typically occur during the evening or night-time
- The highest impacts are during 'peak' scenarios which use noise intensive equipment such as rockbreakers. When noise intensive equipment is not in use during 'typical' works, the worst-case impacts are predicted to reduce to 'moderate' or 'minor' at the nearest receivers
- Piling and surface construction works generate less noise and the worst-case impacts at the nearest receivers are generally predicted to be 'minor' or 'moderate'. These works would also only be undertaken during the daytime
- Most of the works are proposed to occur during the daytime. Spoil haulage (as part of mucking out) would be required during the evening and night-time, however, noise levels from this activity are relatively low and only predicted to result in two 'minor' exceedances during the evening.

Highly affected residential receivers

No receivers are predicted to be highly noise affected by the works at Parramatta metro station construction site.

Sleep disturbance

Only spoil haulage (as part of mucking out) would occur during the night-time. No impacts are predicted during this activity.

Ground-borne construction noise

Vibration intensive works during shaft excavation at this construction site would not be completed in an acoustic shed (or other acoustic measures) meaning airborne noise levels at the nearest receivers would likely be higher than the corresponding internal ground-borne noise levels.

Ground-borne noise levels have been assessed at this site and the potential worst-case impacts are shown in Figure 11-8. The predictions are representative of the highest ground-borne noise levels that would likely be experienced by the nearest receivers when excavation works are at their closest.

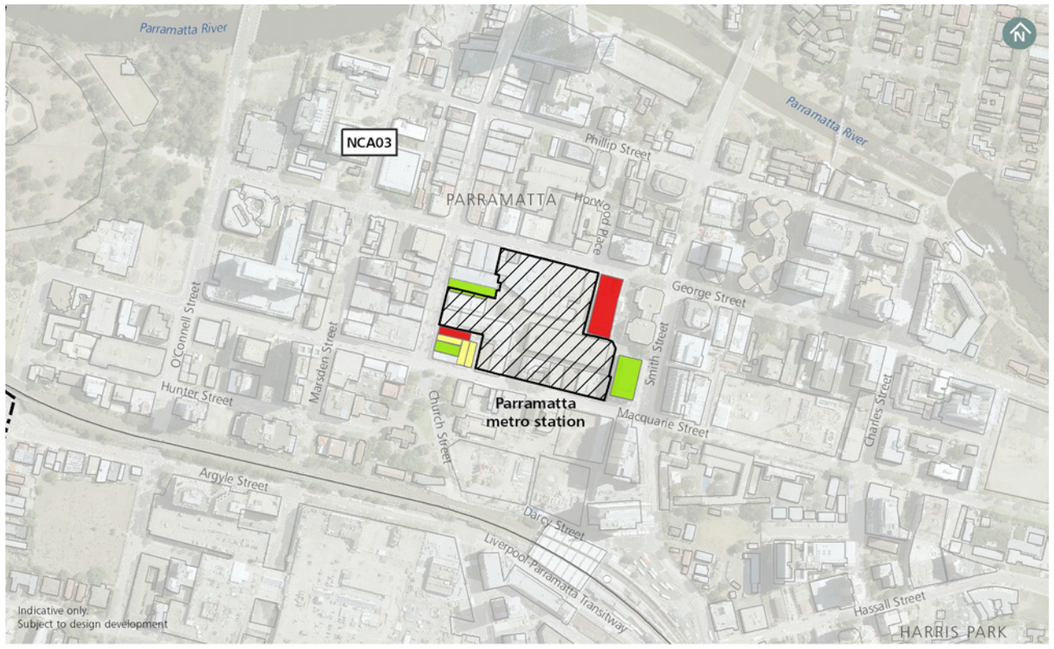


Figure 11-8: Ground-borne noise impacts (daytime construction hours) – Parramatta metro station construction site

Vibration impacts

The predicted impacts during vibration intensive works are shown in Figure 11-9. The predictions are representative of the highest vibration levels that would likely be experienced by the nearest receivers when works are at their closest.

The cosmetic damage screening criteria are predicted to be exceeded at the nine nearest buildings and structures to the site. This includes the Roxy Theatre to the east as well as two heritage listed buildings and one heritage listed structure (underground services) within the construction footprint. Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure and attended vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure.

The human comfort criteria are also predicted to be exceeded at some of the nearest commercial buildings, meaning occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use nearby.

Exceedances of the vibration sensitive equipment screening criteria are predicted at the following two locations identified as potentially having vibration sensitive equipment:

- SunDoctors Skin Cancer Clinic, Parramatta
- Orthodontics Sydney Wide, Parramatta.

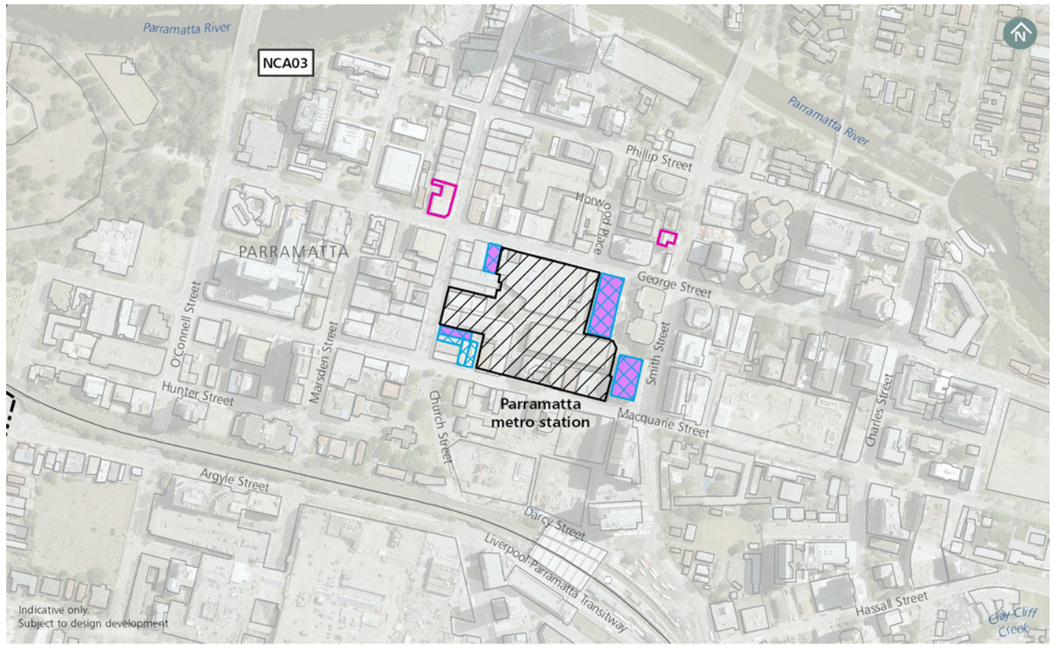


Figure 11-9: Worst-case vibration impacts – Parramatta metro station construction site

Construction traffic noise

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers which are adjacent to construction haul routes. The forecast construction traffic volumes in the study area have been used to determine where potentially noticeable increases in road traffic noise (i.e. a greater than 2 dB increase above the existing noise level) are likely. Roads anticipated to have a greater than 2 dB increase would include George Street to the west of the construction site, although there are no residential receivers along this road. This increase represents the worst-case predicted increase in any period.

11.8 Clyde stabling and maintenance facility construction site

11.8.1 Existing environment

Existing noise levels in area surrounding Clyde stabling and maintenance facility construction site are generally controlled by road traffic noise on the surrounding road network.

Clyde is categorised by four noise catchment areas: NCA04, NCA05, NCA06 and NCA07 (refer to Figure 11-10).

NCA04 is south of the Parramatta River and west of James Ruse Drive. The catchment is mainly residential with small areas of commercial receivers.

NCA05 is north of the M4 Motorway and west of James Ruse Drive. The catchment is mainly residential. 'Other sensitive' receivers include Rosehill Public School and a number of hotels and child care centres.

NCA06 is south of the M4 Motorway in Granville. The catchment is mostly residential adjacent to the motorway, with some commercial use in the south-east.

NCA07 is east of James Ruse Drive, this catchment is mostly commercial and covers Rosehill Gardens racecourse (and associated stables), the Clyde commercial/industrial area, and Silverwater and Newington. Residential receivers and Newington Public School are in the south-east.

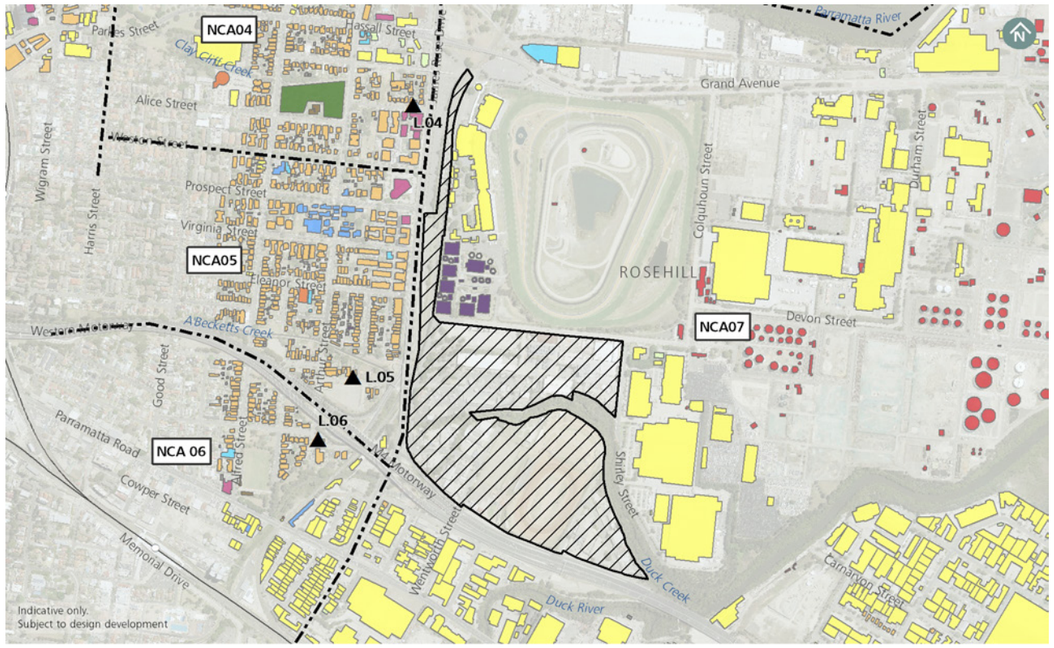


Figure 11-10: Locations of sensitive receivers near Clyde stabling and maintenance facility construction site

Unattended noise monitoring was undertaken at four sensitive receivers located in the vicinity of Clyde stabling and maintenance facility construction site between March and July 2019.

The results of the unattended noise surveys are summarised in Table 11-30.

Table 11-30: Summary of unattended noise monitoring– Clyde stabling and maintenance facility construction site

Location ID	Address	Noise level (dBA)[1]					
		Background noise (RBL)			Average noise level (L^{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.04	5 Hope Street, Rosehill[2]	51	48	41	61	58	57
L.05	9 A'Beckett Street, Granville[2]	50	49	45	56	55	53
L.06	4B Gray Street, Granville[2]	52	51	44	58	57	55
L.07	10 Carnarvon Street, Silverwater	46	44	41	60	57	55

Note 1: The RBL and L^{Aeq} noise levels have been obtained using the calculation procedures documented in the Noise Policy for Industry.
Note 2: Data measured on other recent project (Parramatta Light Rail (Stage1)).

11.8.2 Construction impacts

The construction scenarios at the Clyde stabling and maintenance facility construction site, and the anticipated working hours are shown in Table 11-31. The estimated duration of each activity is also provided, noting that most activities would be intermittent during this period and would not be expected to be undertaken on a continual basis during every day of the activity.

Stage 1 works at the Clyde stabling and maintenance facility construction site are anticipated to have a total duration of about three years and three months.

These temporary airborne noise impacts would be managed through the implementation of standard and additional mitigation measures in accordance with the Sydney Metro Construction Noise and Vibration Standard.

Table 11-31: Construction activities and period of works at Clyde stabling and maintenance facility construction site

Scenario	Activity	Total indicative duration (weeks)[2]	Maximum number of working faces	Hours of works				Comments
				Std. Day	Out-of-hours works			
					Day OOH[1]	Eve	Night	
Enabling works	Supporting and loading	19	1	✓	-	-	-	-
	Demolition using a rockbreaker	19	2	✓	-	-	-	Would occur intermittently. Estimated total duration of about 15 days.
Piling	Supporting works	5	1	✓	-	-	-	-
	Bored piling with support plant	5	2	✓	-	-	-	Would occur intermittently.
Earthworks and civil works	General works	38	1	✓	✓		✓	Delivery and stockpiling would occur on a 24-hour basis. No noise intensive equipment would operate during out-of-hours periods.
	Noise intensive works	38	2	✓	-	-	-	-
Surface construction	General works	13	1	✓	-	-	-	-
	Noise intensive works	13	2	✓	-	-	-	-
Excavation	Mucking out	35	1	✓	-	-	-	Includes concrete batching plant.
	Through soft soil/rock	5	2	✓	-	-	-	Excavation through soil and soft rock using excavator ripper attachment. Includes concrete batching plant.
	Through rock using rockbreaker	30	2		-	-	-	Excavation through rock using rockbreakers. Works restricted to standard construction hours only. Includes concrete batching plant.
Concrete batch plant	50 per cent capacity	143	1	✓	✓	✓	✓	-
	100 per cent capacity	143	1	✓	✓	✓	✓	-

Note 1: Day OOH is Out-of-hours. During the daytime, this refers to the period on Saturday between 7am - 8am, and 1pm - 6pm.

Note 2: Durations should be regarded as indicative and represent the total estimated duration of works at a typical worksite over the entire construction period.

Airborne construction noise

The predicted airborne NML exceedances from works at the Clyde stabling and maintenance facility construction site are summarised in Table 11-32 for all residential receivers. The predicted airborne NML exceedances for commercial and other sensitive receiver types are summarised in Table 11-33. The predictions are representative of the highest noise levels that would be experienced when the works are nearest to sensitive receivers.

The number of receivers predicted to experience exceedances of the NMLs are summarised in bands of 10 dB and are separated into day, evening and night-time periods.

'High' worst-case impacts are predicted for enabling works and excavation works for periods when a rock breaker would be required. These works would be undertaken during standard daytime construction hours. Due to the distance of residential receivers from locations on the site where out of hours works proposed, potential noise impacts are predicted to be 'minor'.

Table 11-32: Overview of NML exceedances (residential receivers) – Clyde stabling and maintenance facility construction site

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Supporting and loading	19	Day	5	-	-
	'Peak'	Demolition using a rockbreaker	19	Day	153	20	5
Piling	'Typical'	Supporting works	5	Day	5	-	-
	'Peak'	Bored piling with support plan	5	Day	11	1	-
Earthworks and civil works	'Typical'	General works	38	Day	-	-	-
				Day OOH	3	-	-
				Evening	5	-	-
				Night	6	-	-
				Sleep disturbance	1	-	-
	'Peak'	Noise intensive works	38	Day	6	-	-
Surface construction	'Typical'	General works	13	Day	8	-	-
	'Peak'	Noise intensive works	13	Day	9	1	-
Excavation	'Typical'	Mucking out	35	Day	39	5	3
	'Peak'	Through soft soil / rock	5	Day	-	-	-
		Through rock using rockbreaker	30	Day	14	3	-
Concrete batch plant	'Typical'	50 per cent capacity	143	Night	6	-	-
	'Peak'	100 per cent capacity	143	Evening	3	-	-
				Night	25	-	-

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 2: Total number of receivers: 2,764

Note 3: Based on worst-case predicted noise levels.

Table 11-33: Overview of NML exceedances ('other' sensitive receiver types) – Clyde stabling and maintenance facility construction site

Scenario	Activity		Duration (weeks)	Receiver type	Number of receivers		
					With NML exceedance		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Supporting and loading	19	Child care	1	-	-
				Stables	8	-	-
	'Peak'	Demolition using a rockbreaker	19	Commercial	20	3	-
				Childcare	5	2	-
				Educational	19	2	-
				Place of worship	1	-	-
				Stables	12	10	5
				Hotel (daytime)	2	-	-
Piling	'Typical'	Supporting works	5	Child care	1	-	-
				Stables	2	-	-
	'Peak'	Bored piling with support plant	5	Child care	1	-	-
				Stables	10	-	-
Earthworks and civil works	'Typical'	General works	38	No receiver types impacted	-	-	-
	'Peak'	Noise intensive works	38	Commercial	1	-	-
				Child care	2	-	-
				Educational	1	-	-
				Stables	13	-	-
Surface construction	'Typical'	General works	13	No receiver types impacted	-	-	-
	'Peak'	Noise intensive works	13	Child care	1	-	-
				Stables	5	-	-
Excavation	'Typical'	Mucking out	35	Child care	1	-	-
				Stables	11	-	-
	'Peak'	Through soft soil/rock	5	Child care	1	-	-
				Stables	11	-	-
		Through rock using rockbreaker	30	Commercial	6	-	-
				Childcare	4	1	-
				Educational	14	-	-
				Stables	19	8	-
				Hotel (daytime)	2	-	-
Concrete batch plant	'Typical'	50 per cent capacity	143	No receiver types impacted	-	-	-
	'Peak'	100 per cent capacity	143		-	-	-

The preliminary findings of the construction noise impact assessment at Clyde stabling and maintenance facility construction site indicate:

- Stage 1 is predicted to result in 'high' worst-case noise impacts at the nearest receivers during the higher noise generating activities. The nearest receivers to the site are generally residential and 'other sensitive' receivers at Rosehill Gardens racecourse (i.e. stables). The worst-case impacts are predicted during enabling works and excavation. These works are, however, limited to standard construction hours and would not occur during the evening or night-time. Impacts would be managed in accordance with the measures outlined in Section 11.16.2
- The highest impacts are during 'peak' scenarios which use noise intensive equipment such as rockbreakers. Rockbreakers would, however, only be used intermittently during demolition works, and the total duration is around 15 days. Excavation works would also require intermittent use of rockbreakers over approximately 30 weeks. When noise intensive equipment is not in use during 'typical' works, the worst-case impacts are predicted to reduce to 'minor' or be compliant with the management levels
- Piling, earthworks and civil works and surface construction works generate less noise and the worst-case impacts at the nearest receivers are predicted to be 'moderate' or 'minor'
- Works associated with delivery and stockpiling of spoil would occur outside of standard construction hours. The worst during the night-time are predicted to be 'minor' at the nearest receivers
- Works associated with the concrete batch plant and segment production facility would occur outside standard construction hours. The worst-case impacts during the night-time are predicted to be 'minor' at the nearest receivers if the facility operates at 100 per cent capacity during, as represented by the 'peak' scenario. The number of 'minor' night-time NML exceedances is substantially reduced when the facility operates at 50 per cent capacity.

Highly affected residential receivers

Enabling works (demolition using rockbreakers) and excavation (through rock using rockbreakers) would result in nine and five highly noise affected receivers during the daytime period (respectively). Figure 11-11 shows the location of predicted highly noise affected receivers near the Clyde stabling and maintenance facility construction site.

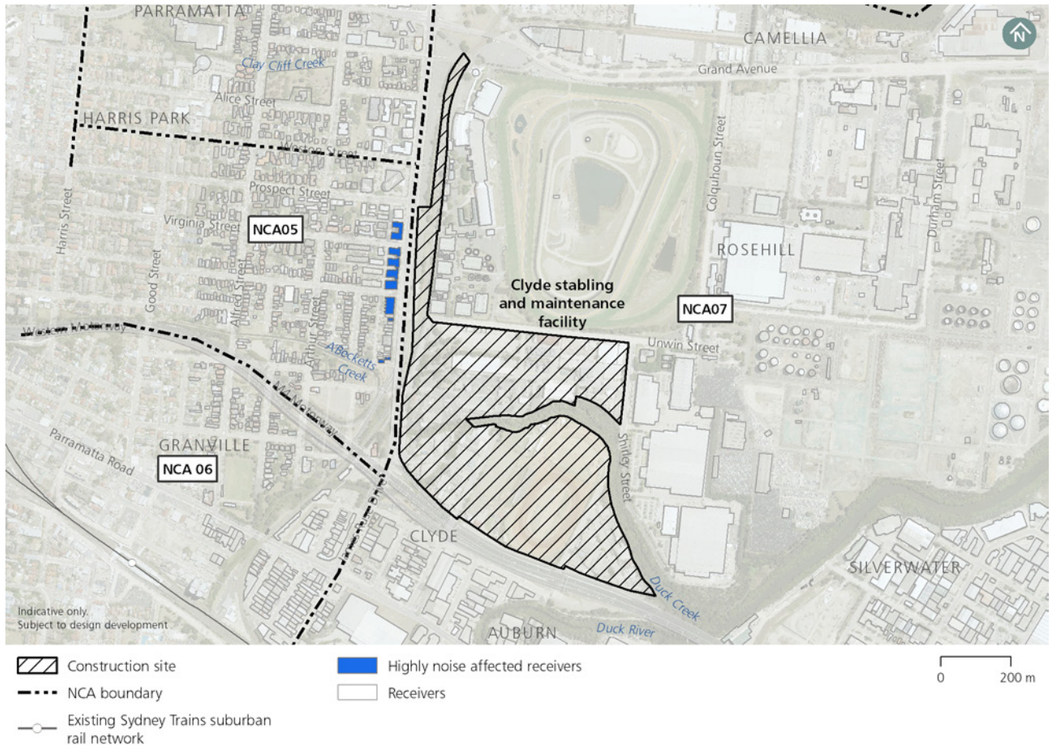


Figure 11-11: Predicted highly noise affected residential receivers – Clyde stabling and maintenance facility construction site

Sleep disturbance

A sleep disturbance screening assessment has been completed for the construction works and is summarised in Table 11-32. 'Minor' sleep disturbance impacts are predicted at one residential receiver to the west during delivery and stockpiling of spoil.

Sleep disturbance impacts from within the construction site are generally controlled by heavy vehicle movements. Existing maximum noise levels from heavy vehicles on James Ruse Drive would likely be higher than maximum noise events at the Clyde stabling and maintenance facility construction site. Night-time truck movements at this construction site are expected to be around 22 trucks per hour with vehicles accessing the site via the southern entrance on Wentworth Street.

The number of night-time awakenings would depend on several factors, including the type of vehicles and equipment being used, the duration of the noisy works and the distance of the works to nearest residential receivers.

Further investigation of awakenings would be completed during the next stages of Stage 1 when detailed construction planning information becomes available.

Ground-borne construction noise

Vibration intensive works during shaft excavation at this construction site would not be completed in an acoustic shed (or other acoustic measures) (as the works would only be undertaken during the daytime period) meaning airborne noise levels at the nearest receivers would likely be higher than the corresponding internal ground-borne noise levels.

Vibration impacts

The predicted impacts during vibration intensive works are shown in Figure 11-12. The predictions are representative of the highest vibration levels that would likely be experienced by the nearest receivers when works are at their closest.

The cosmetic damage screening criteria are predicted to be exceeded at four commercial buildings at Rosehill Gardens racecourse located east of the existing rail corridor section of the site. One heritage listed building at 1 Unwin Street, Rosehill, located to the north of the site would also be impacted. This building is a heritage listed free-standing building facade and is not occupied.

The human comfort criteria are also predicted to be exceeded at one of the nearest commercial buildings located to the north of the site, meaning occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use nearby.

There are no predicted exceedances of the sensitive equipment screening criteria.

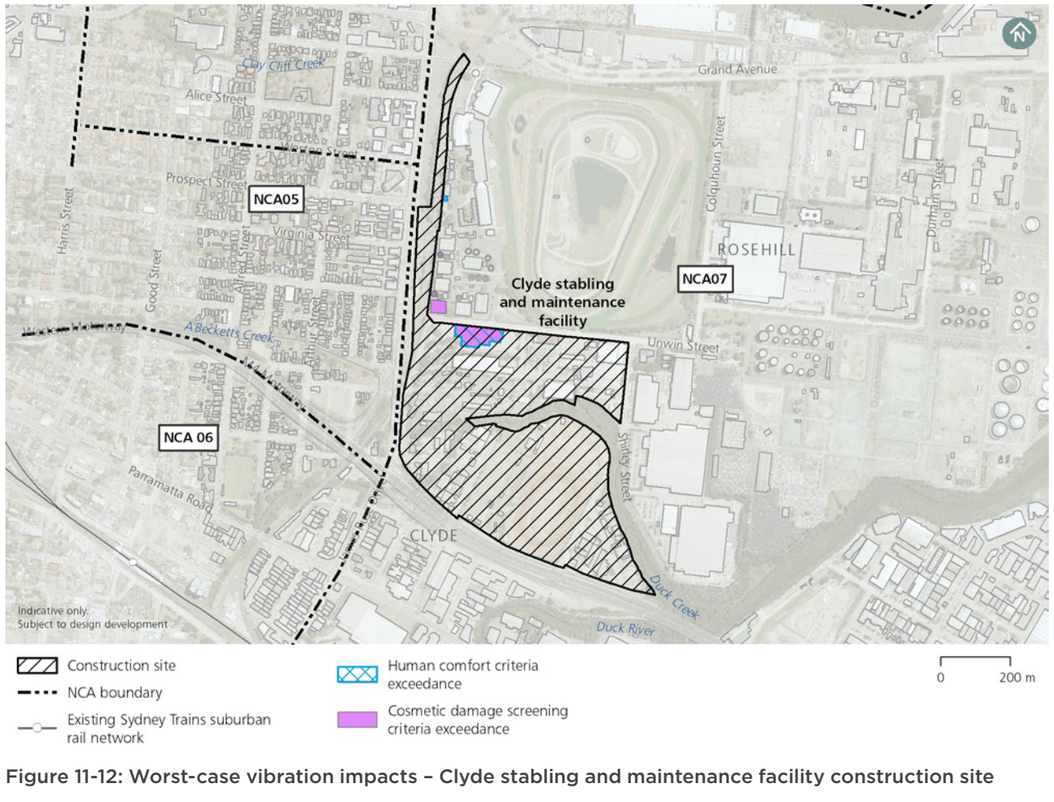


Figure 11-12: Worst-case vibration impacts – Clyde stabling and maintenance facility construction site

Construction traffic noise

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers which are adjacent to construction haulage routes. The forecast construction traffic volumes in the study area have been used to determine where potentially noticeable increases in road traffic noise (i.e. a greater than 2 dB increase above the existing noise level) is likely. Roads anticipated to have a greater than 2 dB increase would include Wentworth street to the south of the construction site, although there are no residential receivers along this road. This increase represents the worst-case predicted increase in any period.

11.8.3 Operational impacts of permanent road network changes

Existing noise levels are not predicted to be altered by the road reconfigurations at Clyde. This is due to the relatively small contribution that the revised location of Unwin Street has to the noise levels at the nearest receivers. Existing and future noise levels at the nearest receivers are expected to be controlled by James Ruse Drive.

11.9 Silverwater services facility construction site

11.9.1 Existing environment

Existing noise levels surrounding the Silverwater services facility construction site are generally controlled by road traffic noise on the surrounding road network and commercial/industrial noise.

The area surrounding the Silverwater services facility construction site contains one Noise Catchment Area (NCA07) which covers the area to the north of the M4 Motorway (refer to Figure 11-13).

NCA07 is east of James Ruse Drive, this catchment is mostly commercial and covers Rosehill Gardens racecourse, the Clyde commercial/industrial area, and Silverwater and Newington. Residential receivers and Newington Public School are in the south-east.

Figure 11-13: Location of sensitive receivers near Silverwater services facility construction site

Unattended noise monitoring was undertaken at one sensitive receiver located in the vicinity of Silverwater services facility construction site between March and July 2019.

The results of the unattended noise surveys are summarised in Table 11-34.

Table 11-34: Summary of unattended noise monitoring – Silverwater services facility construction site

Location ID	Address	Noise level (dBA)[1]					
		Background noise (RBL)			Average noise level (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.07	10 Carnarvon Street, Silverwater	46	44	41	60	57	55

Note 1: The RBL and L_{Aeq} noise levels have been obtained using the calculation procedures documented in the Noise Policy for Industry.

11.9.2 Construction impacts

The construction scenarios at the Silverwater services facility construction site, and the anticipated working hours are shown in Table 11-35. The estimated duration of each activity is also provided, noting that most activities would be intermittent during this period and would not be expected to be undertaken on a continual basis during every day of the activity.

Stage 1 works at the Silverwater services facility construction site are anticipated to have a total duration of about two years and nine months.

These temporary airborne noise impacts would be managed through the implementation of standard and additional mitigation measures in accordance with the Sydney Metro Construction Noise and Vibration Standard.

Table 11-35: Construction activities and period of works at Silverwater services facility construction site

Scenario	Activity	Total indicative duration (weeks)[2]	Maximum number of working faces	Hours of works				Comments
				Std. Day	Out-of-hours works			
					Day OOH[1]	Eve	Night	
Enabling works	Delivery of equipment	4	1	✓	✓	-	-	No site clearing or demolition works would be required. Enabling works would be limited to general site mobilization activities.
	Assembly of site facilities	4	1		✓	-	-	
Piling	Supporting works	4	1	✓	✓	-	-	-
	Bored piling with support plant	4	2	✓	✓	-	-	Would occur intermittently.
Excavation	Mucking out	10	1	✓	✓	-	-	-
	Through soft soil/rock	4	2	✓	✓	-	-	Excavation through soil and soft rock using excavator ripper attachment.
	Through rock using rockbreaker	6	2		✓	-	-	Excavation through rock using rockbreakers. Works restricted to standard construction hours only.

Note 1: Day OOH is Out-of-hours. During the daytime, this refers to the period on Saturday between 7am - 8am, and 1pm - 6pm.

Note 2: Durations should be regarded as indicative and represent the total estimated duration of works at a typical worksite over the entire construction period.

Airborne construction noise

The predicted airborne NML exceedances from works at the Silverwater services facility construction site are summarised in Table 11-36 for all residential receivers. The predicted airborne NML exceedances for commercial and other sensitive receiver types are summarised in Table 11-37. The predictions are representative of the highest noise levels that would be experienced when the works are nearest to sensitive receivers.

The number of receivers predicted to experience exceedances of the NMLs are summarised in bands of 10 dB and are separated into day, evening and night-time periods.

Due to the distance of residential receivers from the site, compliance with the noise management levels is predicted for most construction activities and most periods of the day.

Table 11-36: Overview of NML exceedances (residential receivers) – Silverwater services facility construction site

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Delivery of equipment	4	No impact during any period	-	-	-
	'Peak'	Assembly of site facilities	4	No impact during any period	-	-	-
Piling	'Typical'	Supporting works	4	No impact during any period	-	-	-
	'Peak'	Bored piling with support plan	4	No impact during any period	-	-	-
Excavation	'Typical'	Mucking out	10	No impact during any period	-	-	-
	'Peak'	Through soft soil/ rock	4	No impact during any period	-	-	-
		Through rock using rockbreaker	6	Daytime OOH	14	-	-

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 2: Total number of receivers: 2,761

Note 3: Based on worst-case predicted noise levels.

Table 11-37: Overview of NML exceedances ('other' sensitive receiver types) – Silverwater services facility construction site

Scenario	Activity		Duration (weeks)	Receiver type	Number of receivers		
					With NML exceedance		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Delivery	4	Commercial	1	-	-
	'Peak'	Assembly of site facilities	4	Commercial	2	-	-
Piling	'Typical'	Supporting works	4	Commercial	2	-	-
	'Peak'	Bored piling with support plant	4	Commercial	2	1	-
Excavation	'Typical'	Mucking out	10	Commercial	1	1	-
	'Peak'	Through soft soil/rock	5	Commercial	6	1	-
				Place of worship	1	-	-
		Through rock using rockbreaker	30	Commercial	13	3	-
				Place of worship	1	-	-

The preliminary findings of the construction noise impact assessment at Silverwater services facility construction site indicate:

- Stage 1 is predicted to result in 'moderate' worst-case noise impacts at the nearest receivers during higher noise generating activities. The nearest receivers to the site are commercial and the worst-case impacts are predicted during excavation. These works are would only be completed during the daytime
- The highest impacts are during 'peak' scenarios which use noise intensive equipment such as rockbreakers. When noise intensive equipment is not in use during 'typical' works, the worst-case impacts are predicted to reduce with much fewer exceeding receivers
- Enabling works and piling generate less noise and the worst-case impacts at the nearest receivers are generally predicted to be 'minor'
- The nearest residential receivers are predicted to have 'minor' worst-case impacts during the noisiest scenario.

Highly affected residential receivers

No receivers are predicted to be highly noise affected by the works at Silverwater services facility construction site.

Sleep disturbance

No works are proposed at this construction site during the night-time.

Ground-borne construction noise

Ground-borne noise levels have been assessed at this site and the worst-case impacts are shown in Figure 11-14. Vibration intensive works are predicted to result in 'minor' worst-case ground-borne noise impacts during the daytime at one commercial building located to the east of the site.

The predictions represent the worst-case scenario when shaft excavation works are at surface level and are, therefore, at the closest point to the affected buildings. As the works progress deeper, the impacts are expected to reduce.

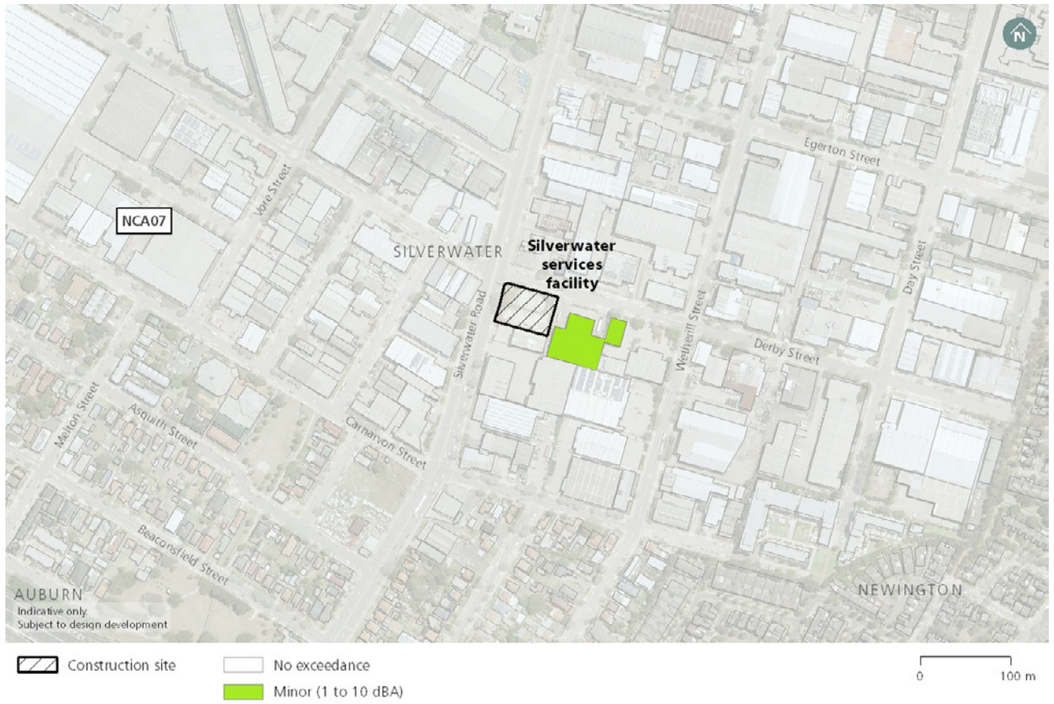


Figure 11-14: Ground-borne noise impacts (daytime construction hours) – Silverwater services facility construction site

Vibration impacts

The predicted impacts during vibration intensive works are shown in Figure 11-15. The predictions are representative of the highest vibration levels that would likely be experienced by the nearest receivers when works are at their closest.

The cosmetic damage screening criteria are predicted to be exceeded at the nearest commercial building located to the south of the site.

The human comfort criteria are also predicted to be exceeded at the two nearest buildings, meaning occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use nearby.

There are no predicted exceedances of the sensitive equipment screening criteria.

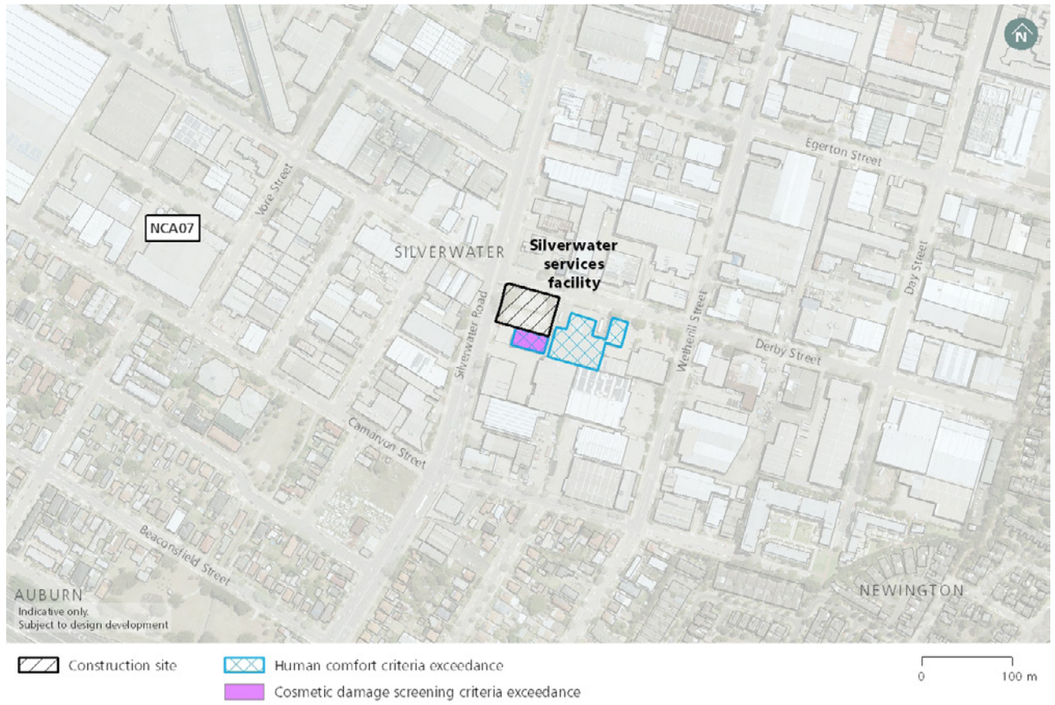


Figure 11-15: Worst case vibration impacts – Silverwater services facility construction site

Construction traffic

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers which are adjacent to construction haulage routes. The forecast construction traffic volumes in the study area have been used to determine where potentially noticeable increases in road traffic noise (i.e. a greater than 2 dB increase above the existing noise level) is likely. Roads anticipated to have a greater than 2 dB increase would include Derby Street to the north-east of the Silverwater services facility construction site, although there are no residential receivers along this road. This increase represents the worst-case predicted increase in any period.

11.10 Sydney Olympic Park metro station construction site

11.10.1 Existing environment

Existing noise levels around the Sydney Olympic Park metro station construction site are dominated by distant road traffic noise from the M4 Motorway and Homebush Bay Drive and general noise from the sport and entertainment complex. The area surrounding the construction site is mainly of commercial use, typically general office or retail. The existing T7 Olympic Park Line circles around the construction site. The tunnels for this line run under Dawn Fraser Avenue and Olympic Boulevard and are aboveground alongside Sarah Durack Avenue and near to residential receivers on Australia Avenue.

Sydney Olympic Park has several open-air sports stadiums and various bars and restaurants. High levels of sporting/spectator noise are a regular feature of the area during sporting events and when crowds disperse afterwards. The stadiums are also used for special events such as music festivals and concerts, which can also result in high levels of noise during the daytime, evening, and parts of the night-time.

Sydney Olympic Park has been divided into two noise catchment areas: NCA08 and NCA09 (refer to Figure 11-16).

NCA08 is located west of Australia Avenue at Sydney Olympic Park and is a mixture of commercial, including two stadiums, and outdoor areas including Sydney Olympic Park Athletic Centre, Sydney Olympic Park Hockey Centre, Sydney Olympic Park Aquatic Centre and the Cathy Freeman Park. The nearest receivers are commercial buildings on Dawn Fraser Avenue, Olympic Boulevard, Herb Elliott Avenue and Figtree Drive. Two hotels and the New South Wales Rugby League Centre of Excellence educational building are also located within the catchment.

NCA09 is located to the east of Australia Avenue and is a mixture of commercial, residential and outdoor active areas including Bicentennial Park, Bressington Park and Mason Park. Residential receivers within the catchment are located on Australia Avenue, Bennelong Parkway and Betty Cuthbert Avenue.

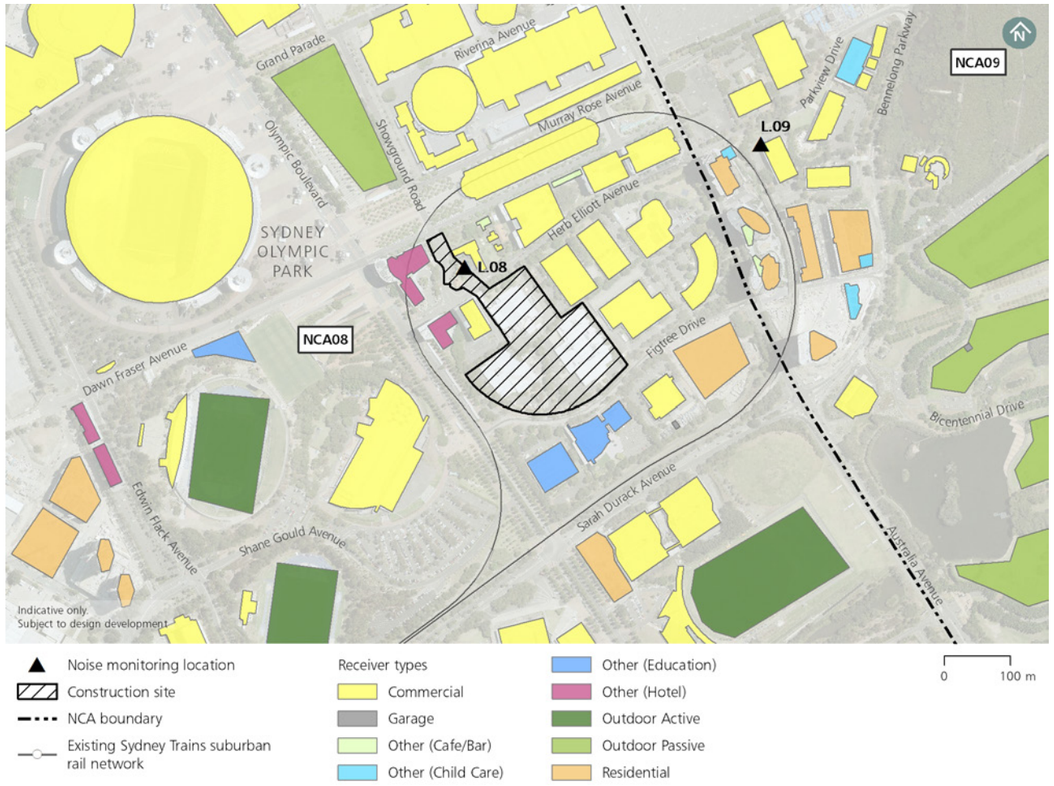


Figure 11-16: Location of sensitive receivers near Sydney Olympic Park metro station construction site

Unattended noise monitoring was undertaken at sensitive receiver locations near Sydney Olympic Park metro station construction site between March and July 2019. The results of the unattended noise surveys are summarised in Table 11-38.

Table 11-38: Summary of unattended noise monitoring – Sydney Olympic Park metro station construction site

Location ID	Address	Noise level (dBA)[1]					
		Background noise (RBL)			Average noise level (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.08	1 Herb Elliot Avenue, Sydney Olympic Park	48	48	46	55	54	52
L.09	6 Parkview Drive, Sydney Olympic Park	48	46	41	57	58	53

Note 1: The RBL and L_{Aeq} noise levels have been obtained using the calculation procedures documented in the Noise Policy for Industry.

11.10.2 Construction impacts

The construction scenarios at the Sydney Olympic Park metro station construction site and the anticipated working hours are shown in Table 11-39. The estimated duration of each activity is also provided, noting that most activities would be intermittent during this period and would not occur on a continual basis.

Stage 1 works within the Sydney Olympic Park metro station construction site are anticipated to have a total duration of about two years and three months.

These temporary airborne noise impacts would be managed through the implementation of standard and additional mitigation measures in accordance with the Sydney Metro Construction Noise and Vibration Standard.

Table 11-39: Construction activities and period of works at Sydney Olympic Park metro station construction site

Scenario	Activity	Total indicative duration (weeks)[3]	Maximum number of working faces	Hours of works[1]				Comments
				Std. Day	Out-of-hours works			
					Day OOH[2]	Eve	Night	
Enabling works	Supporting and loading	13	1	✓	-	-	-	
	Demolition using a rockbreaker	13	2		-	-	-	Would occur intermittently. Estimated total duration of about 10 days.
Piling	Supporting works	28	2	✓	-	-	-	
	Bored piling with support plant	28	4		-	-	-	Would occur intermittently. Estimated total duration of about 6 weeks.
Surface construction	General works	20	1	✓	-	-	-	
	Noise intensive works	20	2		-	-	-	
Initial excavation	Mucking out	4	1	✓	-	-	-	
	Through soft soil/rock	2	2	✓	-	-	-	Excavation through soil and soft rock using excavator ripper attachment, before construction of the acoustic shed (or other acoustic measures).
	Through rock using rockbreaker	2	2	✓	-	-	-	Excavation through rock using rockbreaker, before construction of the acoustic sheds (or other acoustic measures). Works restricted to standard construction hours only.
Excavation within shed	Mucking out	33	1	✓	✓	✓	✓	
	Through rock using rockbreaker	33	2	✓	✓	✓	✓	OOH work would only occur once the acoustic shed (or other acoustic measures) and acoustic panels (where appropriate) have been constructed.
Tunnel boring machine retrieval	Deliveries and on/off loading	7	1	✓	✓	✓	✓	Four tunnel boring machines would be retrieved over a one year period
	Tunnel boring machine disassembly	7	2	✓	✓	✓	✓	

Note 1: Noise intensive works outside of standard construction hours would only be undertaken within the acoustic shed (or other acoustic measures).

Note 2: OOH is Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 3: Durations should be regarded as indicative and represent the total estimated duration of works at a typical worksite over the entire construction period.

Airborne construction noise

The predicted airborne NML exceedances from the Sydney Olympic Park metro station construction site are summarised in Table 11-40 for all residential receiver types and in Table 11-41 for commercial and other sensitive receivers. The predictions are representative of the highest noise levels that would be experienced when the works are nearest to the sensitive receivers.

The number of receivers predicted to experience exceedances of the NMLs are summarised in bands of 10 dB and are separated into day, evening and night-time periods, as appropriate.

Due to the distance of residential receivers form the site, works are generally predicted to either comply with the noise management levels or result in some 'minor' to 'moderate' impacts during all periods. 'High' worst-case impacts are predicted at one education receiver during enabling and excavation works for the short durations when rock breaker are in use.

Table 11-40: Overview of NML exceedances (residential receiver types) – Sydney Olympic Park metro station construction site

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Supporting and loading	13	No impact during any period	-	-	-
	'Peak'	Demolition using a rockbreaker	13	Day	5	3	-
Piling	'Typical'	Supporting works	28	No impact during any period	-	-	-
	'Peak'	Bored piling with support plan	28	Day	1	-	-
Surface construction	'Typical'	General works	20	No impact during any period	-	-	-
	'Peak'	Noise intensive works	20	No impact during any period	-	-	-
Initial excavation	'Typical'	Mucking out	4	No impact during any period	-	-	-
	'Peak'	Through soft soil / rock	2	Day	3	-	-
		Through rock using rockbreaker	2	Day	5	3	-

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Excavation within sheds	'Typical'	Mucking out (doors closed)	33	No impact during any period	-	-	-
	'Peak'	Trough rock using rockbreakers (doors closed)	33	Night	1	-	-
		Through rock using rockbreakers (doors open)	33	Day OOH	2	-	-
				Evening	4	-	-
				Night	6	-	-
				Sleep disturbance	1	-	-
Tunnel boring machine retrieval	'Typical'	Deliveries and on/off loading	7	No impact during any period	-	-	-
	'Peak'	Tunnel boring machine disassembly	7	No impact during any period	-	-	-

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 2: Total number of receivers: 99

Note 3: Based on worst-case predicted noise levels.

Table 11-41: Overview of NML exceedances ('other' sensitive receiver types) – Sydney Olympic Park metro station construction site

Scenario	Activity	Receiver type	Number of receivers		
			With NML exceedance		
			1-10 dB	11-20 dB	>20 dB
Enabling works	Supporting and loading	Educational	2	-	-
	Demolition using a rockbreaker	Commercial	7	4	-
		Café/bar	1	-	-
		Childcare	4	-	-
		Educational	1	1	1
		Passive recreation	1	-	-
		Hotel (daytime)	2	-	-
Piling	Supporting works	Educational	1	1	-
	Bored piling with support plant	Commercial	2	-	-
		Educational	1	1	
Surface construction	General works	Educational	1	-	-
	Noise intensive works	Commercial	1	-	-
		Educational	1	1	-
Initial excavation	Mucking out	Educational	1	1	-
	Through soft soil/rock	Commercial	2	-	-
		Educational	1	1	-
Initial excavation cont.	Through rock using rockbreaker	Commercial	7	2	-
		Café/bar	1	-	-
		Childcare	4	-	-
		Educational	1	1	1
		Passive recreation	1	-	-
		Hotel (daytime)	2	-	-
Excavation within sheds	Mucking out (door closed)	No impact on any receivers			
	Through rock using rockbreaker (doors closed)	No impact on any receivers			
	Through rock using rockbreaker (doors open)	Commercial	5	-	-
		Educational	1	-	-
		Hotel (night-time)	1	-	-
Tunnel boring machine retrieval	Deliveries and on/off loading	No impact on any receivers			
	Tunnel boring machine disassembly	No impact on any receivers			

The preliminary findings of the construction noise impact assessment at Sydney Olympic Park metro station construction site indicate:

- Stage 1 is generally predicted to result in 'moderate' or 'high' worst-case noise impacts at the nearest receivers during the higher noise generating activities. The nearest receivers to the site are generally commercial. The worst-case impacts are predicted during enabling works and initial excavation, which would occur before the acoustic shed (or other acoustic measures) are constructed. These works are, however, limited to standard construction hours and would not occur during the evening or night-time
- The highest impacts are during 'peak' scenarios which use noise intensive equipment such as rockbreakers. Rockbreakers would, however, only be used outdoors intermittently for a duration of around 10 days during enabling works and two weeks during initial excavation works. When noise intensive equipment is not in use during 'typical' works, the worst-case impacts are predicted to generally be reduced to 'minor' or 'moderate' at the nearest receivers
- Piling, surface construction and excavation with sheds works generate less noise and the worst-case impacts at the nearest receivers are predicted to be 'moderate' or 'minor', but affecting much fewer receivers. These works would also be completed prior to the acoustic shed (or other acoustic measures) being built during standard construction hours
- Tunnel boring machine retrieval works are predicted to be compliant with the management levels during all periods
- Noise intensive outside of standard construction hours would only be completed in the acoustic shed (or other acoustic measures) once built. The worst-case impacts from works in the sheds during the night-time are predicted to be 'minor' at one receiver during excavation with shed when rockbreakers are in use and the shed doors are closed. When rockbreakers are in use and the doors are open seven receivers are predicted to have 'minor' impacts.

Highly affected residential receivers

No residential receivers are predicted to be highly noise affected by works at the Sydney Olympic Park metro station construction site.

Sleep disturbance

A sleep disturbance screening assessment has been completed for the construction works and is summarised in Table 11-40. 'Minor' sleep disturbance impacts are predicted at one residential receiver as a result of occasional high noise levels from heavy vehicles accessing the site via Herb Elliott Avenue along with their movements around the outdoor areas of the site. The potential awakenings from heavy vehicles would be influenced by the number of trucks accessing the site during the night-time and the way in which the vehicles are operated. Night-time truck movements at this construction site are expected to be around seven trucks per hour.

Further investigation of awakenings would be completed during the next stages of Stage 1 when detailed construction planning information becomes available.

Ground-borne construction noise

The predicted ground-borne impacts from vibration intensive station shaft excavation works inside the acoustic sheds (or other acoustic measures) are shown in Figure 11-17 for the daytime period. Vibration intensive works are predicted to result in 'minor' worst-case ground-borne noise impacts during the daytime at one educational receiver to the south of the construction site (NSW Institute of Sport).

The predictions are representative of the highest ground-borne noise levels that would likely be experienced by the nearest receivers when excavation works are at their closest.

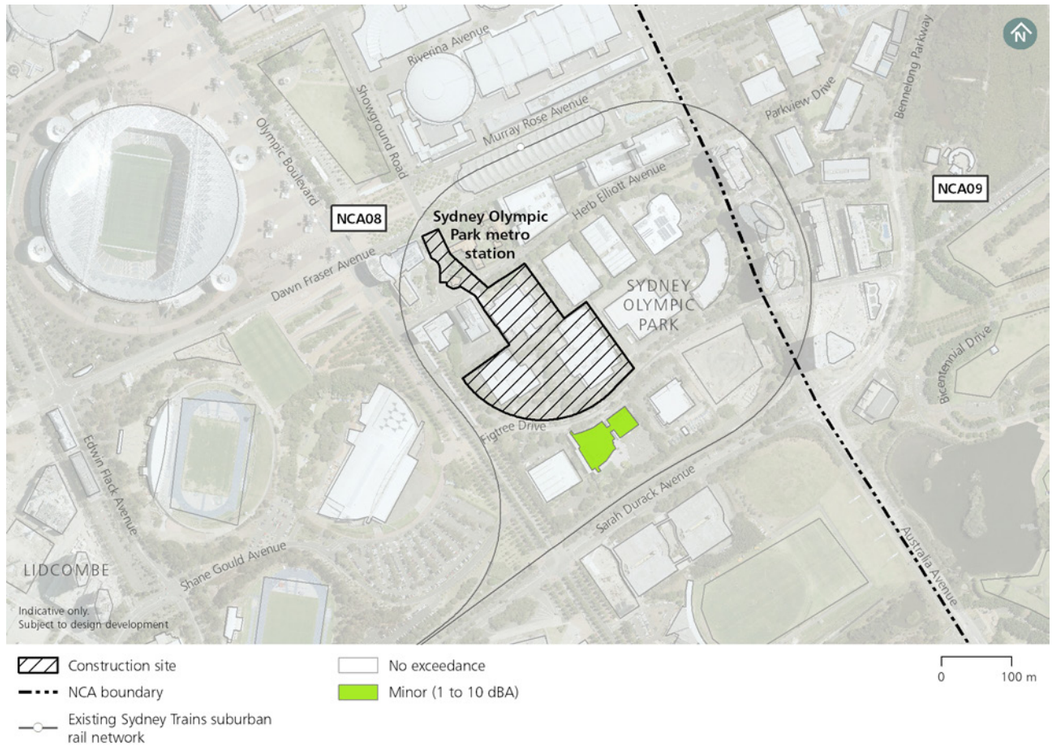


Figure 11-17: Ground-borne noise impacts (daytime construction hours) – Sydney Olympic Park metro station construction site

Vibration impacts

The predicted impacts during vibration intensive works are shown in Figure 11-18. The predictions are representative of the highest vibration levels that would likely be experienced by the nearest receivers when works are at their closest.

There are no predicted exceedances of the sensitive equipment screening criteria. The cosmetic damage screening criteria are predicted to be exceeded at the two nearest heritage listed buildings. This includes one building immediately adjacent the north eastern boundary of the site and one building within the construction site boundary.

The human comfort criteria are predicted to be exceeded at four of the nearest receivers, including two heritage listed buildings as well as a commercial building and hotel to the west, meaning occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use nearby.

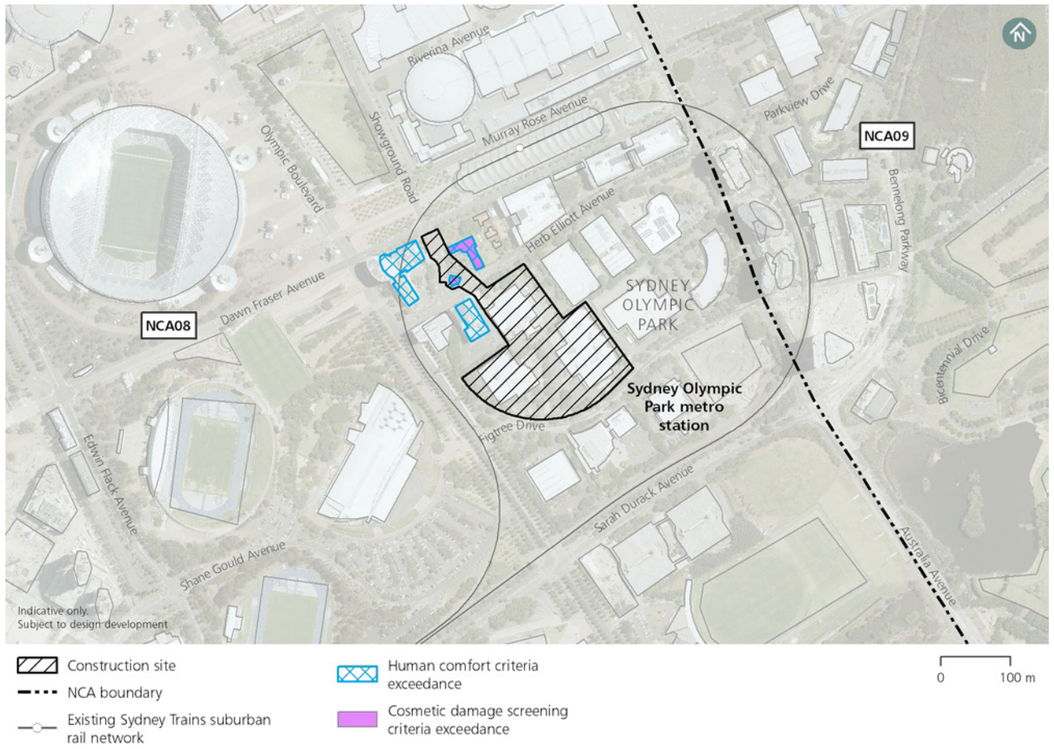


Figure 11-18: Worst-case vibration impacts – Sydney Olympic Park metro station construction site

Construction traffic noise

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers which are adjacent to construction haulage routes. The forecast construction traffic volumes in the study area have been used to determine where potentially noticeable increases in road traffic noise (i.e. a greater than 2 dB increase above the existing noise level) is likely. No roads anticipated to have a greater than 2 dB increase.

11.11 North Strathfield metro station construction site

11.11.1 Existing environment

Existing noise levels around North Strathfield metro station construction site are dominated by noise from existing transport infrastructure (i.e. road and rail). Nearby sensitive land uses include a mixture of residential, commercial and educational facilities.

North Strathfield has been divided into two noise catchment areas; NCA10 and NCA11 (refer to Figure 11-19).

NCA10 is located west of the existing Sydney Trains suburban rail corridor in North Strathfield and is a mix of residential and educational land uses. The mainly residential area has the nearest receivers opposite the rail corridor off George Street. An area of commercial use is located near Underwood Road and Pomeroy Street. The McDonald College is located to the west of the site at a distance of around 50 metres and Our Lady of the Assumption Catholic Primary School is located about 500 metres south west of the construction site on Underwood Road.

NCA11 is located east of the rail corridor in North Strathfield and is mainly residential. The nearest receivers are opposite the rail corridor on Queen Street, around 10 to 20 metres from the site boundary. Two areas of commercial use are located near to Queen Street and Waratah Street and along Concord Road between Correys Avenue and Homedale Avenue. Strathfield North Public School is located in the north of the catchment on Concord Road, about 400 metres away.

Figure 11-19: Location of sensitive receivers near North Strathfield metro station construction site

Unattended noise monitoring was undertaken at sensitive receiver locations near the North Strathfield metro station construction sites between March and July 2019. The results of the unattended noise surveys are summarised in Table 11-42.

Table 11-42: Summary of unattended noise monitoring – North Strathfield metro station construction site

Location ID	Address	Noise level (dBA)[1]					
		Background noise (RBL)			Average noise level (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.18	17 George Street, North Strathfield	47	47	44	60	60	55
L.19	131 Queen Street, North Strathfield	51	47	39	61	60	55

Note 1: The RBL and L_{Aeq} noise levels have been obtained using the calculation procedures documented in the Noise Policy for Industry.

11.11.2 Construction impacts

The construction scenarios at the North Strathfield metro station construction site and the anticipated working hours are shown in Table 11-43. The estimated duration of each activity is also provided, noting that most activities would occur irregularly and would not be expected to be undertaken on a continual basis.

Stage 1 works within the North Strathfield metro station construction site are anticipated to have a total duration of about one year and six months.

These temporary airborne noise impacts would be managed through the implementation of standard and additional mitigation measures in accordance with the Sydney Metro Construction Noise and Vibration Standard.

Table 11-43: Construction activities and period of works at North Strathfield metro station construction site

Scenario	Activity	Total indicative duration (weeks)[2]	Maximum number of working faces	Hours of works				Comments
				Std. Day	Out-of-hours works			
					Day OOH[1]	Eve	Night	
Enabling works	Delivery of equipment	4	1	✓	-	-	-	Enabling works would be limited to general site mobilization activities.
	Assembly of site facilities	4	2	✓	-	-	-	
Piling	Supporting works	20	2	✓	-	-	-	
	Bored piling with support plant	20	4	✓	-	-	-	Would occur intermittently. Estimated total duration of about 20 weeks.
Surface construction	General works	12	1	✓	-	-	-	
	Noise intensive works	12	2	✓	-	-	-	
Excavation	Mucking out	29	1	✓	-	-	-	
	Through soft soil/rock	10	2	✓	-	-	-	Excavation through soil and soft rock using excavator ripper.
	Through rock using rockbreaker	19	2		-	-	-	Excavation through rock using rockbreaker and restricted to standard construction hours only.

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 2: Durations should be regarded as indicative and represent the total estimated duration of works at a typical worksite over the entire construction period.

Airborne construction noise

The predicted airborne NML exceedances from the North Strathfield metro station construction site are summarised in Table 11-44 for residential receiver types. Predicted exceedances for commercial and other sensitive receivers are summarised in Table 11-45. The predictions are representative of the highest noise levels that would be experienced when the works are nearest to the sensitive receivers.

The number of receivers predicted to experience exceedances of the NMLs are summarised in bands of 10 dB and are separated into day, evening and night-time periods, as appropriate.

Works at North Strathfield metro station construction site would typically be restricted to standard daytime construction hours. The majority of works are predicted to result in 'minor' exceedances of the noise management levels with some 'moderate' and 'high' impacts during excavation for the periods when a rock breaker is in use.

Table 11-44: Overview of NML exceedances (residential receiver types) – North Strathfield metro station construction site

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Delivery of equipment	4	Day	4	-	-
	'Peak'	Assembly of site facilities	4	Day	18	-	-
Piling	'Typical'	Supporting works	20	Day	9	-	-
	'Peak'	Bored piling with support plan	20	Day	27	-	-
Surface construction	'Typical'	General works	12	No impact during any period	-	-	-
	'Peak'	Noise intensive works	12	Day	12	-	-
Excavation	'Typical'	Mucking out	10	Day	15	-	-
	'Peak'	Through soft soil/rock	4	Day	43	3	-
		Through rock using rockbreaker	6	Day	380	43	3

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.
Note 2: Total number of receivers: 1388
Note 3: Based on worst-case predicted noise levels.

Table 11-45: Overview of NML exceedances ('other' sensitive receiver types) – North Strathfield metro station construction site

Scenario	Activity	Receiver type	Number of receivers		
			With NML exceedance		
			1-10 dB	11-20 dB	>20 dB
Enabling works	Delivery of equipment	Child care	1	-	-
		Educational	1	-	-
	Assembly of site facilities	Child care	1	-	-
		Educational	6	-	-
Piling	Supporting works	Commercial	3	-	-
		Café/bar	1	-	-
		Educational	6	-	-
	Bored piling with support plant	Commercial	15	-	-
		Café/bar	1	-	-
		Childcare	2	-	-
		Educational	3	3	-
Surface construction	General works	Educational	1	-	-
	Noise intensive works	Commercial	3	-	-
		Café/bar	1	-	-
		Childcare	1	-	-
		Educational	6	-	-
Excavation	Mucking out	Commercial	10	-	-
		Café/bar	1	-	-
		Childcare	1	-	-
		Educational	5	1	-
	Through soft soil/rock	Commercial	15	-	-
		Café/bar	1	-	-
		Childcare	2	-	-
		Educational	2	4	-
	Through rock using rockbreaker	Commercial	4	15	-
		Café/bar	-	1	-
		Childcare	1	2	-
		Educational	3	2	4
		Public building	1	-	-
		Place of worship	3	-	-

The preliminary findings of the construction noise impact assessment at North Strathfield metro station construction site indicate:

- Stage 1 is predicted to result in 'high' worst-case noise impacts at the nearest receivers during higher noise generating activities. The nearest receivers to the site are a mixture of residential, commercial and educational buildings. The worst-case impacts are predicted during excavation works. These works are, however, limited to standard construction hours and would not occur during the evening or night-time
- The highest impacts are during 'peak' scenarios which use noise intensive equipment such as rockbreakers. When noise intensive equipment is not in use during 'typical' works, the worst-case impacts are predicted to reduce to 'minor' or 'moderate' at the nearest receivers
- Enabling works, piling and surface construction works generate less noise and the worst-case impacts at the nearest receivers are predicted to be 'minor' or 'moderate'. These works would also be completed during standard construction hours.

Highly affected residential receivers

The receivers that could potentially be highly noise affected during the worst-case impacts from Stage 1 are shown on Figure 11-20. Two receivers in NCA10 and 13 receivers in NCA11 are predicted to be highly noise affected during rockbreaking activities during the day period.

Figure 11-20: Highly noise affected residential receivers (during any works) – North Strathfield metro station construction site

Sleep disturbance

No works are proposed at this construction site during the night-time.

Ground-borne construction noise

Ground-borne noise levels have been assessed at this site and the worst-case impacts are shown in Figure 11-21. The predictions are representative of the highest ground-borne noise levels that would likely be experienced by the nearest receivers when excavation works are at their closest.

Vibration intensive works are predicted to result in 'minor' worst-case ground-borne noise impacts during the daytime at the nearest receivers on the eastern side of Queen Street, which includes residential and commercial and 'other sensitive' (café) buildings.

The predictions represent the worst-case scenario when shaft excavation works are at surface level and are, therefore, at the closest point to the affected buildings. As the works progress deeper, the impacts are expected to reduce.

Figure 11-21: Ground-borne noise impacts (daytime construction hours) – North Strathfield metro station construction site

Vibration impacts

The predicted impacts during vibration intensive works are shown in Figure 11-22. The predictions are representative of the highest vibration levels that would likely be experienced by the nearest receivers when works are at their closest.

There are no predicted exceedances of the cosmetic damage screening criteria or the sensitive equipment screening criteria.

The human comfort criteria are predicted to be exceeded at the nearest residential, commercial and 'other sensitive' (café) receivers to the east, meaning occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use nearby.

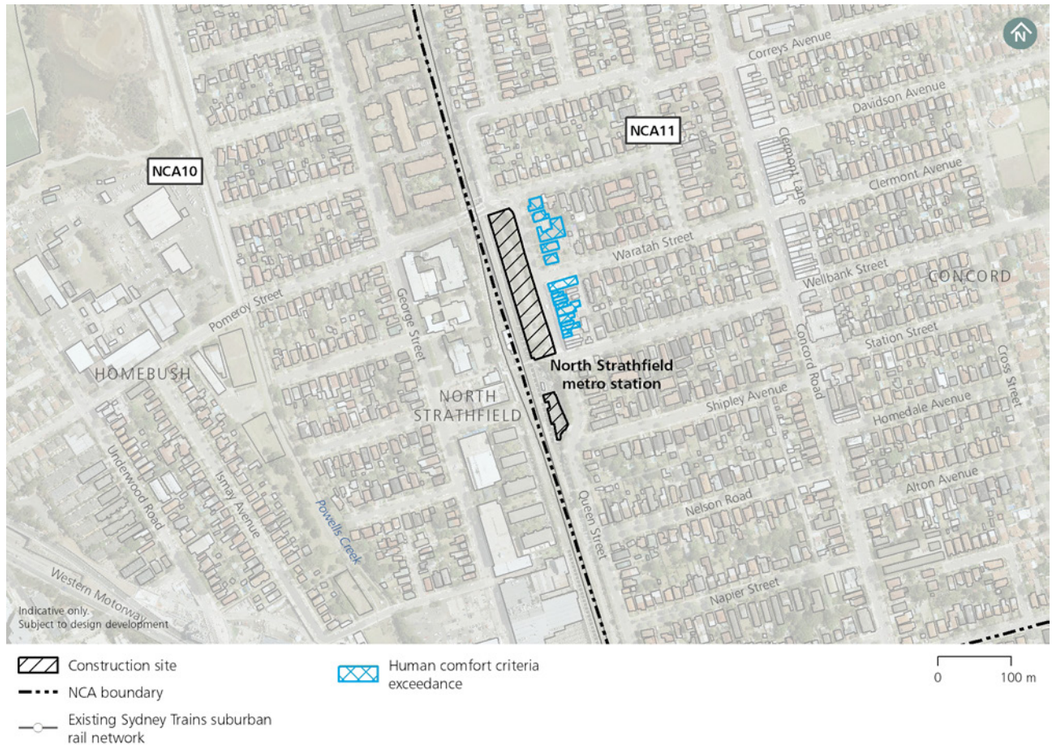


Figure 11-22: Worst case vibration impacts – North Strathfield Station construction site

Construction traffic noise

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers which are adjacent to construction haulage routes. The forecast construction traffic volumes in the study area have been used to determine where potentially noticeable increases in road traffic noise (i.e. a greater than 2 dB increase above the existing noise level) is likely. Roads anticipated to have a greater than 2 dB increase would include Queen Street and Wellbank Street, to the east of the North Strathfield metro station construction site, although these construction traffic movements would generally be restricted to standard daytime construction hours. This represents the worst-case predicted increase in any period.

11.12 Burwood North Station construction site

11.12.1 Existing environment

Existing noise levels around Burwood North Station construction site are dominated by road traffic noise. The area surrounding the construction site is mostly residential with some commercial receivers, typically retail use.

Burwood North has been divided into two noise catchment areas; NCA12 and NCA13 (refer to Figure 11-23).

NCA12 is located to the north of Parramatta Road and is predominately residential with several outdoor active areas including Concord Oval, Cintra Park, St Lukes Park and Goddard Park. The nearest receivers are residential buildings on Burton Street, within around 5-20 metres of the northern construction site. Several commercial receivers and educational facilities are also located within the catchment including St Mary's Catholic Primary School, Concord High School, Concord Public School and Lucas Special School.

NCA13 is located south of Parramatta Road and is a mixture of residential, commercial and educational facilities, including Southern Cross Catholic Vocational College and Methodist Ladies' College School. The nearest residential buildings on Burwood Road and Esher Street, are around five metres from the southern construction site. Several commercial receivers are also located along Parramatta Road. Burwood Park recreation area is located around 350 metres south west of the construction site south of Comer Street.

Figure 11-23: Location of sensitive receivers near Burwood North Station construction site

Unattended noise monitoring was undertaken at sensitive receiver locations in the vicinity of Burwood North Station construction sites between March and July 2019. The results of the unattended noise surveys are summarised in Table 11-46.

Table 11-46: Summary of unattended noise monitoring – Burwood North Station construction site

Location ID	Address	Noise level (dBA)[1]					
		Background noise (RBL)			Average noise level (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.20	17 Burton Street, Concord	43	43 (47)[2]	42	56	55	50
L.21	8 Esher Street, Burwood	48	48	44	57	56	55

Note 1: The RBL and L_{Aeq} noise levels have been obtained using the calculation procedures documented in the Noise Policy for Industry.

Note 2: The monitored evening level was found to be higher than the daytime, the NSW EPA Noise Policy for Industry therefore requires that the evening level be reduced to match the daytime level.

11.12.2 Construction impacts

The construction scenarios at the Burwood North Station construction site and the anticipated working hours are shown in Table 11-47. The estimated duration of each activity is also provided, noting that most activities would be intermittent during this period and would not be expected to be undertaken on a continual basis.

Stage 1 works within the Burwood North Station construction site are anticipated to have a total duration of about two years and three months. The crossover cavern at Burwood North is assessed as part of the tunnelling assessment in Section 11.51.

These temporary airborne noise impacts would be managed through the implementation of standard and additional mitigation measures in accordance with the Sydney Metro Construction Noise and Vibration Standard.

Table 11-47: Construction activities and period of works at Burwood North Station construction site

Scenario	Activity	Total indicative duration (weeks)[3]	Maximum number of working faces	Hours of works[1]				Comments
				Std. Day	Out-of-hours works			
					Day OOH[2]	Eve	Night	
Enabling works	Supporting and loading	16	2	✓	-	-	-	Enabling works would be limited to general site mobilization activities.
	Demolition using a rockbreaker	16	3	✓	-	-	-	
Piling	Supporting works	22	3	✓	-	-	-	Would occur intermittently. Estimated total duration of about 22 weeks.
	Bored piling with support plant	22	6	✓	-	-	-	
Surface construction	General works	10	2	✓	-	-	-	
	Noise intensive works	10	4	✓	-	-	-	
Initial excavation	Mucking out	9	2	✓	-	-	-	
	Through soft soil/rock	4	4	✓	-	-	-	Excavation through soil and soft rock using excavator ripper.
	Through rock using rockbreaker	5	4	✓	-	-	-	Excavation through rock using rockbreaker and restricted to standard construction hours only.
Excavation with shed	Mucking out	32	2	✓	✓	✓	✓	Out of hours works would only occur once the acoustic sheds (or other acoustic measures) have been constructed.
	Through rock using rockbreaker	32	4		✓	✓	✓	
Mined cavern with shed	Spoil removal	34	2	✓	✓	✓	✓	
	Mining with support	34	2	✓	✓	✓	✓	

Note 1: Noise intensive works outside of standard construction hours would only be undertaken within the acoustic shed (or other acoustic measures).

Note 2: OOH is Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 3: Durations should be regarded as indicative and represent the total estimated duration of works at a typical worksite over the entire construction period.

Airborne construction noise

The predicted airborne NML exceedances from works at the Burwood North Station construction site are summarised in Table 11-48 for residential receiver types. Predicted airborne NML exceedances from construction site works for commercial and other sensitive receivers are summarised in Table 11-49. The predictions are representative of the highest noise levels that would be experienced when the works are nearest to the sensitive receivers.

The number of receivers predicted to experience exceedances of the NMLs are summarised in bands of 10 dB and are separated into day, evening and night-time periods, as appropriate.

'High' worst-case impacts are generally associated with early activities such as enabling works, piling and initial excavation. These works are typically of short duration and undertaken during standard daytime construction hours (unless required to be undertaken outside these times such as for traffic management and safety reasons). The majority of works out of standard hours would only be undertaken after the establishment of the acoustic shed (or other acoustic measures).

Table 11-48: Overview of NML exceedances (residential receiver types) – Burwood North Station construction site

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Supporting and loading	16	Day	23	9	1
	'Peak'	Demolition using a rockbreaker	4	Day	433	62	26
Piling	'Typical'	Supporting works	22	Day	24	6	-
	'Peak'	Bored piling with support plan	22	Day	43	14	3
Surface construction	'Typical'	General works	10	Day	13	3	-
	'Peak'	Noise intensive works	10	Day	28	7	2
Initial excavation	'Typical'	Mucking out	9	Day	32	9	2
	'Peak'	Through soft soil/rock	4	Day	62	17	4
		Through rock using rockbreaker	5	Day	454	62	21
Excavation with shed	'Typical'	Mucking out	32	Day	3	-	-
	'Peak'	Through rock using rockbreaker (doors closed)	32	Day	7	1	-
				Day OOH	8	-	-
				Evening	8	-	-
				Night	15	1	-
				Sleep disturbance	1	-	-
		Through rock using rockbreaker (doors open)	32	Day	56	13	2
				Day OOH	72	16	3
				Evening	72	16	3
				Night	145	20	5
				Sleep disturbance	27	5	-
Mined cavern with shed	'Typical'	Spoil removal (doors closed)	34	Day	1	-	-
	'Peak'	Mining with support (doors closed)	34	Day	3	-	-
				Day OOH	1	-	-
				Evening	1	-	-
				Night	2	-	-
				Sleep disturbance	1	-	-
		Mining with support (doors open)	34	Day	14	2	-
				Day OOH	17	2	-
				Evening	17	2	-
				Night	22	5	-
				Sleep disturbance	5	-	-

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 2: Total number of receivers: 1455

Note 3: Based on worst-case predicted noise levels.

Table 11-49: Overview of NML exceedances ('other' sensitive receiver types) – Burwood North Station construction site

Scenario	Activity	Receiver type	Number of receivers		
			With NML exceedance		
			1-10 dB	11-20 dB	>20 dB
Enabling works	Supporting and loading	Place of worship	1	-	-
	Demolition using a rockbreaker	Commercial	15	-	-
		Café/bar	-	1	-
		Childcare	1	-	-
		Educational	12	-	-
		Active recreation	1	-	-
		Place of worship	1	1	-
		Hotel (daytime)	-	1	-
Piling	Supporting works	No impact at any receiver type	-	-	-
	Bored piling with support plant	Place of worship	1	-	-
		Hotel (daytime)	1	-	-
Surface construction	General works	No impact at any receiver type	-	-	-
	Noise intensive works	Place of worship	1	-	-
Initial excavation	Mucking out	Place of worship	1	-	-
	Through soft soil/rock	Place of worship	1	-	-
		Hotel (daytime)	1	-	-
	Through rock using rockbreaker	Commercial	16	-	-
		Café/bar	-	1	-
		Childcare	1	-	-
		Educational	14	-	-
		Active recreation	1	-	-
		Place of worship	1	1	-
		Hotel (daytime)	-	1	-
Excavation within sheds	Mucking out (doors closed)	No impact at any receiver type	-	-	-
	Through rock using rockbreaker (doors closed)	No impact at any receiver type	-	-	-
	Through rock using rockbreaker (doors open)	Commercial	2	-	-
		Café/bar	1	-	-
		Place of worship	1	-	-
		Hotel (daytime)	1	-	-
		Hotel (nighttime)	-	1	-
Mined cavern with shed	Spoil removal (doors closed)	No impact at any receiver type	-	-	-
	Mining with support (doors closed)	No impact at any receiver type	-	-	-
	Mining with support (doors open)	Hotel (night time)	1	-	-

The preliminary findings of the construction noise impact assessment at Burwood North Station construction site indicate:

- Stage 1 is predicted to result in 'high' worst-case noise impacts at the nearest receivers during higher noise generating activities. The nearest receivers to the site are generally residential receivers on Burton Street, which are immediately adjacent to the northern construction site boundary. The worst-case impacts are predicted during enabling works, piling, surface construction and initial excavation which would occur before the acoustic shed (or other acoustic measures) is constructed. These works are, however, limited to standard construction hours and would not occur during the evening or night-time
- The highest impacts are during 'peak' scenarios which generally require noise intensive equipment such as rockbreakers. Rockbreakers would, however, only be used intermittently and the duration is around 10 days for enabling works and five weeks for initial excavation works. When noise intensive equipment is not in use during 'typical' works, the worst-case impacts are predicted to reduce, however, 'high' or 'moderate' worst-case impacts remain at the nearest receivers
- Noise intensive works outside of standard construction hours would only be completed in the acoustic sheds (or other acoustic measures) once built. The worst-case impacts from works in the sheds during the night-time are predicted to be 'moderate' at one receiver during excavation with shed when rockbreakers are in use and the shed doors are closed. When rockbreakers are in use and the doors are open five receivers are predicted to have 'high' impacts with 21 having 'moderate' impacts.

Highly affected residential receivers

The receivers which could potentially be highly noise affected during the worst-case impacts from Stage 1 are summarised in Table 11-50 and shown on Figure 11-24. The table shows the activity and number of residential receivers affected in each NCA.

The assessment shows that the nearest receivers to the site are predicted to be highly noise affected during daytime works involving rockbreakers before the acoustic shed (or other acoustic measures) is constructed. Two receivers are predicted to be highly noise affected when rockbreaking is completed in the shed when the doors are open.

Table 11-50: Highly noise affected residential receivers – Burwood North Station construction site

Scenario	Activity	NCA12			NCA13		
		Day	Eve	Night	Day	Eve	Night
Enabling works	Supporting and loading	1	n/a[1]	n/a	-	n/a	n/a
	Demolition using a rockbreaker	21	n/a	n/a	6	n/a	n/a
Piling	Supporting works	-	n/a	n/a	-	n/a	n/a
	Bored piling with support plant	2	n/a	n/a	1	n/a	n/a
Surface construction	General works	-	n/a	n/a	-	n/a	n/a
	Noise intensive works	2	n/a	n/a	-	n/a	n/a
Initial excavation	Mucking out	1	n/a	n/a	1	n/a	n/a
	Through soft soil/rock	3	n/a	n/a	1	n/a	n/a
	Through rock using rockbreaker	15	n/a	n/a	9	n/a	n/a
Excavation within shed	Mucking out	-	-	-	-	-	-
	Through rock using rockbreaker (doors closed)	-	-	-	-	-	-
	Through rock using rockbreaker (doors open)	-	-	-	-	-	-
Mined cavern with shed	Spoil removal (doors closed)	-	-	-	-	-	-
	Mining with support (doors closed)	-	-	-	-	-	-
	Mining with support (doors open)	-	-	-	-	-	-

Note 1: 'n/a' represents where works would not be performed during the evening or night-time periods

Figure 11-24: Highly noise affected residential receivers – Burwood North Station construction site

Sleep disturbance

A sleep disturbance screening assessment has been completed for the construction works and is also summarised in Table 11-48. 'Moderate' sleep disturbance impacts are predicted for some residential receivers. The number of night-time awakenings during construction works would depend on several factors, including the type of equipment being used, the duration of the noisy works and the distance of the works to residential receivers. Awakening events are generally controlled by limiting the use of noise intensive equipment such as rock breakers to inside the acoustic sheds

Further investigation of awakenings would be completed during the next stages of Stage 1 when detailed construction planning information becomes available.

Ground-borne construction noise

The predicted ground-borne impacts from vibration intensive station shaft excavation works inside the acoustic sheds (or other acoustic measures) are shown in Figure 11-25 and Figure 11-26 for the daytime and night-time periods, respectively. The predictions are representative of the highest ground-borne noise levels that would likely be experienced by adjacent receivers when excavation works are at their closest.

Vibration intensive works are predicted to result in 'high' worst-case ground-borne noise impacts during the daytime at the nearest residential receiver to the north of the northern construction site. 'Moderate' or 'minor' exceedances are also predicted at a number of the other receivers surrounding both sites.

The worst-case impacts during the night-time are predicted to be 'high' at the two nearest residential receivers to the north of the northern construction site. 'Moderate' or 'minor' exceedances are also predicted at the other surrounding receivers at both sites.

The predictions represent the worst-case scenario when shaft excavation works are at surface level and are, therefore, at the closest point to the affected buildings. As the works progress deeper, the impacts are expected to be reduce.

Figure 11-25: Ground-borne noise impacts (daytime construction hours) – Burwood North Station construction site

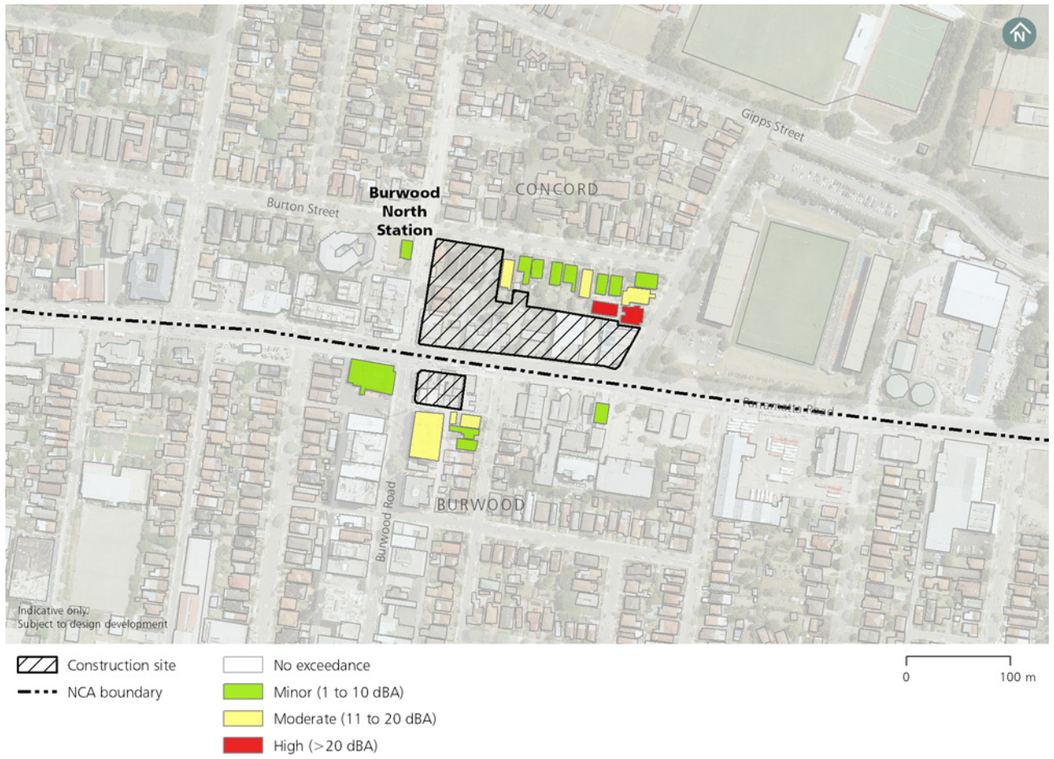


Figure 11-26: Ground-borne noise impacts (night-time construction hours) – Burwood North Station construction site

Vibration impacts

The predicted impacts during vibration intensive works are shown in Figure 11-27. The predictions are representative of the highest vibration levels that would likely be experienced by the nearest receivers when works are at their closest.

The cosmetic damage screening criteria are predicted to be exceeded at the nearest residential buildings to the north of the northern construction site and to the south of the southern construction site.

The human comfort criteria are also predicted to be exceeded at several of the nearest residential and commercial buildings, meaning occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use nearby.

Exceedances of the vibration sensitive equipment screening criteria are predicted to be experienced at Central Sydney ENT in Burwood, which was identified as potentially having vibration sensitive equipment with a VC-A criterion.

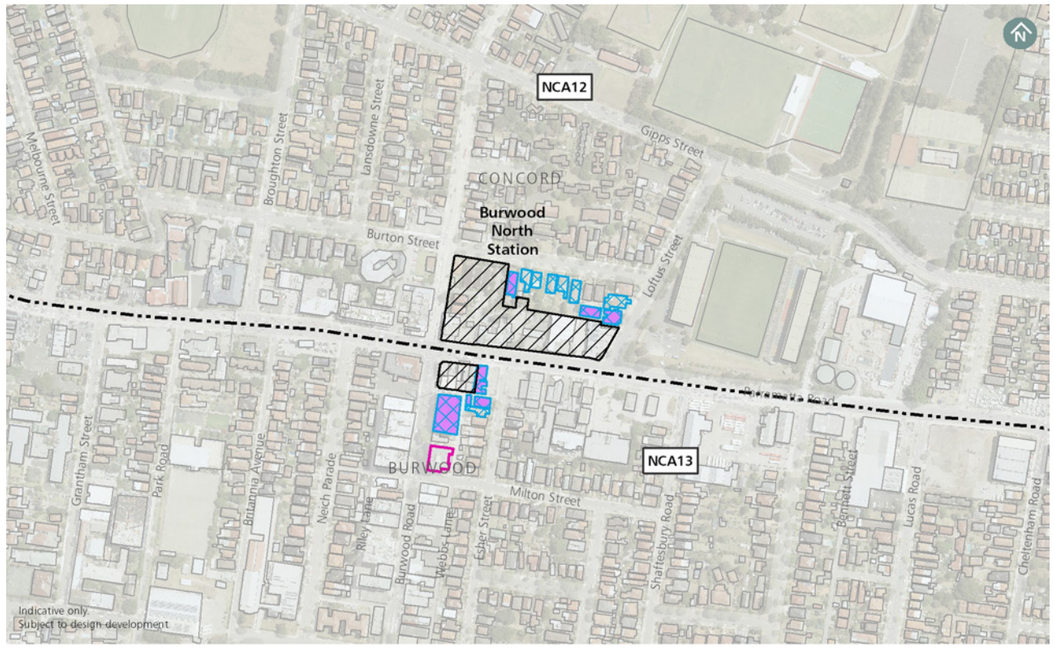


Figure 11-27: Worst-case vibration impacts – Burwood North Station construction site

Figure 11-28: Location of sensitive receivers near Five Dock Station construction site

Construction traffic noise

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers which are adjacent to construction haulage routes. The forecast construction traffic volumes in the study area have been used to determine where potentially noticeable increases in road traffic noise (i.e. a greater than 2 dB increase above the existing noise level) is likely. Roads anticipated to have a greater than 2 dB increase would include Loftus Street and Burton Street to the east of the Burwood North Station construction site. This increase represents the worst-case predicted increase in any period.

11.13 Five Dock Station construction site

11.13.1 Existing environment

Existing noise levels surrounding Five Dock Station construction site are generally controlled by road traffic noise on the surrounding road network. The area surrounding the construction site is a mixture of commercial, 'other sensitive' and residential receivers, with the nearest receivers being close to the boundary of both the sites.

Five Dock has been divided into two noise catchment areas; NCA14 and NCA15 (refer to Figure 11-28).

NCA14 is located to the west of Great Northern Road and contains the western construction site. The nearest receivers to the western construction site are residential buildings and the Caring4Kids Child Care centre on East Street, which are around 20 metres from the site boundary. St Albans Anglican Church is to the immediate north of the western construction site and Five Dock Public School is around 100 metres to the west.

NCA15 is located east of Great Northern Road and contains the eastern construction site. The nearest receivers to the eastern construction site are residential buildings to the immediate east, west and south of the site, near Waterview Street. These receivers are around five to 20 metres from the site boundary. Domremy Catholic College is around 300 metres to the east of the eastern construction site.

Unattended noise monitoring was undertaken at sensitive receiver locations in the vicinity of Five Dock Station construction sites between March and July 2019. The results of the unattended noise surveys are summarised in Table 11-51.

Table 11-51: Summary of unattended noise monitoring – Five Dock Station construction site

Location ID	Address	Noise level (dBA)[1]					
		Background noise (RBL)			Average noise level (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.22	3 Henry Street, Five Dock	42	41	33	58	56	51
L.23	8 Waterview Street, Five Dock	43	43 (44)[2]	38	57	56	50

Note 1: The RBL and L_{Aeq} noise levels have been obtained using the calculation procedures documented in the Noise Policy for Industry.

Note 2: The monitored evening level was found to be higher than the daytime, the NSW EPA Noise Policy for Industry therefore requires that the evening level be reduced to match the daytime level.

11.13.2 Construction impacts

The construction scenarios at the Five Dock Station construction site and the anticipated working hours are shown in Table 11-52. The estimated duration of each activity is also provided, noting that most activities would be intermittent during this period and would not be expected to be undertaken on a continual basis.

Stage 1 works within the Five Dock Station construction site are anticipated to have a total duration of about two years and three months.

These temporary airborne noise impacts would be managed through the implementation of standard and additional mitigation measures in accordance with the Sydney Metro Construction Noise and Vibration Standard.

Table 11-52: Construction activities and period of works at Five Dock Station construction site

Scenario	Activity	Total indicative duration (weeks)[3]	Maximum number of working faces	Hours of works[1]				Comments
				Std. Day	Out-of-hours works			
					Day OOH[2]	Eve	Night	
Enabling works	Supporting and loading	13	2	✓	-	-	-	Intermittent rockbreaking over a total duration of 10 days between 7am – 6pm.
	Demolition using a rockbreaker	13	3	✓	-	-	-	
Piling	Supporting works	26	3	✓	-	-	-	Would occur intermittently.
	Bored piling with support plant	26	6	✓	-	-	-	
Surface construction	General works	5	2	✓	-	-	-	-
	Noise intensive works	5	4	✓	-	-	-	-
Initial excavation	Mucking out	10	2	✓	-	-	-	-
	Through soft soil/ rock	4	4	✓	-	-	-	Excavation through soil and soft rock using excavator ripper.
	Through rock using rockbreaker	6	4	✓	-	-	-	Excavation through rock using rockbreaker and restricted to standard construction hours only.
Excavation with shed	Mucking out	30	2	✓	✓	✓	✓	Out of hours works would only occur once the acoustic shed (or other acoustic measures) has been constructed.
	Through rock using rockbreaker	30	4		✓	✓	✓	
Mined cavern with shed	Spoil removal	30	2	✓	✓	✓	✓	
	Mining with support	30	2	✓	✓	✓	✓	

Note 1: Noise intensive works outside of standard construction hours would only be undertaken within the acoustic shed (or other acoustic measures).

Note 2: OOH is Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 3: Durations should be regarded as indicative and represent the total estimated duration of works at a typical worksite over the entire construction period.

Airborne construction noise

The predicted airborne NML exceedances from works at the Five Dock Station construction site are summarised in Table 11-53 for residential receiver types. Predicted airborne NML exceedances from construction site works for commercial and other sensitive receivers are summarised in Table 11-54. The predictions are representative of the highest noise levels that would be experienced when the works are nearest to the sensitive receivers.

The number of receivers predicted to experience exceedances of the NMLs are summarised in bands of 10 dB and are separated into day, evening and night-time periods, as appropriate.

'High' worst-case impacts are generally associated with early activities such as enabling works, intersection modifications and initial excavation. These works are typically of short duration and undertaken during standard daytime construction hours (unless required to be undertaken outside these times such as for traffic management and safety reasons). The majority of works out of standard hours would only be undertaken after the establishment of the acoustic shed (or other acoustic measures).

Table 11-53: Overview of NML exceedances (residential receiver types) – Five Dock Station construction site

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Supporting and loading	13	Day	30	14	1
	'Peak'	Demolition using a rockbreaker	13	Day	540	107	37
Piling	'Typical'	Supporting works	26	Day	37	11	1
	'Peak'	Bored piling with support plan	26	Day	72	23	1
Surface construction	'Typical'	General works	5	Day	24	1	-
	'Peak'	Noise intensive works	5	Day	41	12	1
Initial excavation	'Typical'	Mucking out	10	Day	60	21	1
	'Peak'	Through soft soil/ rock	4	Day	102	25	5
		Through rock using rockbreaker	6	Day	507	102	30
Excavation with shed	'Typical'	Mucking out	30	Day OOH	2	-	-
				Evening	1	-	-
				Night	13	-	-
				Sleep disturbance	61	20	4
	'Peak'	Through rock using rockbreaker (doors closed)	30	Day	7	-	-
				Day OOH	30	-	-
				Evening	25	-	-
				Night	112	16	-
				Sleep disturbance	61	20	4
		Through rock using rockbreaker (doors open)	30	Day	71	14	2
				Day OOH	173	33	7
				Evening	167	29	6
				Night	375	88	17
				Sleep disturbance	108	22	6
Mined cavern with shed	'Typical'	Spoil removal (doors closed)	30	Day OOH	1	-	-
				Evening	1	-	-
				Night	9	-	-
				Sleep disturbance	61	20	4

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Mined cavern with shed cont.	'Peak'	Mining with support (doors closed)	30	Day	2	-	-
				Day OOH	13	-	-
				Evening	11	-	-
				Night	62	8	-
				Sleep disturbance	61	20	4
		Mining with support (doors open)	30	Day	21	4	-
				Day OOH	51	9	1
				Evening	57	7	1
				Night	164	28	4
				Sleep disturbance	61	20	5

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 2: Total number of receivers: 1814

Note 3: Based on worst-case predicted noise levels.

Table 11-54: Overview of NML exceedances ('other' sensitive receiver types) – Five Dock Station construction site

Scenario	Activity	Receiver type	Number of receivers		
			With NML exceedance		
			1-10 dB	11-20 dB	>20 dB
Enabling works	Supporting and loading	Café/bar	1	-	-
		Child care	1	1	-
		Public building	2	-	-
		Place of worship	1	1	-
		Passive recreation	-	1	-
	Demolition using a rockbreaker	Commercial	14	1	-
		Café/bar	5	5	-
		Childcare	2	2	1
		Educational	10	6	-
		Public building	-	1	1
		Place of worship	2	-	2
		Recording studio	1	-	-
		Passive recreation	-	-	1
Piling	Supporting works	Café/bar	1	-	-
		Child care	-	1	-
		Public building	2	-	-
		Place of worship	1	1	-
		Passive recreation	1	-	-
Piling cont.	Bored piling with support plant	Café/bar	2	-	-
		Child care	1	1	-
		Educational	3	-	-
		Public building	2	-	-
		Place of worship	-	1	1
		Passive recreation	1	-	-
Surface construction	General works	Child care	1	-	-
		Place of worship	1	1	-
	Noise intensive works	Café/bar	1	-	-
		Child care	1	1	-
		Educational	1	-	-
		Public building	2	-	-
		Place of worship	1	-	1
		Passive recreation	1	-	-
Initial excavation	Mucking out	Café/bar	2	-	-
		Child care	1	1	-
		Educational	3	-	-
		Public building	2	-	-
		Place of worship	-	2	-
		Passive recreation	1	-	-
	Through soft soil/rock	Café/bar	3	-	-
		Child care	2	1	-
		Educational	5	-	-
		Public building	2	-	-
		Place of worship	-	1	1
		Passive recreation	1	-	-
	Through rock using rockbreaker	Commercial	13	-	-
		Café/bar	7	3	-
		Childcare	3	2	1
		Educational	10	5	-
		Public building	-	2	-
		Place of worship	2	-	2
		Recording studio	1	-	-
		Passive recreation	-	1	-
Excavation within sheds	Mucking out (doors closed)	No receivers	-	-	-
	Through rock using rockbreaker (doors closed)	Child care	1	-	-
		Place of worship	1	-	-

Scenario	Activity	Receiver type	Number of receivers		
			With NML exceedance		
			1-10 dB	11-20 dB	>20 dB
Excavation within sheds cont.	Through rock using rockbreaker (doors open)	Café/bar	2	-	-
		Child care	2	1	-
		Educational	1	-	-
		Public building	2	-	-
		Place of worship	2	-	-
		Passive recreation	1	-	-
Mined cavern with shed	Spoil removal (doors closed)	No receivers	-	-	-
	Mining with support (doors closed)	Place of worship	1	-	-
	Mining with support (doors open)	Child care	1	-	-
		Public building	1	-	-
		Place worship	2	-	-

The preliminary findings of the construction noise impact assessment at Five Dock Station construction site indicate:

- Stage 1 is predicted to result in 'high' worst-case noise impacts at the nearest receivers during higher noise generating activities. The nearest receivers to the site are generally residential and 'other sensitive' receivers. The worst-case impacts are predicted during enabling works and initial excavation which would occur before the acoustic sheds (or other acoustic measures) are constructed. These works are, however, limited to standard construction hours and would not occur during the evening or night-time
- The highest impacts are during 'peak' scenarios which use noise intensive equipment such as rockbreakers. Rockbreakers would, however, only be used intermittently and the duration is around 10 days for enabling works and around six weeks for initial excavation works. When noise intensive equipment is not in use during 'typical' works, the worst-case impacts are predicted to reduce, however, 'high' or 'moderate' worst-case impacts remain at the nearest receivers
- Noise intensive works outside of standard construction hours would only be completed in the acoustic sheds (or other acoustic measures) once built. The worst-case impacts from works in the sheds during the night-time are generally predicted to be 'moderate' at the nearest receivers during excavation with sheds and mined cavern with sheds when rockbreakers are in use and the shed doors are closed. When rockbreakers and roadheaders are in use and the doors are open several of the nearest receivers are predicted to have 'high' impacts with many surrounding receivers having 'moderate' impacts.

Highly affected residential receivers

The receivers predicted to be highly noise affected during the worst-case impacts are summarised in Table 11-55 and shown in Figure 11-29. The table shows the activity and number of residential receivers affected in each NCA.

The assessment shows that the nearest receivers to the site are predicted to be highly noise affected during the noisiest daytime works before the acoustic shed (or other acoustic measures) is constructed. Works in the shed are predicted to result in highly noise affected impacts at one receiver which is adjacent to the site boundary of the western construction site.

Table 11-55: Highly noise affected residential receivers – Five Dock Station construction site

Scenario	Activity	NCA14			NCA15		
		Day	Eve	Night	Day	Eve	Night
Enabling works	Supporting and loading	-	n/a[1]	n/a	1	n/a	n/a
	Demolition using a rockbreaker	11	n/a	n/a	22	n/a	n/a
Piling	Supporting works	-	n/a	n/a	-	n/a	n/a
	Bored piling with support plant	-	n/a	n/a	1	n/a	n/a
Surface construction	General works	-	n/a	n/a	-	n/a	n/a
	Noise intensive works	-	n/a	n/a	1	n/a	n/a
Initial excavation	Mucking out	-	n/a	n/a	1	n/a	n/a
	Through soft soil/rock	-	n/a	n/a	1	n/a	n/a
	Through rock using rockbreaker	9	n/a	n/a	17	n/a	n/a
Excavation within shed	Mucking out	-	-	-	-	-	-
	Through rock using rockbreaker (doors closed)	-	-	-	-	-	-
	Through rock using rockbreaker (doors open)	-	-	-	1	1	1
Mined cavern with shed	Spoil removal (doors closed)	-	-	-	-	-	-
	Mining with support (doors closed)	-	-	-	-	-	-
	Mining with support (doors open)	-	-	-	-	-	-

Note 1: 'n/a' represents where works would not be performed during the evening or night-time periods

Figure 11-29: Highly noise affected residential receivers – Five Dock Station construction site

Sleep disturbance

A sleep disturbance screening assessment is summarised in Table 11-53. 'High' sleep disturbance impacts are predicted at the adjacent residential receivers during some 'peak' activities, with 'moderate' impacts at receivers which are more distant. These impacts result from heavy vehicles and movements in the outdoor areas of the site. Sleep disturbance impacts are predicted to increase if acoustic shed (or other acoustic measures) doors are opened during excavation works. Night-time truck movements at these construction sites are expected to be around five trucks per hour per site.

Further investigation of awakenings would be completed during the next stages of Stage 1 when detailed construction planning information becomes available.

Ground-borne construction noise

The predicted ground-borne impacts from vibration intensive station shaft excavation works inside the acoustic sheds (or other acoustic measures) are shown in Figure 11-30 and Figure 11-31 for the daytime and night-time periods, respectively. The predictions are representative of the highest ground-borne noise levels that would likely be experienced by adjacent receivers when excavation works are at their closest.

Vibration intensive works are predicted to result in 'high' worst-case ground-borne noise impacts during the daytime at the nearest residential receiver to the west of the eastern construction site. 'Moderate' or 'minor' exceedances are also predicted at several other receivers surrounding both sites.

The worst-case impacts during the night-time are predicted to be 'high' at the same residential receiver to the west of the eastern construction site. 'Moderate' or 'minor' exceedances are also predicted at the receivers surrounding the sites.

The predictions represent the worst-case scenario when shaft excavation works are at surface level and are, therefore, at the closest point to the affected buildings. As the works progress deeper, the impacts are expected to be reduce.

Figure 11-30: Ground-borne noise impacts (daytime construction hours) – Five Dock Station construction site

Figure 11-31: Ground-borne noise impacts (night-time construction hours) – Five Dock Station construction site

Vibration impacts

The predicted impacts during vibration intensive works are shown in Figure 11-32. The predictions are representative of the highest vibration levels that would likely be experienced by the nearest receivers when works are at their closest.

The cosmetic damage screening criteria are predicted to be exceeded at the nearest buildings to both sites. This includes St. Alban's Anglican Church that is located to the north of the western construction site.

The human comfort criteria are also predicted to be exceeded at some of the nearest buildings, meaning occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use nearby.

There are no predicted exceedances of the sensitive equipment screening criteria.

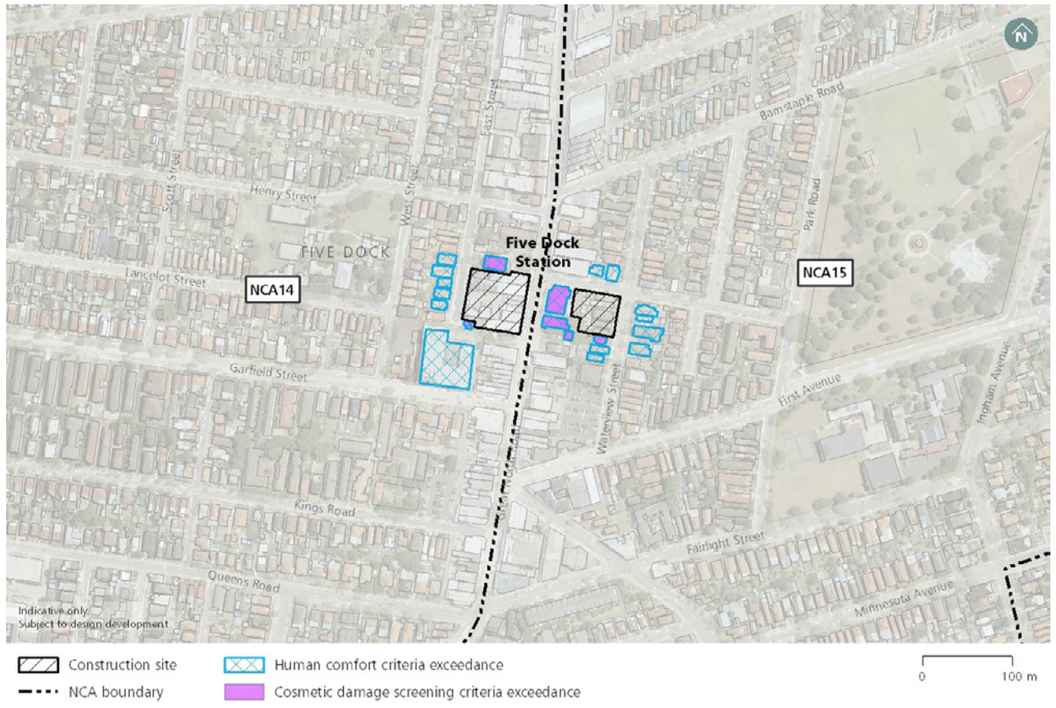


Figure 11-32: Worst-case vibration impacts – Five Dock Station construction site

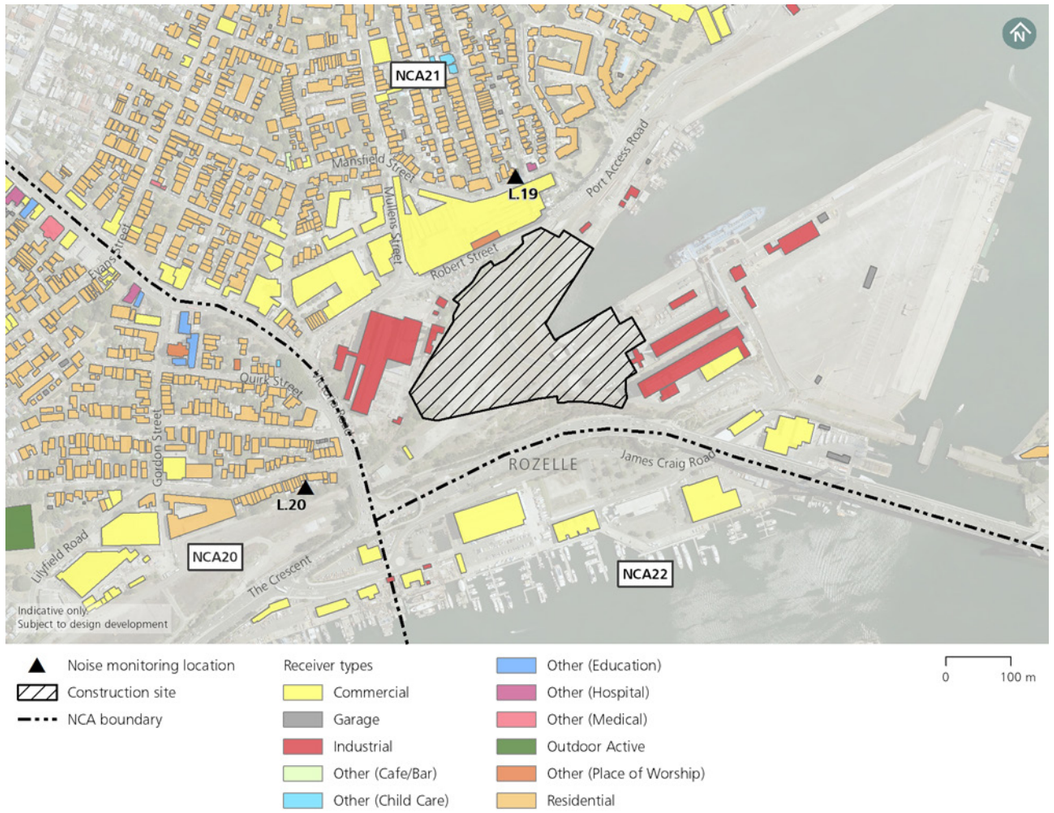


Figure 11-33: Location of sensitive receivers near The Bays Station construction site

Construction traffic noise

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers which are adjacent to construction haulage routes. The forecast construction traffic volumes in the study area have been used to determine where potentially noticeable increases in road traffic noise (i.e. a greater than 2 dB increase above the existing noise level) is likely. Roads anticipated to have a greater than 2 dB increase would include Second Avenue and Waterview Street to the east of the Five Dock Station construction site. This increase represents the worst-case predicted increase in any period.

11.14 The Bays Station construction site

11.14.1 Existing environment

Existing noise levels around The Bays Station construction site are dominated by road traffic noise from Victoria Road and Anzac Bridge, and industrial noise from White Bay and Glebe Island. The area immediately surrounding the construction site consists mainly of commercial/industrial use, with large areas of residential receivers to the east and south of the site.

The Bays has been divided into three noise catchment areas; NCA20, NCA21 and NCA22 (refer to Figure 11-33).

NCA20 is located west of Victoria Road at Rozelle. This catchment is comprised of residential receivers and a mixture of commercial, places of worship (St Joseph's Catholic Church), educational facilities (Sydney Community College) and childcare facilities (Rosebud Cottage Child Care) along Victoria Road.

NCA21 is located north of the Anzac Bridge and east of Victoria Road at Rozelle. This catchment is comprised of commercial/industrial buildings associated with White Bay, Glebe Island and Rozelle Bay. A large commercial area is also located near Robert Street. Large areas of residential receivers are also located to the north west of the catchment. The Bald Rock Hotel is located around 130 metres north of the construction site on Mansfield Street.

NCA22 is located south of the Anzac Bridge and is comprised of residential areas near Glebe Point Road and recreation areas including Jubilee Park and Blackwattle Bay Park.

Unattended noise monitoring was undertaken at sensitive receiver locations in the vicinity of The Bays Station construction site between March and July 2019. The results of the unattended noise surveys are summarised in Table 11-56.

Table 11-56: Summary of unattended noise monitoring – The Bays Station construction site

Location ID	Address	Noise level (dBA)[1]					
		Background noise (RBL)			Average noise level (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.27	21 Mansfield Street, Rozelle	43	43	35	56	54	47
L.28	22 Lilyfield Road, Rozelle	51	51	45	57	57	54
L.29	308 Glebe Point Road, Glebe	48	47	39	59	58	51

Note 1: The RBL and LAeq noise levels have been obtained using the calculation procedures documented in the Noise Policy for Industry.

11.14.2 Construction impacts

The construction scenarios at The Bays Station construction site, and the anticipated working hours are shown in Table 11-57. The estimated duration of each activity is also provided, noting that most activities would be intermittent during this period and would not be expected to be undertaken on a continual basis.

Stage 1 works within The Bays Station construction site are anticipated to have a total duration of about three years.

These temporary airborne noise impacts would be managed through the implementation of standard and additional mitigation measures in accordance with the Sydney Metro Construction Noise and Vibration Standard.

Table 11-57: Construction activities and period of works at The Bays Station construction site

Scenario	Activity	Total indicative duration (weeks)[3]	Maximum number of working faces	Hours of works[1]				Comments
				Std. Day	Out-of-hours works			
					Day OOH[2]	Eve	Night	
Enabling works	Supporting and loading	4	1	✓	✓	-	-	
	Demolition using a rockbreaker	4	2	✓	✓	-	-	Would occur intermittently with an estimated total duration of about 10 days.
Piling	Supporting works	30	2	✓	✓	-	-	
	Bored piling with support plant	30	4	✓	✓	-	-	Would occur intermittently.
Surface construction	General works	12	1	✓	✓	-	-	
	Noise intensive works	12	2	✓	✓	-	-	
Initial excavation	Mucking out	8	1	✓	✓	-	-	
	Through soft soil/rock	1	2	✓	✓	-	-	Excavation through soil and soft rock using excavator ripper attachment, before construction of the acoustic shed (or other acoustic measures).
	Through rock using rockbreaker	7	2	✓	✓	-	-	Excavation through rock using rockbreaker, before construction of the acoustic shed (or other acoustic measures).
Excavation within shed	Mucking out	26	1	✓	✓	✓	✓	
	Through rock using rockbreaker	26	2	✓	✓	✓	✓	OOH work would only occur once the acoustic sheds (or other acoustic measures) have been constructed.
Tunnel boring machine launch and support	Tunnel boring machine support and spoil removal	78	1	✓	✓	✓	✓	The majority of works would be conducted within the acoustic shed (or other acoustic measures) with some loading and other less noisy works being conducted outside the shed.
	Tunnel boring machine assembly and launch	2	1	✓	✓	✓	✓	

Note 1: Noise intensive works outside of standard construction hours would only be undertaken within the acoustic shed (or other acoustic measures).

Note 2: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 3: Durations should be regarded as indicative and represent the total estimated duration of works at a typical worksite over the entire construction period.

Airborne construction noise

The predicted airborne NML exceedances from works at The Bays Station construction site are summarised in Table 11-58 for residential receiver types. Predicted exceedances for commercial and other sensitive receivers are summarised in Table 11-59. The predictions are representative of the highest noise levels that would be experienced when the works are nearest to the sensitive receivers.

The number of receivers predicted to experience exceedances of the NMLs are summarised in bands of 10 dB and are separated into day, evening and night-time periods, as appropriate.

Due to the distance of residential receivers from the site, the majority of works are predicted to result in 'minor' exceedances of the noise management levels, with some 'moderate' exceedances for the periods when rock breakers are in use. These works would generally be undertaken during standard daytime construction hours and extended hours of Saturday afternoons. The majority of works out of standard hours would only be undertaken after the establishment of the acoustic shed (or other acoustic measures) and typically result in 'minor' exceedances of noise management levels.

Table 11-58: Overview of NML exceedances (residential receiver types) – The Bays Station construction site

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Supporting and loading	4	Day	1	-	-
				Day OOH	12	-	-
	'Peak'	Demolition using a rockbreaker	4	Day	536	40	-
				Day OOH	618	182	5
Piling	'Typical'	Supporting works	30	Day OOH	15	-	
	'Peak'	Bored piling with support plan	30	Day	2	-	-
				Day OOH	91	-	-
Surface construction	'Typical'	General works	12	Day OOH	1	-	-
	'Peak'	Noise intensive works	12	Day	5	-	-
				Day OOH	39	-	-
Initial excavation	'Typical'	Mucking out	8	Day OOH	39	-	-
	'Peak'	Through soft soil/ rock	1	Day	26	-	-
				Day OOH	154	-	-
		Through rock using rockbreaker	7	Day	500	26	-
				Day OOH	623	154	-
Excavation with shed	'Typical'	Mucking out	26	Day OOH	1	-	-
				Evening	1	-	-
				Night	118	1	-
				Sleep disturbance	3	-	-
	'Peak'	Through rock using rockbreaker (doors closed)	26	Day	1	-	-
				Day OOH	20	-	-
				Evening	20	-	-
				Night	333	2	-
				Sleep disturbance	3	-	-

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Tunnel boring machine launch and support	'Typical'	Tunnel boring machine support and spoil removal	78	Night	21	-	-
				Sleep disturbance	3	-	-
	'Peak'	Tunnel boring machine assembly and launch	2	Day OOH	3	-	-
				Evening	3	-	-
				Night	182	-	-
				Sleep disturbance	3	-	-

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 2: Total number of receivers: 1126

Note 3: Based on worst-case predicted noise levels.

Table 11-59: Overview of NML exceedances ('other' sensitive receiver types) – The Bays Station construction site

Scenario	Activity	Receiver type	Number of receivers		
			With NML exceedance		
			1-10 dB	11-20 dB	>20 dB
Enabling works	Supporting and loading	Place of worship	1	-	-
	Demolition using a rockbreaker	Commercial	8	2	-
		Child care	4	2	-
		Educational	3	-	-
		Passive recreation	1	-	-
		Place of worship	2	-	1
Piling	Supporting works	No impact on any receiver type	-	-	-
	Bored piling with support plant	Child care	1	-	-
		Place of worship	1	-	-
Surface construction	General works	No impact on any receiver type	-	-	-
	Noise intensive works	Place of worship	1	-	-
Initial excavation	Mucking out	No impact on any receiver type	-	-	-
	Through soft soil/rock	Child care	3	-	-
		Place of worship	1	-	-
	Through rock using rockbreaker	Commercial	2	-	-
		Childcare	3	3	-
		Educational	3	-	-
		Passive recreation	1	-	-
		Place of worship	1	1	-
Excavation within sheds	Mucking out (doors closed)	No impact on any receiver type	-	-	-
	Through rock using rockbreaker (doors closed)	Place of worship	1	-	-
	Through rock using rockbreaker (doors open)	No impact on any receiver type	-	-	-
Tunnel boring machine launch and support	Supporting works	No impact on any receiver type	-	-	-
	Assembly and launch	No impact on any receiver type	-	-	-

The preliminary findings of the construction noise impact assessment at The Bays Station construction site indicate:

- Stage 1 is predicted to result in 'moderate' or 'high' worst-case noise impacts at the nearest receivers during higher noise generating activities. The nearest receivers to the site are a mixture of commercial/industrial and residential. The worst-case impacts are predicted during enabling works and Initial excavation which would occur before the acoustic shed (or other acoustic measures) are constructed. These works are, however, limited to the daytime and would not occur during the evening or night-time
- The highest impacts are predicted during 'peak' scenarios which use noise intensive equipment such as rockbreakers. Rockbreakers would, however, only be used intermittently and the duration is only for around 10 days during enabling works and for up to seven weeks during initial excavation works. When noise intensive equipment is not in use during 'typical' works, the worst-case impacts are predicted to reduce to 'minor' or be compliant with the management levels
- Piling and surface construction works generate less noise and the worst-case impacts at the nearest receivers are predicted to be 'minor'
- Noise intensive works outside of daytime hours would only be completed in the acoustic shed (or other acoustic measures) once built. The worst-case impacts during the night-time are predicted to be 'minor' at most surrounding residential receivers with 'moderate' impacts at two of the nearest receivers.

Highly affected residential receivers

No residential receivers are predicted to be highly noise affected by works at The Bays Station construction site.

Sleep disturbance

A sleep disturbance screening assessment has been completed for the construction works and is summarised in Table 11-58. Minor sleep disturbance impacts are predicted three residential receivers to the north during noisy works as part of Excavation with shed and TBM launch and support. The potential awakenings from heavy vehicles would be in line with the number of trucks accessing the site during the night-time. Night-time truck movements at this construction site are expected to be around 25 trucks per hour with vehicles accessing the site via the southern entrance off James Craig Road. The spoil loading facilities would be on the north-eastern side of the acoustic sheds which is approximately 260 metres from the nearest residential receivers on Mansfield Street.

Further investigation of awakenings would be completed during the next stages of the project when detailed construction planning information becomes available.

Ground-borne construction noise

The offset distances from the shaft excavation areas to the nearest receivers are large enough for there to be no predicted exceedances of the ground-borne noise criteria.

Vibration impacts

The predicted impacts during vibration intensive works are shown in Figure 11-34. The predictions are representative of the highest vibration levels that would likely be experienced by the nearest receivers when excavation works are at their closest.

The cosmetic damage screening criteria are predicted to be exceeded at the following buildings:

- One heritage listed underground canal structure (White Bay Power Station inlet canal)
- One heritage listed building at the former White Bay Power Station
- One commercial building at Gypsum Resources Australia located east of the construction site.

The human comfort criteria are also predicted to be exceeded at some of the nearest commercial buildings, meaning occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use nearby. This includes two buildings on the former White Bay Power Station site which are expected to be disused but are included in this assessment for completeness.

There are no predicted exceedances of the sensitive equipment screening criteria.

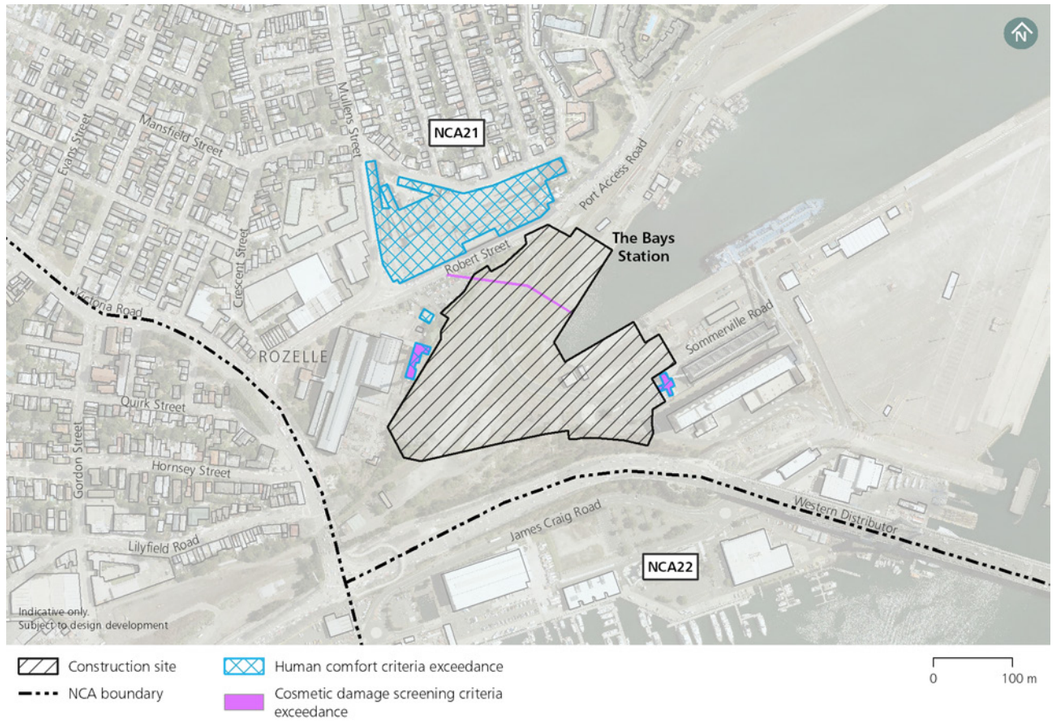


Figure 11-34: Worst-case vibration impacts – The Bays Station construction site

Construction traffic noise

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers adjacent to construction haulage routes. The forecast construction traffic volumes in the study area have been used to determine where potentially noticeable increases in road traffic noise (i.e. a greater than 2 dB increase above the existing noise level) is likely. Roads anticipated to have a greater than 2 dB increase include James Craig Road, Port Access Road, Sommerville Road and Solomon's Way, generally to the south of The Bays Station construction site. No residential receivers are located along these roads. This increase represents the worst-case predicted increase in any period.

11.15 Cumulative impacts

Potential cumulative impacts were considered for assessment based on the likely interactions of Stage 1 with other projects and plans that met the adopted screening criteria. The approach to assessment and the other projects considered are described further in Appendix G (Cumulative impacts assessment methodology – Stage 1).

Potential cumulative construction noise impacts have been considered with reference to both concurrent impacts (the combined effects of multiple projects occurring at the same time) and consecutive impacts (where projects occur consecutively and there is the potential for prolonged construction noise impacts affecting the same receivers).

The main concurrent construction noise impacts identified for Stage 1 are:

- Potential temporary impacts on receivers in NCA01 and NCA02 at Westmead and in NC03 at Parramatta due to the concurrent noise from Parramatta Light Rail Stage 1
- Potential temporary impacts on receivers (mainly commercial) at Sydney Olympic Park due to the construction of various projects consistent with the Sydney Olympic Park Masterplan 2030
- Potential temporary impacts on receivers near The Bays Station construction site due to concurrent construction activities associated with the following projects:
    - WestConnex M4–M5 Link
    - Sydney Metro City & Southwest (Chatswood to Sydenham) truck marshalling facility
    - Bays Precinct Urban Transformation Plan
    - Glebe Island Multi-User Facility
    - Glebe Island Concrete Batching Plant
    - Western Harbour Tunnel and Warringah Freeway Upgrade.

While WestConnex M4–M5 Link has been identified as involving higher impact works near The Bays Station construction site, the potential concurrent impacts from Stage 1 and WestConnex M4-M5 Link for receivers west of Victoria Road between the two sites is considered minimal. If works were occurring on both projects at the same time near this area, construction noise impacts at nearby receivers would generally be limited by the much closer WestConnex M4-M5 Link works.

Other areas to south of Victoria Road in Rozelle Bay could be affected by temporary concurrent impacts, however, these areas are commercial/industrial with relatively low sensitivity to noise impacts.

In relation to other concurrent projects identified near The Bays Station the likelihood of worst-case noise levels being generated by two different works at the same time is low, however if this did occur there could be a temporary increase in worst-case noise levels by around 3 dB. Construction noise levels in any one location would vary and would be frequently much lower than worst-case due to construction phasing moving works around and, in many cases, only a few items of equipment being used at any one time.

In addition to concurrent impacts, if more than one project occurs in the same area consecutively, there may be a prolonged effect from the extended duration of construction noise impacts. This effect is typically referred to as 'construction fatigue'. Table 11-60 identifies the potential for consecutive construction noise impacts at each Stage 1 site.

Table 11-60: Areas with potential consecutive construction noise impacts

Stage 1 construction site	Potential cumulative impacts
Westmead metro station	• Parramatta Light Rail Stage 1 is to north of the construction site. Construction works are currently being undertaken • Western Sydney University Westmead Campus Upgrade is to the north-west of the site. Construction works are currently occurring • Westmead Medical Precinct Redevelopment is located to the north of the site, although this is over 300 metres away • A mixed use development is proposed at 24-26 Railway Parade, Westmead, which is next to the future Parramatta Light Rail Westmead stop.
Parramatta metro station	• One local development project is proposed adjacent to the Parramatta metro station construction site at 69 George Street • The New Powerhouse Museum is located to the north of the site, however, this is over 170 metres away with many intervening buildings.
Clyde stabling and maintenance facility	• Parramatta Light Rail Stage 1 light rail alignment and stabling yard is to north of the construction site • Camellia Town Centre is to the north of the site • Clyde Terminal Conversion is to the east of the site • WestConnex M4 Widening was constructed to the south of the site between 2015 and mid-2017.
Sydney Olympic Park metro station	• Sydney Olympic Park Masterplan 2030 sets out the strategy for future development in the area • WestConnex M4 Widening was constructed to the south of the site between 2015 and mid-2017 • WestConnex M4 Widening, Hill Road Modification is proposed to the south of the site • WestConnex M4 East was constructed to the south-east of the site between 2016 and mid-2019 • Planned Parramatta Light Rail Stage 2 located to the north on Dawn Fraser Avenue.
North Strathfield metro station	• North Strathfield Station Upgrade was completed in late 2019 • WestConnex M4 East was constructed to the south-east of the site between 2016 and mid-2019.
Burwood North Station	• WestConnex M4 East was constructed to the east of the site between 2016 and mid-2019 • Concord Oval Redevelopment is proposed immediately next to the site.
The Bays Station	• WestConnex M4–M5 Link is currently under construction to the south-west of the site and is expected to be complete by 2023 • The Sydney Metro City & Southwest (Chatswood to Sydenham), White Bay truck marshalling yard is currently in use to the north of the site and expected to be in use until 2020 • Glebe Island Multi-User Facility is proposed to the north and east of the site • The Bays Precinct Urban Transformation Plan surrounds the site • Western Harbour Tunnel and Warringah Freeway Upgrade is proposed to the north-east and south-west of the site. Construction scheduling information is not currently available for this project.

11.16 Management and mitigation measures

11.16.1 Approach to management and mitigation

Construction Environmental Management Framework

Noise and vibration would be managed in accordance with Sydney Metro's Construction Environmental Management Framework (described in Chapter 27 (Synthesis of the Environmental Impact Statement)).

The Construction Environmental Management Framework would require the preparation of a Construction Noise and Vibration Management Plan in line with the requirements of the ICNG and the Sydney Metro Construction Noise and Vibration Standard. The Construction Noise and Vibration Management Plan would be prepared before any works begin and would define how the predicted impacts would be mitigated and managed. The Construction Noise and Vibration Management Plan would also consider cumulative construction impacts and the likelihood for 'construction fatigue' from consecutive projects in the areas which have substantial night-time works.

Sydney Metro Construction Noise and Vibration Standard

Stage 1 noise and vibration impacts would be managed in accordance with the Sydney Metro Construction Noise and Vibration Standard (Appendix E), which aims to manage all construction noise and vibration impacts from Stage 1 including tunnelling and utility works where feasible and reasonable using a variety of mitigation measures.

Site-specific Construction Noise and Vibration Impact Statements would be prepared for:

- All works outside standard construction hours likely to exceed the relevant NMLs
- Activities likely to result in highly noise affected receivers
- Activities likely to generate vibration levels at receivers in excess of the relevant criteria.

The Sydney Metro Construction Noise and Vibration Standard also provides:

- A list of standard mitigation measures that would be implemented where feasible and reasonable at all construction sites which includes measures such as prior notification of the works, monitoring of the impacts and offers of alternative accommodation where night-time impacts are expected to be high
- Trigger levels (based on exceedances of airborne and ground-borne NMLs) for the implementation of additional mitigation measures.

These standard and additional mitigation measures would be applied on Sydney Metro West construction sites.

11.16.2 Mitigation measures

Project-specific mitigation measures, in addition to those contained within the Sydney Metro Construction Noise and Vibration Standard, that would be implemented to address potential noise and vibration impacts are described in Table 11-61.

Table 11-61: Specific construction mitigation measures – Noise and vibration Stage 1

Reference	Impact/issue	Mitigation measures	Applicable location(s)[1]
NV01	Community preference for noise mitigation and management	Further engagement and consultation would be carried out with: • The affected communities to understand their preferences for mitigation and management measures. • 'Other sensitive' receivers such as schools, medical facilities or places of worship to understand periods in which they are more sensitive to impacts. Based on this consultation, appropriate mitigation and management options would be considered and implemented where feasible and reasonable to minimise the impacts.	All
NV02	Alternative construction methodologies	Alternative construction methodologies and measures that minimise noise and vibration levels during noise intensive works would be investigated and implemented where feasible and reasonable. This would include consideration of alternative techniques that have been effective on previous similar projects such as: • The use of hydraulic concrete shears in lieu of hammers/rock breakers • Sequencing works to shield noise sensitive receivers by retaining building wall elements • Locating demolition load out areas away from the nearby noise sensitive receivers • Providing respite periods for noise intensive works • Minimising structural-borne noise to adjacent buildings including separating the structural connection prior to demolition through saw-cutting and propping, using hand held splitters and pulverisers or hand demolition • Installing sound barrier screening to scaffolding facing noise sensitive neighbours • Using portable noise barriers around particularly noisy equipment, such as concrete saws • Modifying demolition works sequencing / hours to minimise impacts during peak pedestrian times and / or adjoining neighbour outdoor activity periods.	All
NV03	Construction noise – respite periods	Appropriate respite would be provided to affected receivers in accordance with the Sydney Metro Construction Noise and Vibration Standard. This would include consideration of impacts from Stage 1 utility and power supply works when determining appropriate respite periods for affected receivers. When determining appropriate respite, the need to efficiently undertake construction would be balanced against the communities' preferred noise and vibration management approach.	All
NV04	Construction noise – out of hours work	The use of noise intensive equipment at construction sites with 'moderate' and 'high' out-of-hours noise management level exceedances would be scheduled for standard construction hours, where feasible and reasonable. Where this is not feasible and reasonable, the works would be undertaken as early as possible in each work shift.	All
NV05	Night-time noise impacts	Air brake silencers would be used on heavy vehicles that access construction sites multiple times per night or over multiple nights.	All
NV06	Sleep disturbance impacts from heavy vehicles	Perimeter site hoarding would be designed with consideration of on-site heavy vehicle movements with the aim of minimising sleep disturbance impacts.	All
NV07	Noise emissions from equipment	Long term construction site support equipment and machinery would be low noise emitting and suitable for use in residential areas, where feasible and reasonable. Examples include: • Low noise water pumps for use in water treatment facilities • Low noise generators and compressors • Low noise air conditioner units for use of amenities buildings.	All
NV08	Acoustic sheds	For all sites where acoustic sheds are proposed, the sheds would be designed and constructed to minimise noise emissions. This would likely include the following considerations: • All significant noise producing equipment that would be used during the night-time would be inside the shed, where feasible and reasonable • Noise generating ventilation systems such as compressors, scrubbers, etc, would also be inside the shed and external air intake/discharge ports would be appropriately acoustically treated • The door of the acoustic shed would be kept closed during the night-time period, where feasible and reasonable. Where night-time vehicle access is required, the doors would be designed and constructed to minimise noise breakout.	WMS, SOPMS, BNS, FDS, TBS
NV09	Ground-borne noise	Feasible and reasonable measures would be implemented to minimise ground-borne noise where exceedances are predicted. This may require implementation of less ground-borne noise and less vibration intensive alternative construction methodologies.	All
NV10	Ground-borne noise – cross passages	The proximity of cross passages to nearby receivers and the corresponding construction ground-borne noise and vibration impacts during the excavation works would be considered when determining locations. Relocation of cross passages to be further away from sensitive receivers to mitigate potential construction impacts would be considered, where feasible and reasonable.	Metro rail tunnels
NV11	Ground-borne noise – underground rockbreaking	An activity specific Construction Noise and Vibration Impact Statement (in accordance with the requirements of the Construction Noise and Vibration Standard) would be developed for rockbreaking in the tunnel and at cross passages, specifically addressing the activity where it is required between 10pm-7am.	Metro rail tunnels
NV12	Blasting Management Strategies	Blasting would be planned during hours that would cause the least disruption and disturbance to the nearest receivers. Notification protocols prior to blasting for the nearest sensitive receivers would be established.	WMS, PMS, SSF, SOPMS, NSMS, BMS, FDS, TBS
NV13	Blasting Monitoring	Attended vibration and overpressure measurements would be completed at the start of any blasting activities to confirm that vibration levels are within the blasting criteria.	WMS, PMS, SSF, SOPMS, NSMS, BMS, FDS, TBS

Reference	Impact/issue	Mitigation measures	Applicable location(s)[1]
NV14	Construction traffic noise	Further assessment of construction traffic would be completed during detailed design, including consideration of the potential for exceedances of the NSW Road Noise Policy base criteria (where greater than 2 dB increases are predicted). The potential impacts would be managed using the following approaches, where feasible and reasonable: • On-site spoil storage capacity would be maximised to reduce the need for truck movements during sensitive times • Vehicle movements would be redirected away from sensitive receiver areas and scheduled during less sensitive times • The speed of vehicles would be limited and the use of engine compression brakes would be avoided • Heavy vehicles would not be permitted to idle near sensitive receivers.	All
NV15	Noise impacts to horses at Rosehill Racecourse Stables	Consultation with the owners and operators of the horse stables near the Clyde stabling and maintenance facility construction site would be carried out so that potential impacts to horses are appropriately managed.	CSMF
NV16	Construction vibration	Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure (in consultation with a structural engineer) and attended vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure. For heritage items, the more detailed assessment would specifically consider the heritage values of the structure in consultation with a heritage specialist to ensure sensitive heritage fabric is adequately monitored and managed.	All
NV17	Building condition surveys – construction vibration	Condition surveys of buildings and structures near to the tunnel and excavations would be undertaken prior to the commencement of excavation at each site, where appropriate. For heritage buildings and structures the surveys would consider the heritage values of the structure in consultation with a structural engineer.	All
NV18	Cumulative construction noise impacts	The likelihood of cumulative construction noise impacts would be reviewed during detailed design when detailed construction schedules are available. Co-ordination would occur between potentially interacting projects to minimise concurrent or consecutive works in the same areas, where possible. Specific mitigation strategies would be developed to manage impacts. Depending on the nature of the impact, this could involve adjustments to construction program or activities of Sydney Metro West or of other construction projects.	All
NV19	Operational road traffic noise impacts	Further assessment of operational road traffic noise mitigation would be undertaken for receivers identified as being eligible for consideration of treatment. The mitigation would likely include at-property treatment. Receivers that are identified as requiring at-receiver noise mitigation would be identified and, where possible, offered treatment prior to the start of construction works which have the potential to affect them.	WMS

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (e.g. tunnel boring machine works); PSR: Power supply routes.

11.16.3 Interactions between mitigation measures

Mitigation measures to control construction noise and vibration impacts generally do not overlap with other measures proposed for other environmental issues.

Measures to manage construction traffic would potentially assist in minimising road traffic noise by minimising vehicle numbers where feasible and reasonable and limiting the use of local streets.

There are no mitigation measures identified in the assessment of other environmental aspects that are likely to affect the assessment of noise and vibration impacts.

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12 Non-Aboriginal heritage – Stage 1

12 Non-Aboriginal heritage – Stage 1

This chapter provides an assessment of the potential impacts on non-Aboriginal heritage items and archaeological remains as a result of Stage 1 and identifies mitigation measures to address these impacts. This chapter draws on information in Technical Paper 3 (Non-Aboriginal heritage).

12.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to non-Aboriginal heritage, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 12-1.

Table 12-1: Secretary's Environmental Assessment Requirements – Non-Aboriginal Heritage Stage 1

Reference	Secretary's Environmental Assessment Requirements	Where addressed
7. Non-Aboriginal heritage		
7.1	Potential direct and/or indirect impacts (including cumulative impacts) to the heritage significance of: a. environmental heritage, as defined under the Heritage Act 1977; and	Sections 12.5 to 12.15
	b. items listed on National and World Heritage lists; and	Section 12.5.1
	c. heritage items and conservation areas identified in environmental planning instruments applicable to the project area.	Sections 12.5 to 12.15
7.2	Where impacts to State or locally significant heritage items are identified, the assessment must: a. include a significance assessment, a statement of heritage impact for all heritage items and a historical archaeological assessment;	Sections 12.5 to 12.15
	b. consider any relevant conservation management plan;	Section 12.10 and 12.14
	c. consider impacts to the item of significance caused by, but not limited to, vibration, demolition, archaeological disturbance, altered historical arrangements and access, visual amenity, landscape and vistas, curtilage, subsidence and architectural noise treatment (as relevant) and whether these are temporary or permanent	Sections 12.5 to 12.15
	d. outline measures to avoid and minimise those impacts during construction in accordance with current guidelines; and	Section 12.16
	e. be undertaken by a suitably qualified heritage consultant(s) and/or historical archaeologist (note: where archaeological excavations are proposed the relevant consultant must meet the NSW Heritage	Section 1.4 of Technical Paper 3 (Non-Aboriginal heritage)

12.2 Legislative and policy context

12.2.1 World and Commonwealth

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* provides a legislative framework for the protection and management of matters of national environmental significance. This includes heritage places of national and international importance which are protected through their inclusion on the World Heritage List, Commonwealth Heritage List or the National Heritage List.

12.2.2 New South Wales

The NSW *Heritage Act 1977* (Heritage Act) provides protection for items of 'environmental heritage' in NSW. 'Environmental heritage' includes places, buildings, works, relics, movable objects or precincts considered significant based on historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic values. Items considered to be significant to the state are listed on the State Heritage Register.

Although the requirements for permits under the Heritage Act are not required for an approved State significant infrastructure project, the Heritage Act is relevant in that it guides assessment and defines statutory listed items. Relevant regulations are required to be used under the Secretary's Environmental Assessment Requirements and certain sections of the Heritage Act are potentially relevant to the project, such as Section 146 (notification of a relic), and would still be applicable to approved State significant infrastructure projects.

Statutory registers provide legal protection for heritage items. The State Heritage Register, government agency Heritage and Conservation Registers established under Section 170 of the Heritage Act, and the environmental heritage schedules of Local Environmental Plans (LEPs) are statutory listings.

12.3 Assessment approach

12.3.1 Study area

For the non-Aboriginal heritage assessment of Stage 1, the study area was defined as the proposed construction sites and an additional 50 metre buffer around each construction site. The construction site includes the physical footprint of each site, any excavation or underground work associated with station construction, such as mined caverns and underground pedestrian connections as well as ancillary works, facilities and access ways to each area during construction.

The study area is used to identify heritage items and their potential impacts as a result of Stage 1 and includes heritage items that may be potentially affected by either direct impacts (such as from construction, excavation or vibration) and indirect impacts (such as items within the visual catchment).

Tunnel sections between stations and service facilities would generally be too deep to affect heritage items or archaeological deposits and (with the exception of the tunnel dive and tunnel boring machine launch shaft at the Clyde stabling and maintenance facility) are generally not included in the study area, unless identified as impacted in the noise and vibration assessment – refer to Chapter 11 (Noise and vibration – Stage 1). In those instances, the item has also been included in this heritage assessment. Similarly, in some locations, heritage items which are outside the study area but directly visible from construction sites have been included in the assessment. Potential heritage impacts caused by settlement and power supply routes have also been included within this assessment.

The study area also includes any underground work associated with station construction, such as mined caverns and underground pedestrian connections.

12.3.2 Identification of heritage items

Heritage register searches were carried out across April and May 2019. Heritage items within the study area of each construction site were identified through a search of relevant State and Federal statutory and non-statutory heritage registers. A list of the registers searched is provided in Section 3.2 of Technical Paper 3 (Non-Aboriginal heritage).

Items listed on these registers have been previously assessed against the NSW Heritage Office guideline Assessing Heritage Significance (NSW Heritage Office, 2001). Statements of heritage significance identified in this chapter are consistent with those included in relevant heritage inventory sheets and are based on the guideline.

Where relevant, Conservation Management Plans and other heritage management documents (such as the Parramatta Historical Archaeological Landscape Management Strategy (GML, 2000)) and guidelines have been used to provide additional information regarding heritage significance.

As part of this identification process, a preliminary assessment of potential unlisted heritage items that are located within construction sites and would be directly impacted by Stage 1 was also undertaken.

12.3.3 Significance of heritage items

Determining the significance of heritage items or a potential archaeological resource is undertaken by using a system of assessment centred on the Australia ICOMOS Burra Charter, 2013 (Burra Charter) The principles of the Burra Charter are relevant to the assessment, conservation and management of sites and relics.

If an item meets one of seven heritage criteria, and retains the integrity of its key attributes, it can be considered to have heritage significance. The significance of an item or potential archaeological site can then be assessed as being of local or State significance depending on its importance in a local or NSW State context.

The seven heritage criteria include:

- Criterion (a): Historical significance
- Criterion (b): Associative significance
- Criterion (c): Aesthetic significance
- Criterion (d): Social significance
- Criterion (e): Research potential
- Criterion (f): Rarity
- Criterion (g): Representativeness.

The heritage significance of all identified relics, items, areas and / or landscapes that are considered to be potentially directly or indirectly affected by Stage 1 are identified in Technical Paper 3 (Non-Aboriginal Heritage).

12.3.4 Assessment of heritage impact

Impacts on heritage are identified as:

- Direct impacts, resulting in the demolition or alteration of fabric of heritage significance or significant archaeological remains
- Indirect impacts, resulting in changes to the setting or curtilage of heritage items or places, historic streetscapes and landscapes, visual amenity or views
- Potential direct impact, resulting in impacts from vibration, subsidence, architectural noise treatment and demolition of adjoining structures.

Once the level of all three types of impacts are assessed, adverse and positive impacts to aspects of significance are balanced to determine an overall level of impact to the heritage significance of the listed item as a result of Stage 1. Where major impacts to heritage significance are identified, discussion is provided on whether the item would continue to meet the threshold of significance necessary for heritage listing.

The terminology and definitions used in the assessment are shown in Table 12-2.

Table 12-2: Terminology for assessing the magnitude of heritage impact

Magnitude	Definition
Major	Actions that would have a long term and substantial impact on the significance of a heritage item. Actions that would remove key historic building elements, key historic landscape features, or significant archaeological materials, thereby resulting in a change of historic character, or altering of a historical resource. These actions cannot be fully mitigated.
Moderate	Actions that would involve the modification of a heritage item, including altering the setting of a heritage item or landscape, partially removing archaeological resources, or the alteration of significant elements of fabric from historic structures. The impacts from such actions may be able to be partially mitigated.
Minor	Actions that would result in the slight alteration of heritage buildings, archaeological resources, or the setting of a historical item. The impacts arising from such actions can usually be mitigated.
Negligible	Actions that would result in very minor changes to heritage items.
Neutral	Actions that would have no heritage impact.

Stage 1 works include both permanent and temporary impacts to heritage. Permanent impacts may include the removal of features including structures, whilst temporary impacts may be the installation of acoustic sheds which would eventually be removed. Unless otherwise stated, Stage 1 impacts to heritage are assumed to be permanent.

Consultation was undertaken with the Sydney Metro Heritage Working Group and the Heritage Council of NSW to discuss the approach to the non-Aboriginal heritage assessment.

Assessment of visual impacts

Heritage items that fall within the study area have been assessed for potential visual impacts. In order to assess visual impact on heritage significance, sightlines from the heritage item to Stage 1 works have been established. Both the views towards the heritage item (whether Stage 1 would impair views of the item's significant visual characteristics) and views away from the item (whether Stage 1 would impair views of the heritage-significant surroundings or character of the item) have been assessed.

Assessment of power supply routes

Heritage items located adjacent to power supply routes or may be impacted by the power supply route works have been identified and impacts assessed. Potential preliminary archaeological impacts have also been considered. Heritage and archaeological impacts as a result of the power supply route works are outlined in Section 12.5.3.

Assessment of settlement impacts

Ground excavation for Stage 1 has the potential to cause ground movement caused by the redistribution of the stresses within the ground or groundwater drawdown. Section 12.5.2 outlines the magnitude of settlement and potential heritage impact within the study area. This assessment has excluded heritage items which have been assessed as having a slight settlement risk.

Assessment of vibration impacts

In locations where heritage items are adjacent to demolition, construction or excavation works, an assessment of potential direct impacts through vibration has been undertaken. A conservative vibration damage screening level of 7.5 millimetres per second peak particle velocity has been adopted for heritage items potentially impacted by Stage 1. This screening level has been established with reference to the minor cosmetic damage criteria in British Standard BS 7385:2 – 1993. The vibration levels specified in this standard are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have potential to cause damage to the main structure, except where the item is already structurally unsound. Sydney Metro would complete condition surveys of potentially affected buildings and structures near to the tunnel and excavations prior to the commencement of excavation, where appropriate. Where heritage items are found to be structurally unsound, a more conservative cosmetic damage screening level of 2.5 millimetres per second peak particle velocity would be applied.

During main tunnelling works, it is anticipated that ground-borne vibration associated with tunnel boring machine use would be much lower than the 7.5 millimetres per second peak particle velocity screening level. As such, the study area for assessment of potential impacts to heritage items does not extend to areas above the tunnel alignment that are outside the nominated study area for each construction site.

12.3.5 Limitations

The non-Aboriginal archaeological assessment provides an overview of predicted archaeological remains and their significance, as well as an assessment of potential impacts that would occur from Stage 1. This assessment does not provide detailed archaeological management or archaeological research designs for these impacts.

Only publicly accessible parts of the study area were surveyed. An assessment of settlement, vibration and power supply routes is a desktop assessment only.

12.4 Avoidance and minimisation of impacts

The design development of Stage 1 has included a focus on avoiding or minimising potential non-Aboriginal heritage impacts. This has included:

- Developing a tunnel alignment that avoids potential direct impacts to heritage items, in particular World Heritage listed Old Government House within Parramatta Park
- Selecting construction sites that avoid direct impacts to State and local heritage items where possible, including the State heritage listed Parramatta Station and Roxy Cinema (Parramatta), St Alban's Church (Five Dock), and the White Bay Power Station and Glebe Island Silos (The Bays)
- Where a heritage item is within a construction site, impacts have been avoided or minimised. In Parramatta, this includes the local heritage listed shop on George Street and Kia Ora which would be retained and protected. In Sydney Olympic Park, the heritage structure associated with the State Abattoir located in the construction site would be retained and protected, with direct impacts limited to the gardens only.

12.5 Project-wide impacts

12.5.1 World, National and Commonwealth Heritage

No items listed on the World Heritage List, the National Heritage List or the Commonwealth Heritage List were identified within the study area. Settlement levels have also been assessed, identifying that no World, National or Commonwealth heritage listed structures above the tunnel would be impacted. As such, there would be no direct impacts to World, National or Commonwealth listed heritage items.

12.5.2 Settlement impacts

Ground excavation for Stage 1 has the potential to cause ground movement associated with the redistribution of stresses within the ground or groundwater drawdown. Table 12-3 identifies the potential heritage impact and magnitude of settlement to heritage items within or near the proposed construction sites. Overall, potential damage to heritage items from settlement is unlikely.

Table 12-3: Settlement – Potential impacts on heritage items

Item and listing	Significance	Potential impact
Parramatta metro station construction site		
Roxy Theatre **SHR 00711**	State	Settlement of 25 millimetres resulting in possible superficial damage which is unlikely to have structural significance
North Strathfield metro station construction site		
North Strathfield Railway Station Group **Railcorp s170 4801029**	Local	Settlement of 18 millimetres resulting in possible superficial damage which is unlikely to have structural significance
Five Dock Station construction site		
St Albans Anglican Church Rectory **Canada Bay LEP 1227**	Local	Settlement of 17 millimetres resulting in possible superficial damage which is unlikely to have structural significance
St Alban's Anglican Church **Canada Bay LEP I226**	Local	Settlement of 30 millimetres resulting in possible superficial damage which is unlikely to have structural significance
The Bays Station construction site		
Anzac Bridge **RMS s170 4305018**	Local	Settlement of 10 millimetres resulting in possible superficial damage which is unlikely to have structural significance
Glebe Island Silos **Ports Authority of NSW s170 4560016**	Local	Settlement of 20 millimetres resulting in possible superficial damage which is unlikely to have structural significance

12.5.3 Power supply routes

High voltage power supply would be required for the operation of tunnel boring machines at the Westmead metro station construction site and The Bays Station construction site, and for roadheaders at the station sites and services facility sites.

Most of the power supply routes would be constructed by trenching within the existing road reserve. Trenches are expected to be around one metre wide and 1.5 to two metres deep. It is therefore likely that any subsurface archaeological which remains to this depth below the road treatment and pavement would be impacted. Where previous disturbance has occurred as a result of landform modification, road development and installation of existing services, archaeological potential would be low.

Table 12-4 assesses the potential archaeological and heritage impacts associated with the construction of the power supply routes.

Table 12-4: Power supply routes – Potential impacts on heritage items and archaeological remains

Item and listing	Significance	Potential impact
Westmead power supply route		
Parramatta Park and Old Government House **WHL Place ID 106209, SHR 00596, Parramatta LEP I00596**	World – state	Potential for locally significant and State significant archaeology in undisturbed sections of the road corridor. Impacts to fabric and visual impacts are likely to be temporary and minor. Within the buffer zone for the World Heritage listed Parramatta Park and Old Government House.
Archaeological resources	State – local	Late 18th and early 19th century archaeological resources of local to State significance including convict accommodation and workshops, early agricultural holdings, residential and commercial holdings
Parramatta power supply route		
Parramatta Park and Old Government House **WHL Place ID 106209, SHR 00596, Parramatta LEP I00596**	World – state	Potential for locally significant and State significant archaeology in undisturbed sections of the road corridor. Impacts to fabric and visual impacts are likely to be temporary and minor.
Archaeological resources	State – local	Late 18th and early 19th century archaeological resources of local to State significance including convict accommodation and workshops, early agricultural holdings, residential and commercial holdings
The Bays power supply route		
The Valley Heritage Conservation Area **Leichhardt LEP C7**	Local	Within conservation area. Impacts to fabric and visual impacts are likely to be temporary and minor.
Archaeological resources	Local	Power supply route traverse's outlet canal for White Bay Power Station and may result in adverse direct impacts; remainder of power supply route would not impact any known non-Aboriginal archaeological resources

12.6 Westmead metro station construction site

12.6.1 Historical context and existing heritage items

The area that is now Westmead was originally part of the domain of Government House at Parramatta. This area included the Government Domain, as well as the lands beyond.

These lands were subdivided over the later parts of the 19th Century, first for farmland and then for urban development. The rate of this development was accelerated following the creation of a station on the Main Western Line at Westmead in 1883.

The study area is within the curtilage of the original Government Farm and Government Domain. This area was subdivided and constructed for residential use in 1903, with a number of these structures still present today.

The Westmead metro station construction site study area and existing heritage items are shown in Figure 12-1.

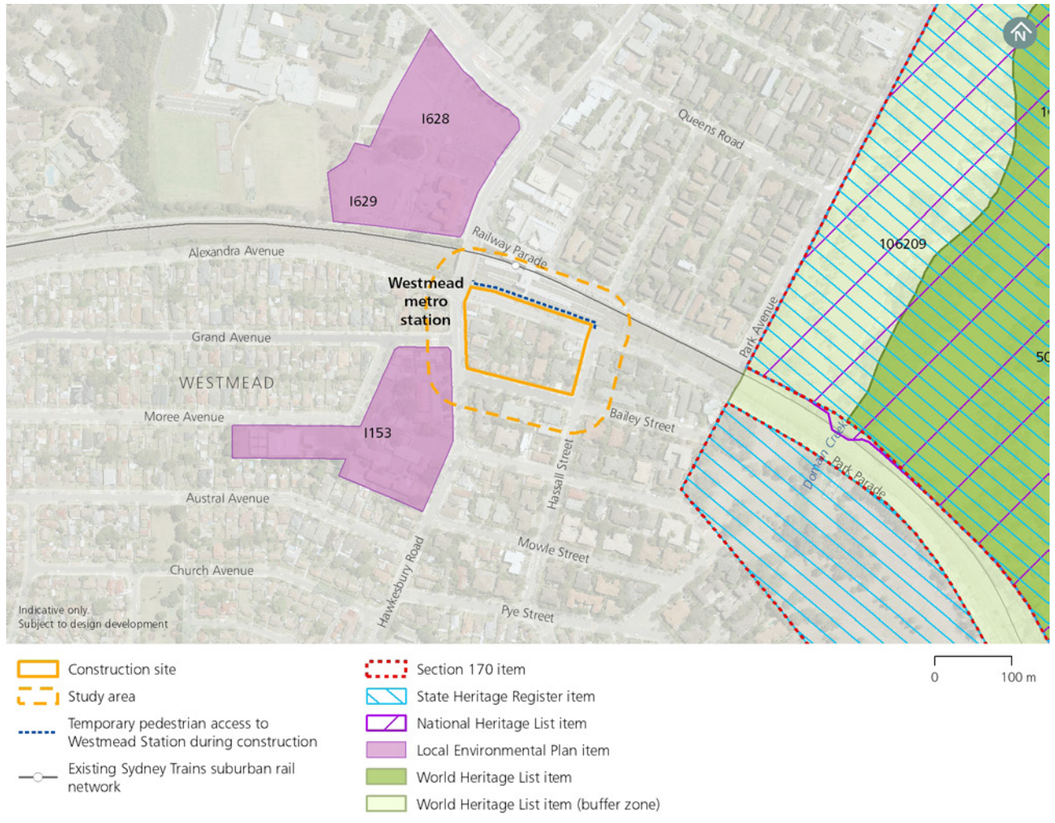

Figure 12-1: Westmead metro station construction site – Heritage items and conservation areas

12.6.2 Assessment of heritage significance and impact

Heritage items and conservation areas

There would be no direct impacts to heritage items or conservation areas. Stage 1 would potentially indirectly impact on the locally heritage listed Westmead Public School. The potential magnitude of impact to this item (using the magnitude scale from Table 12-2) is described in Table 12-5.

Table 12-5: Westmead metro station construction site – Impacts on heritage items and conservation areas

Item and listing	Significance	Potential impact	Magnitude
Westmead Public School, c1917 **Holroyd LEP 2013 (I153)**	Local	**Indirect impact – views and vistas (temporary)** The demolition of existing buildings on the construction site and construction activities, including intersection works and the acoustic shed (or other acoustic measures), would result in changes to the surrounding setting and context of the heritage item. Views and vistas are not considered an integral element of the item's heritage significance.	Minor

Potential unlisted heritage items

This assessment did not identify any potential unlisted heritage items within the Westmead metro station construction site.

Archaeological remains

Significant archaeological remains are not predicted to be located at the Westmead metro station construction site.

Table 12-6 identifies the type of archaeological remains that may be present; the potential for those archaeological remains to occur within the study area, their likely heritage significance and the potential for those remains to be impacted by Stage 1.

Table 12-6: Westmead metro station construction site – Potential archaeological impacts

Phase and potential archaeological feature	Potential for occurrence	Heritage significance	Potential archaeological remains
Phase 1 (1788-1860) **Government Farm and Government Domain**	Nil	N/A	Significant archaeological remains are not predicted to be located at the Westmead metro station construction site. Demolition, clearing and excavation works that would result in widespread ground disturbance would not result in any impacts to significant archaeological remains.
Phase 2 (1860-1943) **Railway line and subdivision**	Low	Local	
Phase 3 (1943-Present) **Late twentieth century development**	Moderate	Unlikely to be of local significance	

12.7 Parramatta metro station construction site

12.7.1 Historic context and existing heritage items

The Parramatta CBD has grown from an early convict settlement based around the presence of arable land for farming. Fertile lands discovered at the head of the Parramatta River were a significant improvement from the sandstone soils of coastal Sydney, which were unsuitable for cultivation.

The development of the Government Farm and Government House at Parramatta prompted the development of the town of Parramatta, which was laid out from 1790. Around this time, George Street was also laid out as the key long street for the settlement, linking Government House to the original landing place on the Parramatta River.

This transformation of Parramatta from a settlement to a township took place through the 19th Century, with Parramatta growing as a centre for professional services, suppliers, education and health. This growth continued through the 20th Century, with the expansion of the surrounding area around Church Street and Macquarie Street.

The study area is located on land which was laid out by Governor Philip for the establishment of early convict timber housing, with small gardens that provided food for residents. Over time these houses were replaced, first by more substantial brick and sandstone residences and workshops, then ultimately by commercial development. In the period since, the site has undergone frequent commercial redevelopment as part of the commercial growth of the Parramatta CBD generally.

The Parramatta metro station construction site study area and existing heritage items are shown in Figure 12-2.

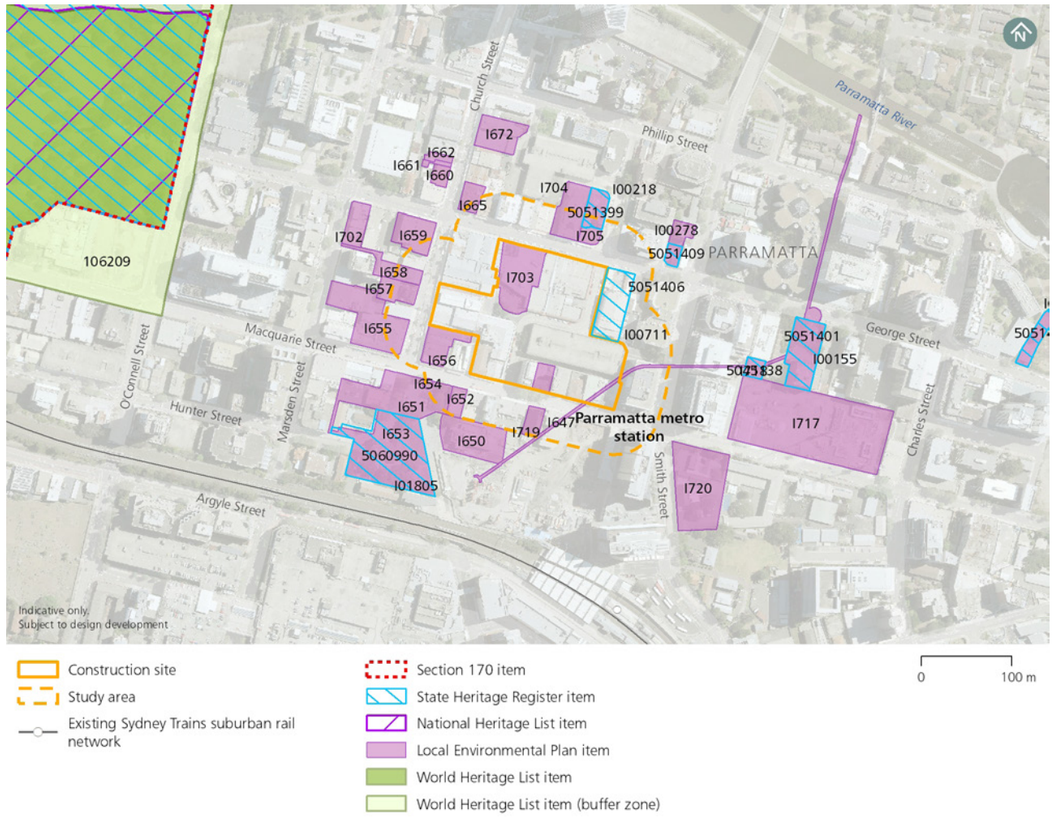

Figure 12-2: Parramatta metro station construction site – Heritage items and conservation areas

12.7.2 Assessment of heritage significance and impact

Heritage items and conservation areas

Stage 1 would potentially impact on the heritage items identified in Table 12-7.

Table 12-7: Parramatta metro station construction site – Impacts on heritage items and conservation areas

Item and listing	Significance	Potential impacts	Magnitude
Shops (and potential archaeological site) (41-59 George Street, Parramatta) **Parramatta LEP 2011 (I703)**	Local	**Direct impact – accidental damage during construction (potential)** The demolition of existing adjoining modern buildings (which are not considered to have heritage significance) within the heritage curtilage of the item and cut and cover excavation would not result in the item's heritage listing eligibility being reduced. It is possible that minor impact to the remaining historic building could occur due to accidental damage during construction, which could potentially result in localised physical impact, although appropriate measures would be put in place to reduce the likelihood of impact.	Minor
		Potential direct impact – vibration Vibration modelling indicates that this item could experience vibration levels above the cosmetic damage screening criteria. Further assessment (including a structural assessment) and vibration impact monitoring (if required) would be completed to ensure safe vibration levels for the structure are met.	Minor
		Indirect impact – views and vistas (temporary) The works would result in changes to the visual amenity and character of the site, as well as views and vistas around the site. The context of the item has been previously altered by modern development restricting views towards this item. Following the demolition of the modern developments, the construction site would potentially temporarily detract from views towards the heritage item from the northern side of George Street and intersection at Church Street.	Minor
Convict Drain **Parramatta LEP 2011 (I647)**	Local	**Direct impact – Partial demolition (potential)** It is possible that minor impact to the heritage item could occur due to accidental damage during construction, which could potentially result in localised physical impact although this would be minor in nature.	Minor
		Potential direct impact – vibration As the exact location, fabric condition and depth of the convict drain heritage item are unknown, vibration may exceed the cosmetic damage screening criteria. Further assessment (including a structural assessment) and vibration impact monitoring (if required) would be completed to ensure safe vibration levels for the structure are met.	Minor
Roxy Theatre **SHR (00711), Parramatta LEP 2011 (I00711)**	State	**Potential direct impact – vibration** Vibration modelling indicates that this item could experience vibration levels above the cosmetic damage screening criteria. Further assessment (including a structural assessment) and vibration impact monitoring (if required) would be completed to ensure safe vibration levels for the structure are met.	Minor
		Indirect impact – views and vistas (temporary) Demolition of nearby buildings and structures associated with Stage 1 would change the wider context of the Roxy Theatre. While the context of the item has been previously altered by modern development, the construction site would potentially temporarily detract from the landmark qualities of the theatre building.	Minor

Item and listing	Significance	Potential impacts	Magnitude
Horse Parapet Façade (and potential archaeological site) **Parramatta LEP 2011 (I656)**	Local	**Direct impact – accidental damage during construction (potential)** It is possible that minor impact to the heritage item could occur due to accidental damage during construction, which could potentially result in localised physical impact although this would be minor in nature and appropriate measures would be put in place to reduce the likelihood of impact.	Minor
		Potential direct impact – vibration The Horse Parapet Façade is not located within the construction site but is adjoined to modern buildings which are subject to demolition works. Vibration modelling indicates that this item could experience vibration levels above the cosmetic damage screening criteria. Further assessment (including a structural assessment) and vibration impact monitoring (if required) would be completed to ensure safe vibration levels for the structure are met.	Minor
		Indirect impact – views and vistas (temporary) Demolition of buildings immediately north and nearby to the east of the item would change the context of the historic building, however, this context has been previously altered by modern development. A construction site directly adjacent to the item would result in a minor temporary visual impact.	Minor
Murrays' Building (and potential archaeological site) **Parramatta LEP 2011 (I652)**	Local	**Indirect impact – views and vistas (temporary)** Demolition of most buildings and structures within the construction footprint and construction activities near the building would temporarily impact the context and setting of the item.	Minor
Kia Ora (and potential archaeological site) **Parramatta LEP 2011 (I716)**	Local	**Direct impacts – Accidental damage during construction (potential)** Risk of minor localised physical impact caused by accidental damage during Stage 1 demolition and construction, although appropriate measures would be put in place to reduce the likelihood of impact.	Minor
		Potential direct impact – vibration Vibration modelling indicates that this item could experience vibration levels above the cosmetic damage screening criteria. Further assessment (including a structural assessment) and vibration impact monitoring (if required) would be completed to ensure safe vibration levels for the structure are met.	Minor
		Indirect impact – views and vistas (temporary) Stage 1 demolition and construction in the vicinity of Kia Ora would change the configuration and presentation of the site, and would potentially detract from the historic quality of the 19th century residence. The construction site would result in an additional visual impact on Kia Ora, although this would be temporary in nature.	Negligible
Dr Pringle's Cottage **Parramatta LEP 2011 (I705)**	Local	**Indirect impact – views and vistas (temporary)** Demolition and construction near the building would impact its context and setting. This context has already been altered by modern development and adjacent buildings are not considered to represent a significant visual element in the surroundings of Dr Pringle's Cottage.	Negligible
Redcoat's Mess House **SHR (00218), Parramatta LEP 2011 (I00218)**	State	The significant fabric of this heritage item is located more than 40 metres from the construction site and therefore there would be no direct impacts, vibration is not anticipated and there are no sightlines between the item and the Parramatta metro station construction site.	Neutral
Civic Arcade (former theatre) (and potential archaeological site) **Parramatta LEP 2011 (I704)**	Local	**Indirect impact – views and vistas (temporary)** Stage 1 would result in demolition and construction directly opposite the item, however the context has been previously altered by modern development and the adjacent buildings are not considered to represent a significant visual element in the surrounding setting of the item.	Negligible
Westpac Bank **Parramatta LEP 2011 (I665)**	Local	**Indirect impact – views and vistas (temporary)** Stage 1 would result in demolition and construction directly opposite the item, however, the context has been previously altered by modern development and the adjacent buildings are not considered to represent a significant visual element in the surrounding setting of the item.	Minor
Former Courthouse Wall and Sandstone Cellblock (and potential archaeological site) **Parramatta LEP 2011 (I659)**	Local	The significant fabric of this heritage item is located more than 100 metres from the construction site and therefore there would be no direct impacts, vibration is not anticipated and there are no sightlines between the item and the Parramatta metro station construction site.	Neutral
HMV (former Commonwealth Bank) (and potential archaeological site) **Parramatta LEP 2011 (I658)**	Local	**Indirect impact – views and vistas (temporary)** Stage 1 would result in demolition and construction directly opposite the item, however the context has been previously altered by modern development and the nearby modern buildings are not considered to represent a significant visual element in the surrounding setting of the item. The construction site would result in an additional temporary minor visual impact on the heritage item.	Negligible
Telstra House (former Post Office) (and potential archaeological site) **Parramatta LEP 2011 (I657)**	Local	**Indirect impact – views and vistas (temporary)** Stage 1 would result in demolition and construction directly opposite the item, however the context has been previously altered by modern development and the nearby buildings are not considered to represent a significant visual element in the surrounding setting of the item. The construction site would result in an additional temporary minor visual impact on the heritage item.	Negligible
Shop (and potential archaeological site) (197 Church Street, Parramatta) **Parramatta LEP 2011 (I655)**	Local	**Indirect impact – views and vistas (temporary)** Stage 1 would result in demolition and construction directly opposite the item, however the context has been previously altered by modern development and the nearby buildings are not considered to represent a significant visual element in the surrounding setting of the item. The construction site would result in an additional temporary minor visual impact on the heritage item.	Negligible

Item and listing	Significance	Potential impacts	Magnitude
Bicentennial Square and adjoining buildings **Parramatta LEP 2011 (I651)**	Local	**Indirect impact – views and vistas (temporary)** Stage 1 would result in demolition and construction in the vicinity of Bicentennial Square, however the nearby modern buildings within the construction site are not considered to represent a significant visual element in the surrounding setting of the item, and none of the important sightlines to surrounding heritage items would be obstructed or permanently altered by the construction site. The construction site would be visually screened by existing development.	Negligible
Centennial Memorial Clock **Parramatta LEP 2011 (I654)**	Local	**Indirect impact – views and vistas (temporary)** Stage 1 would result in demolition and construction directly opposite the item, however the context has been previously altered by modern development and the nearby buildings are not considered to represent a significant visual element in the surrounding setting of the item. The construction site would be visually screened by existing development.	Negligible
Leigh Memorial Uniting Church **Parramatta LEP 2011 (I719)**	Local	**Indirect impact – views and vistas (temporary)** Stage 1 would result in demolition and construction activities near the item, however the context has been previously altered by modern development and the nearby buildings are not considered to represent a significant visual element in the surrounding setting of the item. The construction site would be visually screened somewhat by existing development.	Negligible

Potential unlisted heritage items

Table 12-8 identifies potential unlisted heritage items, their significance and the impacts of Stage 1 on these items.

Table 12-8: Parramatta metro station construction site – Impacts on unlisted items

Item	Potential heritage significance	Potential impact	Magnitude
Late 19th century commercial building **220 Church Street, Parramatta**	Local	Stage 1 would require the demolition of these items resulting in the complete removal of any heritage fabric. The items would not retain their heritage significance and would no longer provide a representative example of its type.	Major
Mid-20th century Inter-War Modern style commercial building **48 Macquarie Street, Parramatta**			

Archaeological remains

Table 12-9 identifies the type of archaeological remains that may be present; the potential for those archaeological remains to occur within the study area, their likely heritage significance and the potential for those remains to be impacted by Stage 1.

Ground disturbance works would be widespread across the Parramatta metro station construction site and in some places deep (i.e. in the location of the station box excavation). The heritage-listed structures at 45 George Street and Kia Ora at 62 – 64 Macquarie Street would be preserved. All other existing buildings and street surfaces would be removed, and the ground surface below stripped prior to the station box excavation commencing. This ground disturbance may result in a major impact to all significant archaeological resources in the construction site.

Archaeological remains located at the Parramatta metro station construction site represent a highly significant and rare deposit of high research value and would be subject to further robust archaeological investigation prior to the commencement of works. In the event that State significant archaeology associated with early convict occupation is located at Parramatta metro station, appropriate mitigation would be developed including potential in situ conservation, publication and/or curation of artefacts.

Table 12-9: Parramatta metro station construction site – Potential archaeological impacts

Phase and potential archaeological feature	Potential for occurrence	Heritage significance	Potential archaeological remains
Phase 1 (1788-1821) **Founding of Parramatta and early convict accommodation**	Low and low to moderate	State	Convict huts, yards and gardens – remains include timber posts and postholes, earthen floor surfaces, informal drains, buried historical soil deposits, isolated artefact deposits (bone, glass, metal, ceramic, stone).
Phase 2 (1821-1850) **Growth of Parramatta township**	Low to moderate	Local to State	Early colonial residences and yards – remains include timber posts and postholes, sandstock brick or stone footings, timber boards and underfloor artefact deposits, fence and informal earthen or stone drains and kerbs, former yard surfaces, deep well and privy refuse deposits, buried historical soils, and isolated artefact deposits (bone, glass, metal, ceramic, stone). Convict drain – remains include sandstock brick lined barrel drain or later machine-pressed brick drain repairs, infilled artefact and soil deposits.
Phase 3 (1850-1900) **Late nineteenth century commercial development**	Moderate	May be of local significance	Commercial buildings, rear yards and outbuildings - brick footings, timber postholes and posts, ceramic drains, fence and informal earthen or stone drains and kerbs, former yard surfaces, industrial debris and slag, deep well and privy refuse deposits, buried historical soils, and isolated artefact deposits (bone, glass, metal, ceramic, stone).

12.8 Clyde stabling and maintenance facility construction site

12.8.1 Historic context and existing heritage items

In 1793, an early 100-acre land grant was used to establish Elizabeth Farm. The estate was further extended through additional land grants and purchasing of neighbouring lots reaching over 1,100 acres by 1816. Between 1883 and 1884, much of Elizabeth Farm was subdivided and sold off to allow for greater residential development.

The planned residential development did not prove to be economically viable and the majority of the land grants were purchased by industrial companies who seized the opportunity the Duck River frontage and rail connections provided. On these properties industrial yards and warehouses were developed during the late nineteenth and early twentieth centuries. Another section of land directly northwest of the study area was developed for a racecourse and for recreational purposes. This became the Rosehill Gardens racecourse, which opened in 1885. Most of the residential development in the area was for the workers of the local industries.

In 1925, an approximate 30-acre area north of Duck Creek was resumed for the establishment of the Agricultural Society's Granville Show and Sports Ground including stalls for horses and cattle, a trotting track and a dog show ring. A clay Sprintcar Speedway track was laid out at the Granville Showgrounds with first practices undertaken in January 1977. From this point, the Granville Showgrounds became known as the 'Parramatta City Raceway'.

The Clyde stabling and maintenance facility construction site is divided by Duck Creek and A'Becketts Creek, which are upper tributaries of Duck River. The northern portion of the site is located within the curtilage of land which formed Elizabeth Farm and was used for agricultural purposes. Aerial imagery from 1943 indicates that parts of the northern portion of Clyde stabling and maintenance facility construction site were used for industrial purposes with the remainder of the land remaining relatively undeveloped and used for agricultural purposes or as part of the T6 Carlingford Rail Line rail corridor. South of Duck Creek the Clyde stabling and maintenance facility construction site mainly comprises the Sydney Speedway (location on NSW Government owned land).

The Clyde stabling and maintenance facility construction site study area and existing heritage items are shown in Figure 12-3.

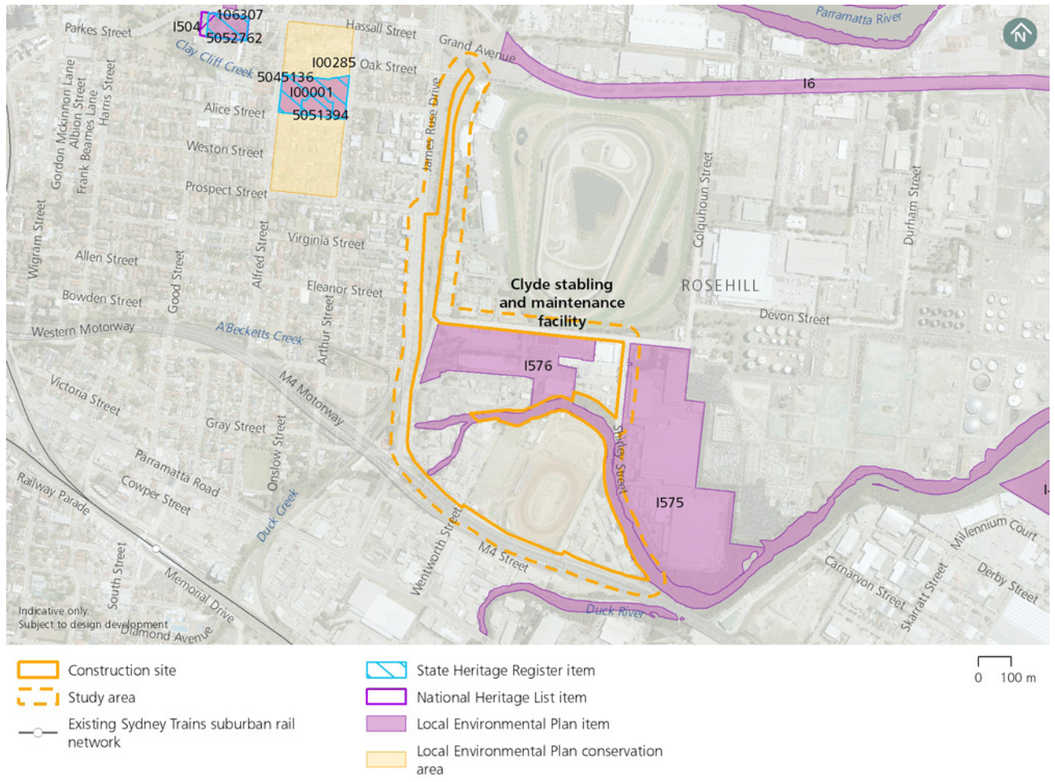

Figure 12-3: Clyde stabling and maintenance facility construction site – Heritage items and conservative areas

12.8.2 Assessment of heritage significance and impact

Heritage items and conservation areas

Stage 1 would potentially impact on the listed heritage items identified in Table 12-10.

Table 12-10: Clyde stabling and maintenance facility construction site – Impacts on heritage items and conservation areas

Item and listing	Significance	Potential impact	Magnitude
Wetlands **Parramatta LEP 2011 (I1)**	Local	**Direct impact** Construction activities would require direct impact on the wetlands, resulting in permanent changes. Civil works to establish the stabling and maintenance facility landform and associated structures over A'Becketts Creek and Duck Creek would involve localised removal of around 0.7 ha of vegetation within the affected portion of the item. The wetlands heritage item covers a large area and the impact to around 0.7 ha would represent a relatively minor direct impact.	Minor
		Indirect impacts – views and vistas The removal of vegetation, civil works and establishment of new structures over A'Becketts Creek and Duck Creek would result in permanent visual changes to the character and aesthetic qualities of the wetland, whilst changing the wider context and setting of the ecological item.	Minor
RTA Depot **Parramatta LEP 2011 (I576)**	Local	**Direct impact – partial demolition/removal** Construction of Stage 1 would result in demolition of modern development/additions within the heritage curtilage of this item, in addition to all other developments/structures within the construction zone, excluding the historic multi-storey brick structure fronting Unwin Street which would be retained. It is possible that minor impact to the remaining historic building could occur due to accidental damage during construction, which could potentially result in localised physical impact although this would be minor in nature and appropriate measures would be put in place to reduce the likelihood of impact.	Minor
		Potential direct impacts – vibration Vibration modelling indicates that this item could experience vibration levels above the cosmetic damage screening criteria. Further assessment (including a structural assessment) and vibration impact monitoring (if required) would be completed to ensure safe vibration levels for the structure are met.	Minor
		Indirect impacts – views and vistas The demolition of existing modern buildings within the heritage item for Stage 1 would result in changes to the existing aesthetic quality and character of the RTA Depot, although the modern buildings are not considered to represent a significant visual component of the historic shop.	Minor

Item and listing	Significance	Potential impact	Magnitude
Capral Aluminium **Parramatta LEP 2011 (I575)**	Local	**Indirect impacts – views and vistas** The item is located directly adjacent to the construction site and would have direct view between the historic office building and the construction site. The introduction of structures over Duck Creek and A'Becketts Creek is not expected to cause an indirect (visual) impact above minor to the heritage item due to the extensive vegetation screening along the alignment of the creeks. Stage 1 would result in changes to the wider context and setting of the heritage item, which has historically comprised an industrial landscape.	Minor

Potential unlisted heritage items

This assessment has not identified any potential unlisted heritage items within Clyde stabling and maintenance facility construction site.

Archaeological remains

Significant archaeological remains have not been predicted to be located within the Clyde stabling and maintenance facility construction site.

Table 12-11 identifies the type of archaeological remains that may be present, the potential for those archaeological remains to occur within the study area, their likely heritage significance and the potential for those remains to be impacted by Stage 1.

Table 12-11: Clyde stabling and maintenance facility construction site – Potential archaeological impacts

Phase and potential archaeological feature	Location	Potential for occurrence	Heritage significance	Potential archaeological remains
Phase 1 (1796 – 1872) **Early agricultural land grants**	North and south of Duck Creek	Nil	N/A	Significant archaeological remains have not been predicted to be located within the Clyde stabling and maintenance facility construction site. As such, demolition, clearing and excavation works that would result in widespread ground disturbance would not result in any impacts to significant archaeological remains.
Phase 2 (1872 – 1925) **Residential subdivision of early estates and railway construction**	North and south of Duck Creek	Nil	N/A	
Phase 3 (1925 – Present) **Clyde Showground and industrial development**	North and south of Duck Creek	Low to moderate	Unlikely to be of local significance	
	West of Duck Creek, south of A'Becketts Creek	Nil	N/A	

12.9 Silverwater services facility construction site

12.9.1 Historic context and existing heritage items

Land within Liberty Plains, today known as Silverwater, Homebush, Rookwood and Lidcombe, was first settled in 1797. During this period land grants were allocated to settlers to establish farms and estates for agricultural purposes. In 1807 the Newington Estate covered land between the Parramatta River and Parramatta Road, the Duck River and Haslam's Creek. Industrial and commercial pursuits within the Newington Estate were undertaken from the earliest years of the estate's existence including the development of cottages, farmland, a slaughterhouse, and saltworks.

From 1860 onwards, the Newington Estate began to break up with portions of land being sold off to private and public interests. The twentieth century saw mainly industrial development occurring within Silverwater along with the subdivision and development of some modest homes.

The Silverwater services facility construction site is located within the curtilage of the Newington Estate on land originally cultivated in 1807 for agricultural purposes. There is no evidence that any structures were constructed within the Silverwater services facility construction site during this period. By 1880s, Silverwater was mostly subdivided and aerial imagery from 1940s shows the construction site was not developed at this time. During the mid to late twentieth century a large structure was constructed within the Silverwater services facility construction site however this structure was demolished by 2009.

12.9.2 Assessment of heritage significance and impacts

There are no heritage items located within the study area surrounding the Silverwater services facility construction site. No unlisted heritage items were identified.

Archaeological remains

Significant archaeological remains are not been predicted to be located within the Silverwater services facility construction site.

Table 12-12 identifies the type of archaeological remains that may be present; the potential for those archaeological remains to occur within the study area, their likely heritage significance and the potential for those remains to be impacted by Stage 1.

Table 12-12: Silverwater services facility construction site – Potential archaeological impacts

Phase and potential archaeological feature	Potential for occurrence	Heritage significance	Potential archaeological remains
Phase 1 (1807 – 1909) **Newington Estate**	Nil	N/A	Significant archaeological remains are not been predicted to be located within the Silverwater services facility construction site. As such, demolition, clearing and excavation works that would likely result in widespread ground disturbance would not result in any impacts to significant archaeological remains.
Phase 2 (1909 – 1950) **Incomplete suburban subdivision**	Nil	N/A	
Phase 3 (1950 – present) **Commercial and industrial development**	High	None	

12.10 Sydney Olympic Park metro station construction site

12.10.1 Historic context and existing heritage items

The Sydney Olympic Park metro station construction site study area is located in an area initially granted in 1794, and within an estate where a homestead and racing track was constructed in the 1820s. Through the 19th Century, the property was rented by various tenants and the land was described as empty and cleared. Some residential subdivision occurred in the 1880s, but growth in the area was slow.

In the early 20th Century the Public Works Department moved the State Abattoir from Glebe to Homebush (then known as the Home Bush Estate) and much of the land was acquired by the NSW Government. The construction of the State Abattoir included substantial public infrastructure construction at the site including earthworks, buildings, railways and service roads. The State Abattoir was established in 1907, became one the largest slaughterhouses in the Commonwealth, and operated at the site until its closure in 1988.

From 1911, the State Brick Works was also located in Homebush to the north of the construction site. In World War II the State Brick Works was taken over as a munitions store. After the war it resumed brick making until its closure in 1988.

As industrial development in Sydney expanded in the mid-20th century, Homebush was also used as a dumping location for toxic waste with a number of landfills located there.

The area was rehabilitated and redeveloped for sports and recreational use for the 2000 Sydney Olympic and Paralympic Games.

The Sydney Olympic Park metro station construction site study area and existing heritage items are shown in Figure 12-4.

Figure 12-4: Sydney Olympic Park metro station construction site – heritage items and conservation areas

12.10.2 Assessment of heritage significance and impact

Heritage items and conservation areas

Stage 1 would potentially impact on one listed heritage item (the State Abattoirs) within the study area, which is identified at Table 12-13. Sydney Metro is investigating feasible options to avoid direct impacts to this heritage item.

Table 12-13: Sydney Olympic Park metro station construction site – Impacts on heritage items and conservation areas

Item and listing	Significance	Potential impact	Magnitude
State Abattoirs **SEPP (State Significant Precincts) (Item 141)**	State[1]	**Direct impact – partial demolition** Stage 1 would encroach on the heritage curtilage of the item. Trees and vegetation within the Sydney Olympic Park metro station construction site would be removed, including existing planting and landscaping identified as being of 'high/medium' significance. This would have a permanent physical impact, although reinstatement of sympathetic landscaping that is in keeping with the provisions of the Conservation Management Plan would assist in mitigating this impact. Sydney Metro is currently investigating alternate construction options to cut and cover in the vicinity of Herb Elliot Avenue which would potentially avoid or minimise impacts to elements of the heritage item.	Moderate
		Potential direct impact – vibration Vibration modelling indicates that the Gatehouse and the Administration Block building (to the east of the construction site) could experience vibration levels above the cosmetic damage screening criteria. Further assessment (including a structural assessment) and vibration impact monitoring (if required) would be completed to ensure safe vibration levels for the structure are met.	Minor
		Indirect impact – views and vistas The removal of trees, landscape elements and garden would result in changes to the aesthetic quality and character of the historic complex although reinstatement of sympathetic landscaping that is in keeping with the provisions of the Conservation Management Plan would assist in mitigating this impact. Stage 1 would also involve demolition on the southern side of Herb Elliott Avenue, which would result in visual changes to the surrounding context and setting of the former State Abattoirs, although these modern buildings are not considered to represent a significant visual component of the historic agricultural complex. The context of the heritage item has also previously been altered by the Sydney Olympic Park redevelopment and existing commercial development. The acoustic sheds (or other acoustic measures) would be visible from the former State Abattoirs, including the principal multi-storey historic buildings and gardens, but would only be temporary in nature.	Moderate

Note 1: The State Abattoirs are listed as State significant on the State Environmental Planning Policy (SEPP) and the Sydney Regional Environmental Plan (SREP), however, the item is not listed on the State Heritage Register

Abattoir Heritage Precinct Conservation Management Plan

The Abattoir Heritage Precinct is subject to the Abattoir Heritage Precinct, Sydney Olympic Park: Conservation Management Plan (Graham Brooks and Associates, 2003). An assessment of impact in response to the relevant recommendations of the Conservation Management Plan is included in Table 12-14.

Table 12-14: Assessment against Abattoir Heritage Precinct, Sydney Olympic Park Conservation Management Plan recommendations

Recommendation	Assessment of impacts
Assess the impact of any near-by large-scale development upon the heritage significance of the site.	Stage 1 involves demolition of existing development and construction within the State Abattoirs heritage curtilage, which would change the existing visual context and setting of the site. The setting is graded as being of 'low/neutral' significance in the Conservation Management Plan, and is not considered to contribute to the significance of the item. The acoustic sheds (or other acoustic measures) at the site would also have a visual impact on the setting on a temporary basis. However, modern development adjacent to the construction site already exceeds the height of the proposed acoustic sheds (or other acoustic measures).
Any proposed new large-scale development in the vicinity should not overshadow the open spaces in the Abattoir Heritage Precinct.	The acoustic sheds (or other acoustic measures) would exceed the height of existing development in the construction site. This would result in a temporary impact, given that the acoustic sheds (or other acoustic measures) would temporarily change the nature and quality of open spaces within the heritage precinct during construction. The acoustic shed (or other acoustic measures) located directly opposite the State Abattoirs on the southern side of Herb Elliot Avenue would potentially visually dominate the State Abattoirs, although this indirect impact would be temporary in nature.
Significant building and landscape fabric, both internally and externally should be retained and conserved, in accordance with the levels of significance identified in Part 7 Summary of Elements	Stage 1 has been developed to retain the former gatehouse structure, which is identified as an element of Exceptional significance in the Conservation Management Plan. However, Stage 1 would also result in the removal of significant landscaping elements adjacent to the gatehouse and former carriage loop, including the removal of mature tree planting, garden beds, kerbing and other associated public domain elements. This removal would result in a permanent adverse heritage impact. This impact could be lessened with the reinstatement of the gardens with appropriate similar species and plantings in keeping with the provisions of the Conservation Management Plan.
Where landscape elements require replacement due to growth or senescence, replant with species to match existing, in the existing layout, or one determined by further research.	This would be considered during design development for the station as part of a future stage of Sydney Metro West.
Make decisions requiring change to the Abattoir Heritage Precinct with a clear understanding of the implications on its heritage values and seek to minimise negative heritage impacts.	Stage 1 has considered the heritage values of different elements of, and views towards, the Abattoir Heritage Precinct, with the aim of minimising heritage impacts. This has included the protection of the former gatehouse structure, which would maintain the overall integrity and heritage value of the historic precinct. Removal of trees and landscaping would be a negative heritage impact, although this impact could be lessened with the reinstatement of the gardens with appropriate similar species and plantings in keeping with the provisions of the Conservation Management Plan.
Undertake formal archival recording of the Abattoir Heritage Precinct prior to undertaking works, including conservation works, to significant elements. Keep ongoing records of changes.	Archival recording would be undertaken in accordance with the mitigation measures identified in this assessment (further discussed in Section 12.16).

Potential unlisted heritage items

This assessment did not identify any potential unlisted heritage items within the Sydney Olympic Park metro station construction site.

Archaeological remains

Significant archaeological remains are not predicted to be located at the Sydney Olympic Park metro station construction site.

Table 12-15 identifies the type of archaeological remains that may be present, the potential for those archaeological remains to occur within the study area, their likely heritage significance and the potential for those remains to be impacted by Stage 1.

Table 12-15: Sydney Olympic Park metro station construction site – Potential archaeological impacts

Phase and potential archaeological feature	Potential for occurrence	Heritage significance	Potential archaeological remains
Phase 1 (1810-1907) **Wentworth's Homebush Estate**	Nil	N/A	Significant archaeological remains are not predicted to be located at the Sydney Olympic Park metro station construction site. Demolition, clearing and excavation works that would result in widespread ground disturbance would not result in any impacts to significant archaeological remains.
Phase 2 (1907-1988) **State Abattoir**	Low	Unlikely to be of local significance	
Phase 3 (1988-Present) **Sydney Olympic Park**	Nil	N/A	

12.11 North Strathfield metro station construction site

12.11.1 Historic context and existing heritage items

The North Strathfield metro station construction site study area previously formed land grants to free settlers, known as Liberty Plains. This area was initially used for agricultural purposes but was abandoned as it was not suited for arable farming. Due to this, development in the area progressed at a slow pace.

The construction of the Main North Line through the study area by 1887 resulted in the consolidation of settlement and development patterns in the area, although a station was not initially constructed at North Strathfield. Industrial development to the west and south of the study area, including the Arnott's biscuit factory, was established in the early 20th Century.

This industrial development spurred residential growth in North Strathfield and led to the construction of North Strathfield Station. North Strathfield Station was opened on 15 June 1918, and rapidly accelerated subdivision and development of the surrounding area. By 1943, North Strathfield had developed into an expansive suburban area comprising small residential allotments. Land to the west of the rail line continued to be used for industrial purposes with several rail sidings present.

The North Strathfield metro station construction site study area and existing heritage items are shown in Figure 12-5.

Figure 12-5: North Strathfield metro station construction site – Heritage items and conservation areas

12.11.2 Assessment of heritage significance and impact

Heritage items and conservation areas

Stage 1 would potentially impact on two listed heritage items, which are identified in Table 12-16.

Table 12-16: North Strathfield metro station construction site – Impacts on heritage items and conservation areas

Item and listing	Significance	Potential impact	Magnitude
Street Trees (adjacent to North Strathfield Railway Station) **Canada Bay LEP 2013 (I397)**	Local	**Indirect impact – views and vistas (temporary)** The southern construction site including temporary site parking, site office and amenities, would not substantially alter the existing visual amenity of the locality.	Negligible
North Strathfield Railway Station Group **Railcorp s170 (4801029)**	Local	**Direct impact – partial demolition** Stage 1 would involve direct impacts including changes to a portion of the gardens at the eastern entry to the station precinct off Queen Street. The pedestrian overbridge and stairs would not be impacted and are identified as being components of 'Little' significance within the North Strathfield Railway Station Group. The entry gardens are identified as significant for their aesthetic qualities and impacts are considered adverse. In the overall context of the North Strathfield Railway Station Group, the impacts would be relatively localised.	Minor
		Indirect impact – views and vista Stage 1 would include construction activities within and adjacent to the North Strathfield Railway Station Group heritage item. Cut and cover excavations to a depth of around 18 metres would result in impacts to the visual amenity of the heritage item.	Minor

Potential unlisted heritage items

This assessment did not identify any potential unlisted heritage items within the North Strathfield metro station construction site.

Archaeological remains

Significant archaeological remains are not predicted to be located at the North Strathfield metro station construction site. Demolition, clearing and excavation works that would result in widespread ground disturbance would not result in any impacts to significant archaeological remains.

12.12 Burwood North Station construction site

12.12.1 Historic context and existing heritage items

The Burwood North Station construction site study area was initially used for the Longbottom Government Stockade and Farm from the 1790s. This was a halfway point for road gangs on trips between Sydney and Parramatta, and was located around the area of the grandstand in Concord Oval. The stockade and farm employed varying numbers of convicts over this period.

In the 19th Century the stockade was no longer required and fell into disrepair. An informal village formed and was formalised in 1843. Development surrounding the site was slowly subdivided, and Concord Oval was created in 1866. Residential development was replaced with commercial development and car parking along Parramatta Road.

The Burwood North Station northern construction site is located within the original curtilage of the Longbottom Government Farm. The Burwood North Station southern construction site is located in a 250-acre land grant made to Thomas Rowley in 1799. By 1828, shops had established on the corner of Burwood and Parramatta Roads. By 1943, the building form structures at the site were generally as they exist today, subject to the replacement of some dwellings by commercial and car parking uses.

The Burwood North Station construction site study area and existing heritage items are shown in Figure 12-6.

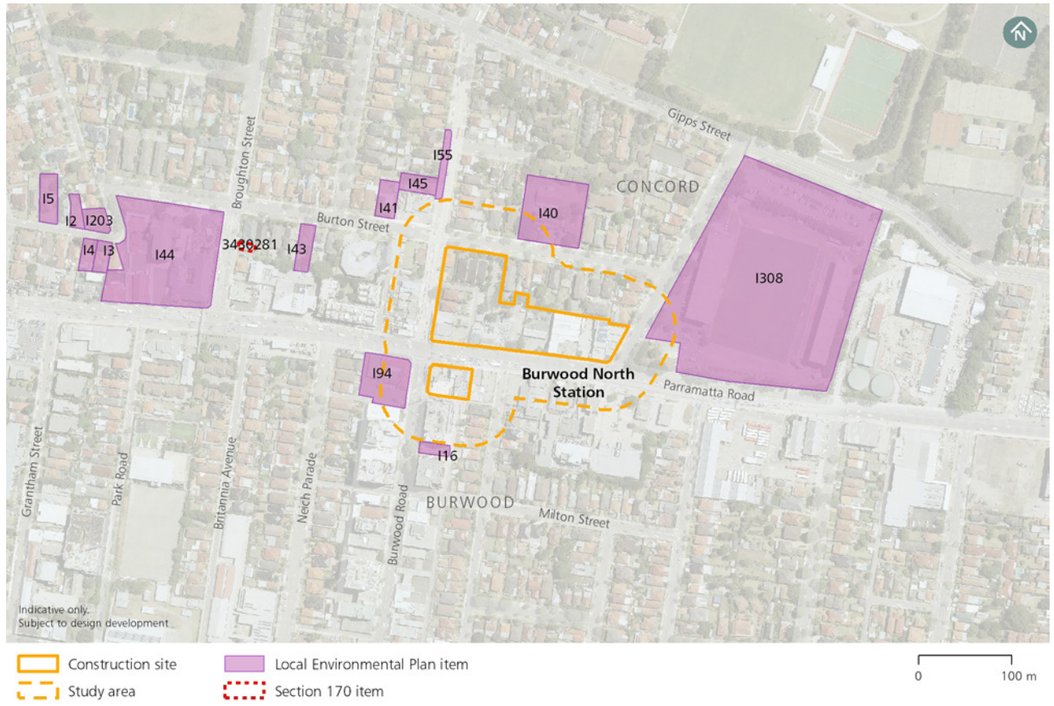

Figure 12-6: Burwood North Station construction site – Heritage items and conservation areas

12.12.2 Assessment of heritage significance and impact

Heritage items and conservation areas

Stage 1 would potentially impact on the listed heritage items identified in Table 12-17.

Table 12-17: Burwood North Station construction site – Impacts on heritage items and conservation areas

Item and listing	Significance	Potential impact	Magnitude
St Luke's Park gateway/ entrance (gates and trees only) **Canada Bay LEP 2013 (I308)**	Local	**Indirect Impact – views and vistas (temporary)** Demolition of existing development, construction activities and establishment of an acoustic shed (or other acoustic measures) at the Burwood North Station northern construction site would potentially detract from the landmark qualities of the plantings within and adjacent to the entrance of the park, however these impacts would be temporary in nature, and views towards the item would not be affected.	Negligible
St Luke's Anglican Church and grounds **Canada Bay LEP 2013 (I40)**	Local	**Indirect Impact – views and vistas (temporary)** Demolition of existing development, construction activities and establishment of an acoustic shed (or other acoustic measures) near the item would potentially detract from the setting and context of the item, however these impacts would be temporary in nature, sightlines towards the construction site would be obstructed, and views towards the item would not be affected.	Negligible
Bath Arms Hotel **Burwood LEP (I94)**	Local	**Indirect Impact – views and vistas (temporary)** Stage 1 would involve indirect impacts, changing views looking out from the hotel and would potentially detract from its landmark qualities. However, construction activities would be temporary in nature, and views towards the heritage item would not be affected.	Minor

Potential unlisted items

Table 12-18 identifies potential unlisted heritage items, their significance and the impacts of Stage 1 on these items.

Table 12-18: Burwood North Station construction site – Impacts on unlisted items

Item	Potential significance	Potential impacts	Magnitude
Pine Inn **19 Parramatta Road, Concord** **19th century Victorian era building** **338-340 Parramatta Road, Burwood**	Local	Stage 1 would require the demolition of these items resulting in the complete removal of any heritage fabric. The items would not retain their heritage significance and would no longer provide representative examples of their type.	Major

Archaeological remains

Significant archaeological remains have not been predicted to be located within the Burwood North Station construction site.

Table 12-19 identifies the type of archaeological remains that may be present, the potential for those archaeological remains to occur within the study area, their likely heritage significance and the potential for those remains to be impacted by Stage 1.

Table 12-19: Burwood North Station construction site – Potential archaeological impacts

Phase and potential archaeological feature	Potential for occurrence	Heritage significance	Potential archaeological remains
Phase 1 (1792-1819) **Longbottom Stockade and early land grants**	Nil	N/A	Significant archaeological remains have not been predicted to be located within the Burwood North Station construction site. As such, demolition, clearing and excavation works that would result in widespread ground disturbance would not result in any impacts to significant archaeological remains.
Phase 2 (1819-1850) **Longbottom Village and Riley Estate**	Nil	N/A	
Phase 3 (1950-Present) **Late 19th c. residential development**	Moderate	Unlikely to be of local significance	

12.13 Five Dock Station construction site

12.13.1 Historic context and existing heritage items

Five Dock originally formed part of the 'Eastern section of the District of Concord', an area comprising foreshores within the Drummoyne Municipality. In 1806 Five Dock was subdivided which resulted in the creation of Five Dock Farm.

The Great North Road was created in 1828, which ran from Parramatta Road towards Abbotsford. Large allotments were created along this alignment, which resulted in Five Dock growing rapidly as a residential area. In the 20th Century, this area became an industrial hub in the Inner West.

The Five Dock Station western construction site has historically been used for residential and commercial purposes. Historical aerial imagery from 1943 shows a World War II anti-aircraft trench along the southern portion of the site. In the period since 1943, the scale of commercial and higher density mixed uses has increased, and a car park has been constructed at the site.

The Five Dock Station eastern construction site was subdivided during the 1880s, within what was known as 'Waterview Estate' and residential houses were constructed.

The Five Dock Station construction site study areas and existing heritage items are shown in Figure 12-7.

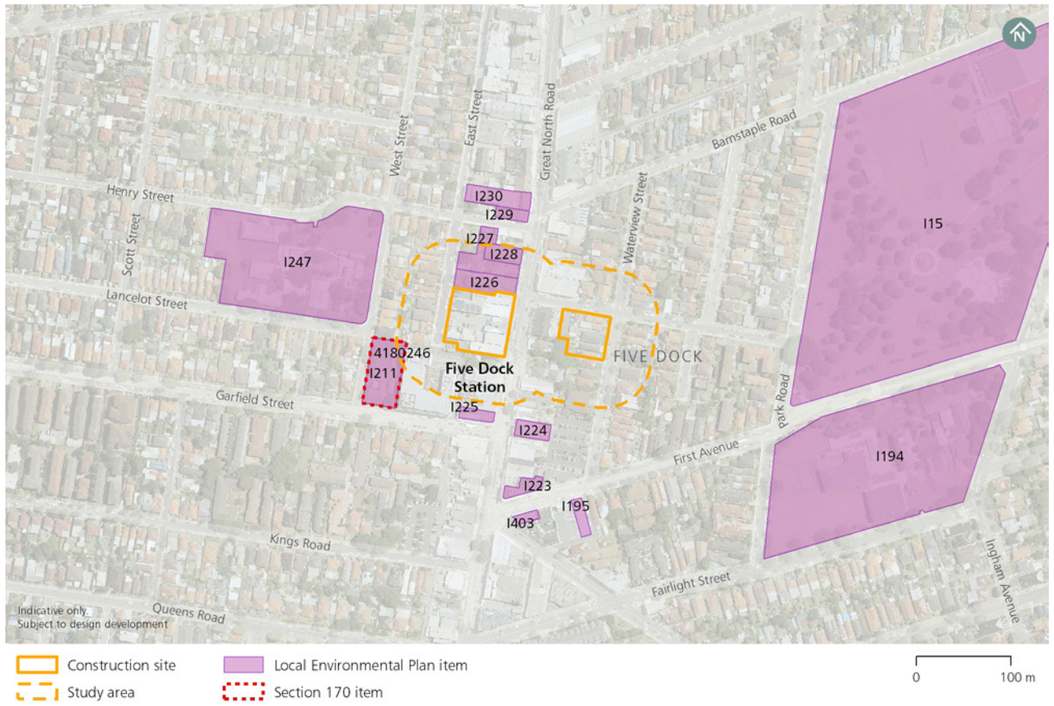

Figure 12-7: Five Dock Station construction site – Heritage items and conservation areas

12.13.2 Assessment of heritage significance and impact

Heritage items and conservation areas

Stage 1 would potentially impact on the listed heritage items identified in Table 12-20.

Table 12-20: Five Dock Station construction site – Impacts on heritage items and conservation areas

Item and listing	Significance	Potential impact	Magnitude
St Alban's Anglican Church Hall and Shops **Canada Bay LEP 2013 (I228)**	Local	**Indirect impact – views and vistas** Stage 1 demolition and construction would change the wider context of the church precinct, including a direct sightline between the church hall and western construction site. However, the existing buildings within the construction site are not considered to represent a significant visual element in the surrounding setting of the heritage item.	Minor
St Alban's Anglican Church Rectory **Canada Bay LEP 2013 (I227)**	Local	**Indirect impact – views and vistas** Buildings in the Five Dock Station western construction site would be demolished as part of Stage 1. This would change the wider context of the church precinct, however there are limited sightlines between the western construction site and the Rectory. Existing buildings within the construction site are not considered to represent a significant visual element in the surrounding setting of the heritage item.	Minor

Item and listing	Significance	Potential impact	Magnitude
St Alban's Anglican Church **Canada Bay LEP 2013 (I226)**	Local	**Potential direct impact – vibration** Vibration modelling indicates that during demolition works this item could experience vibration levels above the cosmetic damage screening criteria. Further assessment (including a structural assessment) and vibration impact monitoring (if required) would be completed to ensure safe vibration levels for the structure are met.	Minor
		Indirect impact – views and vistas Stage 1 demolition and construction would change the wider context of the church precinct, including a direct sightline between the church and construction site. However, the existing buildings within the construction site are not considered to represent a significant visual element in the surrounding setting of the heritage item.	Moderate
Police Station **Canada Bay LEP 2013 (I211)** **NSW Police Service s170 (4180246)**	Local	The significant fabric of this heritage item is located more than 50 metres from the construction site and therefore there would be no direct impacts, vibration is not anticipated and there are no sightlines between the item and the Five Dock metro station construction site.	Neutral

Potential unlisted items

This assessment did not identify any potential unlisted heritage items within Five Dock Station construction site.

Archaeological remains

Significant archaeological remains have not been predicted to be located at the Five Dock Station construction site.

Table 12-21 identifies the type of archaeological remains that may be present, the potential for those archaeological remains to occur within the study area, their likely heritage significance and the potential for those remains to be impacted by Stage 1.

Table 12-21: Five Dock Station construction site – Potential archaeological impacts

Phase and potential archaeological feature	Potential for occurrence	Heritage significance	Potential archaeological remains
Phase 1 (1794-1837) **Early grants and John Harris' Five Dock Farm**	Nil	N/A	Significant archaeological remains have not been predicted to be located at the Five Dock Station construction site. Demolition, clearing and excavation works that would result in widespread ground disturbance would not result in any impacts to significant archaeological remains.
Phase 2 (1837-1910) **Villa subdivision of Five Dock**	Nil	N/A	

12.14 The Bays Station construction site

12.14.1 Historic context and existing heritage items

The Bays Station construction site study area forms part of White Bay, a key area of land with significant water frontage and close proximity to the Sydney CBD enabling reliable water transportation for people and merchandise. Subdivision in the 19th Century led to the establishment of a number of industries in the White Bay area. A causeway near White Bay was proposed in 1861 to connect to Glebe Island.

From 1854, White Bay was the site of a prominent timber and joinery works site in Sydney, which principally supplied the emerging boat and ship building industries in Balmain. This timber/manufacturing use continued up until 1923, when the Sydney Harbour Trust purchased White Bay to establish a shipyard. Other industrial uses in Balmain included an Australian Gas Light Company works near the corner of Robert Street and Mansfield Street (which operated between 1841 and 1909), and the Lever Brothers (subsequently Unilever) soap factory on Booth Street (which operated between 1900 and 1988).

White Bay Power Station comprised a key power plant to support the Sydney transport network, including the underground city circle rail tunnels and the tramway network. The Power Station operated between 1917 and 1983 and remains a prominent visual landmark in Balmain.

In 1966, a ten year plan was drawn up for the development of White Bay for shipping containerisation, which included container berths. Container berths were constructed in 1969. However, the wharves lacked back-up space for truck movements and were ultimately superseded by facilities at Botany Bay.

The study area is located within the curtilage of the original land grant made to William Balmain in 1800, and is located in an area occupied largely by the original White Bay water body prior to reclamation in the 1890s. The White Bay Power Station is also located in the study area.

The Bays Station construction site study area and existing heritage items are shown in Figure 12-8.

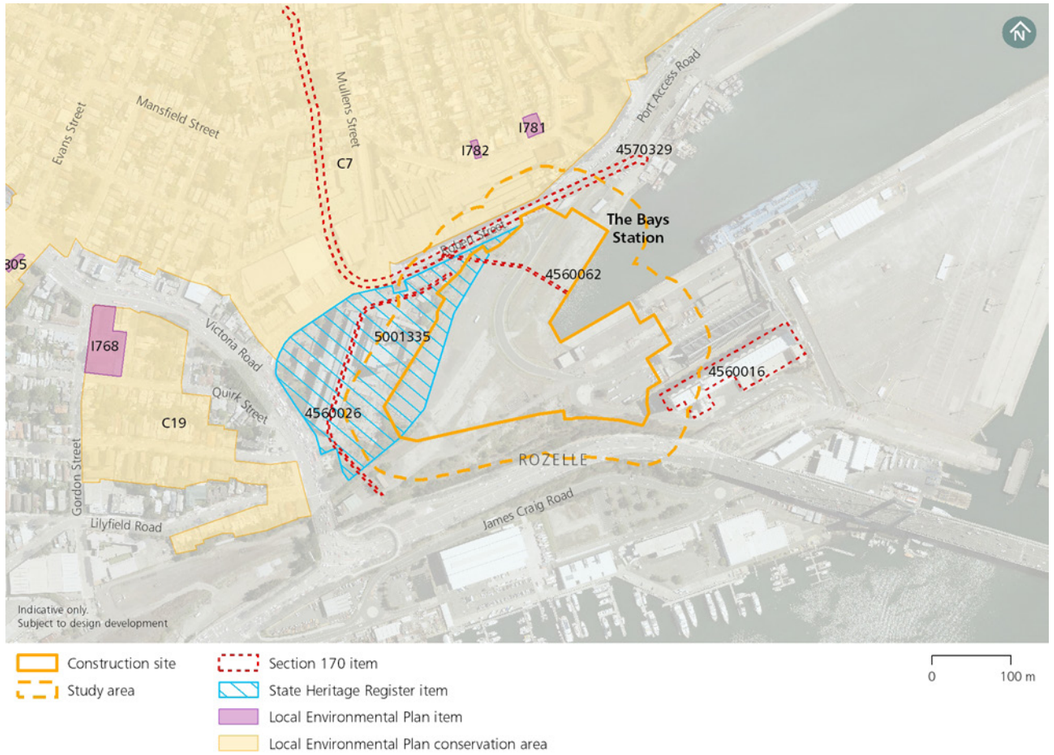

Figure 12-8: The Bays Station construction site – Heritage items and conservation areas

12.14.2 Assessment of heritage significance and impact

Heritage items and conservation areas

Stage 1 would potentially impact on the listed heritage items and heritage conservation area identified in Table 12-22.

Table 12-22: The Bays Station construction site – Impacts on heritage items and conservation areas

Item and listing	Significance	Potential impact	Magnitude
White Bay Power Station **SHR (01015)** **Urban Development Corporation s170 (4500460)** **SREP No. 26 – City West Part 3 No. 11**	State	**Direct impact – partial demolition** Stage 1 would encroach on about 0.7 ha of the curtilage of the White Bay Power Station, involving demolition of all structures, ground works and excavations in this zone. No significant buildings or structures in the curtilage are located in the construction site, which largely comprises vacant land and is not considered to be of exceptional or high significance. The land is designated to be retained or adapted suitably, resulting in a moderate impact.	Moderate
		Potential direct impact – vibration Modelling indicates that this item could experience vibration levels above the cosmetic damage screening criteria. Further assessment (including a structural assessment) and vibration impact monitoring (if required) would be completed to ensure safe vibration levels for the structure are met.	Minor
		Indirect impact – views and vistas Stage 1 would result in visual changes within the heritage item and changes to the arrangement and configuration of the land surrounding the significant industrial structures, which have identified spatial significance for their contribution to the scale and industrial quality of the item and its built components. Although the orientation of the station has been planned to retain heritage significant view lines to and from the power station.	Moderate
The Valley Heritage Conservation Area **Leichhardt LEP 2013 (C7)**	Local	**Indirect impact – views and vistas (temporary)** Stage 1 would result in visual changes in the vicinity of the conservation area, and would change the wider setting of the conservation area. While the conservation area maintains several view lines and view corridors towards The Bays, views towards the conservation area from the surrounding streetscape would be maintained and the aesthetic significance of the item would not be diminished.	Minor
White Bay Power Station (outlet) Canal **Ports Authority of NSW s170 (4560026)**	Local	Most significant fabric of this heritage item is located more than 50 to 100 metres from the construction site and therefore there would be no direct impacts, vibration is not anticipated. The White Bay Power Station (Outlet) Canal is located primarily below ground and has a limited visual curtilage and there are no sightlines between the item and The Bays Station construction site.	Neutral
		Direct impact – accidental damage during construction (potential) The inlet canal is located entirely underground and excavation work has the potential to directly impact the heritage item. Following the confirmation of the relative depth of the heritage item, in addition to further excavation detail, the direct impact on the item may be reduced to neutral or increased to moderate.	Minor
White Bay Power Station (inlet) canal **Ports Authority of NSW s170 (4560062)**	Local	**Potential direct impact - vibration** Vibration modelling indicates that during construction and excavation works this item could experience vibration levels above the cosmetic damage screening criteria. Further assessment (including a structural assessment) and vibration impact monitoring (if required) would be completed to ensure safe vibration levels are met.	Minor
Beattie Street Stormwater Channel No. 15 **Sydney Water s170 (4570329)**	Local	The item is located a sufficient distance from The Bays Station construction site such that therefore there would be no direct impacts, vibration is not anticipated and there are no sightlines between the item and the construction site.	Neutral
Glebe Island Silos **Ports Authority of NSW s170 (4560016)** **SREP No. 26 – City West Part 3 No. 1**	Local	**Indirect impact – views and vistas (temporary)** Demolition of structures within The Bays Station construction site would result in visual changes in the immediate vicinity of the Glebe Island Silos which maintains several view lines towards The Bays and change the wider setting of the heritage item. The acoustic sheds (or other acoustic measures) would be discernible from the Glebe Island Silos, although this additional visual impact would be temporary in nature.	Minor

White Bay Power Station Conservation Management Plan

The White Bay Power Station is subject to the White Bay Power Station: Conservation Management Plan (Design 5 Architects, 2011). A response to the key recommendations of the Conservation Management Plan has been detailed at Table 12-23.

Table 12-23: Assessment against White Bay Power Station: Conservation Management Plan

No.	Conservation Management Plan recommendation	Assessment of impacts
1.1.1	White Bay Power Station retains considerable cultural significance and must be retained and conserved. In order to ensure its long term maintenance and survival it must be adapted for an appropriate new use or uses. Such uses must retain and respect the significant elements and attributes of the place.	Stage 1 does not involve the demolition of structures considered significant.
1.1.6	White Bay Power Station must retain a use or uses, which allow reasonable public access to, and interpretation of, those significance spaces, elements and machinery that represent the component parts of the power generation process. Such access should not place significant fabric or qualities of these areas at risk of alteration, damage or removal.	Stage 1 does not involve the demolition of any structures considered significant. Stage 1 works are not expected to significantly reduce areas of public access further than presently accessible, or require the need for interpretation.
1.1.7	The aesthetic (including the sensory aspects of visual, aural and tactile) qualities of the internal and external spaces and elements of exceptional and high significance must be retained and respected, viz. the visual and special qualities of the Turbine Hall.	No significant buildings or structures in the heritage curtilage are located within the construction site, which mainly comprises vacant land. The Bays Station construction site is located within a portion of the SHR curtilage of the White Bay Power Station and construction activities would involve the demolition of non-significant structures, ground works and excavations

No.	Conservation Management Plan recommendation	Assessment of impacts
1.2.1	Any development being proposed in the vicinity of the White Bay Power Station must carefully consider its bulk, scale and placement in order to respect the visibility and prominence of the power station as a harbourside landmark.	Stage 1 would result in demolition of development, site establishment and the excavation for the station within a portion of the White Bay Power Station SHR heritage curtilage. This would result in temporary visual changes within the heritage item and changes to the arrangement and configuration of the land surrounding the significant industrial structures. These external spaces have identified spatial significance for their contribution to the scale and industrial quality of the item and its built components, and excavation and redevelopment of this land would result in an adverse visual impact. The acoustic sheds (or other acoustic measures) within the construction site would be around 15 metres in height, although additional visual impact associated within this aspect of Stage 1 would be temporary.
1.2.2	Those views from major axial approaches such as Anzac Bridge, Glebe Point Road, Johnston Street Annandale, City West Link, Victoria Road (from north west), Mullens Street and Robert Street must be maintained as substantially unobstructed views. Any new structures in the vicinity of the White Bay Power Station must not substantially mask the visibility of the power station or threaten its landmark qualities as the major focal element in these views.	The proposed acoustic shed (or other acoustic measures), at 15 metres in height, would not exceed the height of the existing structure and the visual impact associated within this aspect of Stage 1 would be temporary.
1.2.3	General and changing views towards White Bay Power Station from the harbour, major parks and public areas of the southern edge of Balmain and Rozelle, Glebe Point, Pyrmont Point, Observatory Hill and Darling Harbour, as well from the Harbour Bridge, Anzac Bridge, City West Link road, The Crescent and Victoria Road, should be retained substantially unobstructed by other large elements, existing or future. Such elements should be sited, so as to be seen as part of its industrial context, framing the power station and strengthening its maritime related industrial character.	The proposed acoustic shed (or other acoustic measures), at 15 metres in height, would not exceed the height of the existing structure and the visual impact associated within this aspect of Stage 1 would be temporary.
1.2.5	Lower level structures between the Anzac Bridge (western approaches) and the White Bay lower Station could be constructed as long as they do not substantially obscure the major view of the east front of the power station. The full height of the glass curtain wall to the 1958 boiler house should be visible from the western approaches to the Bridge.	Stage 1 would result in demolition of development, site establishment and the excavation for the station within a portion of the White Bay Power Station SHR heritage curtilage. This would result in visual changes within the heritage item and changes to the arrangement and configuration of the land surrounding the significant industrial structures. These external spaces have identified spatial significance for their contribution to the scale and industrial quality of the item and its built components, and excavation and redevelopment of this land would result in an adverse visual impact. The acoustic sheds (or other acoustic measures) within the construction site would be around 15 metres in height, although additional visual impact associated within this aspect of Stage 1 would be temporary.

Potential unlisted heritage items

Table 12-24 identifies potential unlisted heritage items, their significance and the impacts of Stage 1 on these items.

Table 12-24: The Bays Station construction site – Impacts on unlisted items

Item	Potential heritage significance	Potential impact	Magnitude
Former warehouse shed – Glebe Island	Local	Stage 1 would require the demolition of this item resulting in the complete removal of any heritage fabric. The item would not retain its heritage significance and would no longer provide a representative example of its type.	Major

Archaeological remains

Table 12-25 identifies the type of archaeological remains that may be present, the potential for those archaeological remains to occur within the study area, their likely heritage significance and the potential for those remains to be impacted by Stage 1.

Impacts to significant archaeological resources are likely to occur during demolition and excavation work for The Bays Station. Further robust archaeological investigation would be undertaken prior to the commencement of works to identify the extent of these impacts. If significant archaeology is encountered, consideration would be given to inclusion in the Heritage Interpretation Plan for future stages.

Table 12-25: The Bays Station construction site – Potential archaeological impacts

Phase and potential archaeological feature	Potential for occurrence	Heritage significance	Potential archaeological remains
Phase 1 (1800-1851) **William Balmain Estate**	Nil to low	Local	Historic soil deposits and discarded artefacts – Archaeological remains associated with this would include stratigraphically-controlled and sealed soil deposits, ex-situ artefactual material from this period which may have washed into the site or been discarded.
Phase 2 (1851-1912) **Rozelle Subdivision and Waterfront Industries**	Low to moderate	Local	Outbuildings and structures of the original White Bay Hotel – Archaeological remains associated with these former buildings could include brick and stone footings, timber boards and intact underfloor deposits, ceramic pipes, brick or stone lined drains, isolated ceramic, glass, bone, or metal deposits, lined cesspits or wells containing occupation or discarded artefactual (glass, ceramic, bone) material and soil deposits. Reclamation fills – Archaeological remains relating to reclamation fills could include discrete stratigraphic historic soil deposits, artefactual (glass, ceramic, bone, timber, brick) materials and infill rubble, and timber retaining or infill structures such as piers, posts, beams or walls.
Phase 3 (1912-1984) **White Bay Power Station and Port Facilities**	Moderate to high	Local	Rail Infrastructure and former industrial structures – Archaeological remains could include evidence of turntables, stabling facilities and roundhouses, loading equipment, rail beams, ballast and timber or concrete sleepers, rail switches, levers and points, concrete, steel and brick building footings, tile and brick rubble, discarded industrial equipment, artefactual refuse deposits (metal, glass, ceramic).

12.15 Cumulative impacts

Potential cumulative impacts were considered for assessment based on the likely interactions of Stage 1 with other projects and plans that met the adopted screening criteria. The approach to assessment and the other projects considered are described further in Appendix G (Cumulative impacts assessment methodology).

There is potential for cumulative impacts to occur at the following Stage 1 construction sites:

- Parramatta metro station
- Sydney Olympic Park metro station
- North Strathfield metro station
- The Bays Station.

Parramatta metro station

The Parramatta and North Parramatta commercial areas are undergoing significant development, with the construction of new high rise buildings significantly altering the urban character of the city. In addition to this, Parramatta Light Rail (Stage 1) provides significant new infrastructure throughout the Parramatta and North Parramatta commercial areas.

The Sydney Metro West Stage 1 works are expected to result in moderate cumulative impacts to the heritage setting of items which would also be impacted by both the Parramatta Light Rail (Stage 1) project. These items include Kia Ora (Parramatta LEP Item No. I716) and Horse Parapet Façade and potential archaeological site (Parramatta LEP Item No. I656). The removal of tall modern structures from the Parramatta metro station construction site may temporarily improve sightlines for the low-lying heritage-listed structures during the construction period, therefore having a positive cumulative heritage impact in this regard.

Archaeological remains related to early convict huts in Parramatta are a rare resource of significant research value. Sydney Metro West Stage 1 works have the potential to directly impact several predicted convict huts, further reducing the diminishing archaeological resource which is unique to Parramatta. Early nineteenth century archaeological remains, which are of research value for understanding the commercial development of Parramatta and the early colony, may also be impacted by Stage 1.

Sydney Olympic Park metro station

The Sydney Olympic Park metro station construction site is directly adjacent to a number of developments, including the proposed route of the planned Parramatta Light Rail (Stage 2) project. As the Parramatta Light Rail (Stage 2) is expected to have relatively minor impacts to the State Abattoirs, cumulative impacts to the items in regard to Stage 1 would be minor. Cumulative impacts to setting and amenity of the surrounding area would also be minor as the current urban context comprises a combination of commercial buildings, retail development and high density residential apartment buildings which do not have associated heritage values. Cumulative heritage impacts to archaeological resources are not expected.

North Strathfield metro station

North Strathfield Station has recently undergone upgrades which have been assessed as having potential direct impacts to heritage station. The North Strathfield metro station construction site would have only a minor impact on the curtilage of the s170 listed North Strathfield Railway Station and would not impact significant fabric, therefore any cumulative heritage impact in relation to upgrade works at the station would be minor.

The Bays Station

The Bays is undergoing significant development, with a number of projects within the vicinity of The Bays Station construction site which are expected to result in potential heritage impact to the White Bay Power Station curtilage. This includes The Bays road relocation works, WestConnex M4-M5 Link – Rozelle Interchange, Sydney Metro City & Southwest (Chatswood to Sydenham), Glebe Island concrete batching plant and aggregate handling project, Western Harbour Tunnel and Warringah Freeway Upgrade, Glebe Island Multi-User Facility, and The Bays Precinct Urban Transformation project. In addition, The Bays road relocation works involving the relocation of the existing Ports Access Road would impact State significant heritage. As Stage 1 would also impact the curtilage of the White Bay Power Station, cumulative impacts to the curtilage would be moderate, although Stage 1 does not propose to impact significant fabric.

The Bays road relocation works and Stage 1 could both have a potential minor impact to the curtilage of White Bay Power Station (Inlet) Canal, a locally significant heritage item. As Stage 1 would impact the curtilage of the White Bay Power Station (Inlet) Canal, cumulative impact to the curtilage would be minor, although Stage 1 does not propose to impact significant fabric. However, little information is available regarding the precise depth of the heritage item. Following the confirmation of the relative depth of the heritage item, in addition to further excavation detail for the proposal and Stage 1, the direct impact on the item may be reduced to neutral or increased to moderate.

It is expected significant archaeology is located within the Stage 1 construction site. The M4-M5 link and Western Harbour Tunnel are also expected to impact non-Aboriginal archaeology, so cumulative impacts as a result of the Stage 1 project area are expected. Depending on the nature of archaeological remains located within The Bays Station construction site, cumulative impacts on archaeological resources would be moderate.

Given that other projects such as the WestConnex M4-M5 link and Western Harbour Tunnel are proposing to utilise the area around the White Bay Power Station for ancillary and construction sites there would be some cumulative visual impacts, although as these uses align with the current industrial character of the locality cumulative impacts would be minor to moderate.

12.16 Management and mitigation measures

12.16.1 Approach to management and mitigation

Stage 1 Non-Aboriginal heritage impacts would be managed in accordance with the Construction Environmental Management Framework. Of relevance, the Construction Environmental Management Framework includes heritage management objectives to minimise impacts on items or places of heritage value, avoid accidental impacts on heritage items, and maximise workers' awareness of Aboriginal and non-Aboriginal heritage.

The Construction Environmental Management Framework also requires the preparation and implementation of a Heritage Management Plan, including as a minimum:

- Procedures for undertaking any recordings of heritage items prior to works commencing
- Procedures for unexpected heritage finds
- Heritage monitoring requirements.

More details of the Construction Environmental Management Framework are provided in Chapter 27 (Synthesis of the Environmental Impact Statement).

12.16.2 Mitigation measures

The mitigation measures that would be implemented to address potential non-Aboriginal heritage impacts are described in Table 12-26.

Table 12-26: Mitigation measures – Non-Aboriginal heritage Stage 1

Reference	Impact/issue	Mitigation measure	Application location(s)[1]
NAH1	Archival recording	Archival recording and reporting of the following heritage items would be carried out in accordance with the NSW Heritage Office's How to Prepare Archival Records of Heritage Items (1998), and Photographic Recording of Heritage Items Using Film or Digital Capture (2006): • Shops (and potential archaeological site (Parramatta LEP Item No. I703) • Kia Ora (and potential archaeological site) (Parramatta LEP Item No. I716) • RTA Depot (Parramatta LEP Item No. I576) • State Abattoirs (SEPP Listing No. A) • White Bay Power Station (SHR Listing No. 01015)	PMS, CSMF, SOPMS, TBS
NAH2	Demolition	A method for the demolition of existing buildings and/or structures at specified construction sites would be developed to minimise direct and indirect impacts to adjacent and / or adjoining heritage items.	PMS, CSMF, SOPMS, TBS
NAH3	Salvage	Prior to commencement of demolition of heritage elements at White Bay Power Station within The Bays construction site, significant heritage fabric would be identified for salvage and reuse opportunities for salvaged fabric considered.	TBS
NAH4	Visual impacts	The policies of the White Bay Power Station Conservation Management Plan would be considered in regard to visual impacts of the Stage 1 works, particularly the acoustic shed (or other acoustic measures) and any temporary structures. Significant view lines would be retained during Stage 1 works.	TBS
NAH5	Heritage interpretation	Where heritage items, including significant archaeology are impacted by Stage 1 works, consideration would be given to their inclusion in the Heritage Interpretation Plan for future stages.	All
NAH6	Archaeology	An archaeological research design(s) would be prepared and implemented identifying archaeological testing or monitoring requirements, which would be carried out in accordance with Heritage Council guidelines, and where appropriate supervised by a suitably qualified Excavation Director with experience in managing State significant archaeology.	All
NAH7	Archaeology	An Archaeological Excavation Report would be prepared by the Excavation Director and be provided to the NSW Heritage Division within two years of the completion of archaeological excavations specified in the archaeological research design(s).	All
NAH8	Archaeology	In the event that State significant archaeology associated with early convict occupation is located at Parramatta metro station: • In situ conservation would be considered. If in situ conservation is not feasible and reasonable, a strategy to mitigate impacts would be prepared in consultation with the NSW Heritage Council (or delegate) • An Archaeological Method Statement would be prepared in consultation with the NSW Heritage Council (or delegate) for management of the archaeological remains, whether for conservation or archaeological investigation and recording • An accessible publication would be prepared within two years of archaeological excavations to document the archaeological investigations • Sydney Metro would provide for the meaningful curation, display and public access of any artefacts collected. This may involve partnerships with museums, local heritage centres and/or universities.	PMS
NAH9	Direct heritage impacts	The impacted gardens within the State Abattoirs would be reinstated with sympathetic landscaping that is in keeping with the provisions of the Conservation Management plan	SOPMS

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (eg tunnel boring machine works); PSR: Power supply routes.

12.6.3 Interactions between mitigation measures

Mitigation measures in other chapters that are relevant to the management of non-Aboriginal heritage impacts include:

- Chapter 11 (Noise and vibration – Stage 1), specifically measures which addresses the management of potential vibration impacts to heritage structures during construction
- Chapter 13 (Aboriginal heritage – Stage 1), specifically measures which address the coordination of non-Aboriginal heritage investigations and Aboriginal archaeological investigations during construction and the management of potential Aboriginal and non-Aboriginal archaeological resources
- Chapter 15 (Landscape character and visual amenity – Stage 1), specifically measures which address the management of potential visual impacts to heritage items during construction
- Chapter 18 (Groundwater and ground movement – Stage 1), specifically measures which address the management of ground settlement
- Chapter 20 (Contamination – Stage 1), specifically measures which address the management of contamination during non-Aboriginal archaeological investigations.

Together, these measures would minimise the potential non-Aboriginal heritage impacts of Stage 1.

There are no mitigation measures identified in the assessment of other environmental aspects that are likely to affect the assessment of non-Aboriginal heritage.

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13 Aboriginal heritage – Stage 1

13 Aboriginal heritage – Stage 1

This chapter provides an assessment of the potential impact on Aboriginal heritage sites and areas of archaeological potential as a result of Stage 1, and identifies mitigation measures to minimise these impacts. This chapter draws on information provided in Technical Paper 4 (Aboriginal cultural heritage assessment report).

13.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to Aboriginal heritage, and where these requirements are addressed in this Environmental Impact Statement, are provided in Table 13-1.

Table 13-1: Secretary's Environmental Assessment Requirements – Aboriginal heritage Stage 1

Reference	Secretary's Environmental Assessment Requirement	Where addressed
6. Aboriginal Heritage		
6.1	Direct and/or indirect impacts (including cumulative impacts) associated with construction to the heritage significance of: a. Aboriginal places, objects and cultural heritage values, as defined under the *National Parks and Wildlife Act 1974* and in accordance with the principles and methods of assessment identified in the current guidelines; and	Section 13.5 to Section 13.14
	b. Aboriginal places of heritage significance, as defined in the Standard Instrument – Principal Local Environmental Plan.	
6.2	Where impacts to Aboriginal objects and/or places are proposed, consultation must be undertaken with Aboriginal people in accordance with the current guidelines.	Section 13.3.2
6.3	The assessment must consider requirements for: a. *in-situ* conservation of items and/or areas;	Section 13.16
	b. the need for further archaeological testing and/or detailed archaeological investigations;	
	c. measures to avoid, minimise and/or mitigate potential impacts	

13.2 Legislative and policy context

The main statutory protection of Aboriginal heritage is provided by the *National Parks and Wildlife Act 1974*. The following guidelines are relevant to the assessment of Aboriginal heritage:

- Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales 2010 (Department of Environment, Climate Change and Water, 2010b) outlines the requirements for archaeological investigations of Aboriginal objects in NSW, and sets out:
  - Assessment steps to be undertaken for all archaeological investigations
  - Analytical steps to characterise the Aboriginal objects being investigated
  - When an Aboriginal Heritage Impact Permit is not required for test excavations
  - Minimum qualifications for persons undertaking archaeological investigations under the code in NSW
- Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW (Office of Environment and Heritage, 2011) provides a process for the investigation and assessment of Aboriginal cultural heritage including identifying values of Aboriginal cultural heritage, and the assessment of potential harm of a proposed activity on Aboriginal objects and declared Aboriginal places. Technical Paper 4 (Aboriginal cultural heritage assessment report) has been prepared in accordance with this guideline
- Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010 (Department of Environment, Climate Change and Water, 2010a) outlines the requirements for proponents to consult with Aboriginal stakeholders during heritage assessment and/or applications for Aboriginal Heritage Impact Permit. The document describes the following four stages with mandatory timeframes:
  - Notification of project proposal and invitation to register interest (14 days for receipt of registrations)
  - Presentation of information about the proposed project
  - Gathering information about cultural significance (allowing 28 days for comments)
  - Review of draft cultural heritage assessment report (allowing 28 days for comments).

  Consultation carried out as part of the assessment has been conducted in accordance with this guideline
- The Burra Charter 2013 (Australia ICOMOS, 2013) provides guidance for the conservation and management of places of cultural significance (cultural heritage places). The Charter sets a standard of practice for those who provide advice, make decisions about, or undertake works to places of cultural significance, including owners, managers and custodians. The Burra Charter provides several significance criteria that attempt to define why a site is important. Such assessment recognises that sites may be important for different reasons to different people, and even at different times. Technical Paper 4 (Aboriginal cultural heritage assessment report) has been developed based on the five values of the Australia ICOMOS Burra Charter (Australia ICOMOS, 2013).

13.3 Assessment approach

13.3.1 Methodology

The Aboriginal heritage assessment comprised:

- A desktop review of archaeological literature and databases to identify listed Aboriginal sites and places including:
  - A search of the Aboriginal Heritage Information Management System (AHIMS) for listed Aboriginal sites, undertaken on 5 December 2019. The results for the AHIMS extensive search area (study area) is shown in Figure 13-1
  - A search of relevant local environmental plans for listed Aboriginal places
- Consultation with registered Aboriginal parties (described in Section 13.3.2)
- Field surveys undertaken in January, March, June and July 2019 at each construction site to identify visible surface evidence of Aboriginal heritage sites and landforms. Additional surveys were undertaken with representatives of the Deerubbin and Metropolitan Local Aboriginal Land Councils in November 2019 (refer to Section 13.3.2)
- Developing a predictive model to assist in determining archaeological potential
- Assessing the significance of the archaeological potential (refer to Section 13.5.3)
- Assessing the potential direct and indirect impacts of Stage 1
- Identifying mitigation measures to minimise the risk of impacting Aboriginal items or areas of Aboriginal cultural sensitivity
- Consultation with Sydney Metro Heritage Working Group to discuss the approach to the Aboriginal heritage assessment.

Direct impacts may occur as a result of activities which disturb the ground surface including site preparation activities, and the installation of services and infrastructure. Indirect impacts may affect sites or features located within the proposed construction sites, or immediately beyond. Indirect harm may include impacts from vibration, increased visitation, increased erosion, or changing access to wild resources.

The majority of Stage 1 construction sites are located within heavily built environments with minimal registered Aboriginal sites within the vicinity. Registered Aboriginal sites which are within the vicinity of Stage 1 construction sites are comprised of artefact sites or areas of potential archaeological deposit which are located below existing development. Any buried Aboriginal objects would not be subject to impacts as a result of vibration. There are no Aboriginal places in the vicinity of the construction sites which may be subject to indirect impacts.

Further details on the Aboriginal heritage assessment methodology are provided in Technical Paper 4 (Aboriginal cultural heritage assessment report).

13.3.2 Aboriginal consultation

Aboriginal community consultation has been conducted in accordance with the Aboriginal cultural heritage consultation requirements for proponents 2010 (Department of Environment, Climate Change and Water, 2010a). Consultation was undertaken with Aboriginal Land Councils, Local Councils and Aboriginal stakeholders in May 2019 to identify Aboriginal people who may hold cultural knowledge relevant to determining the Aboriginal significance of Aboriginal objects and/or places within the Stage 1 study area. Advertisements were also placed in the Koori Mail and Sydney Morning Herald. A total of 59 Aboriginal stakeholder groups registered their interest in the consultation process.

Deerubbin Local Aboriginal Land Council representatives carried out a site survey for construction sites between, and inclusive of, the Westmead metro station construction site and the Clyde stabling and maintenance facility construction site which fall within the boundaries of Deerubbin Local Aboriginal Land Council. It was identified that further assessment should be undertaken within the Clyde stabling and maintenance facility construction site and within the Parramatta metro station construction site.

Metropolitan Local Aboriginal Land Council representatives carried out a site survey for construction sites between, and inclusive of, the Silverwater services facility and The Bays Station construction sites which fall within the boundaries of the Metropolitan Local Aboriginal Land Council. Representatives identified construction sites within the vicinity of water sources as containing potential for archaeological remains given the importance of water as a resource. It was also acknowledged that many of the construction sites had been heavily modified by current development. It was recommended that the telling of Aboriginal stories through heritage interpretation within the future stations should be a priority.

Further consultation would be undertaken with Aboriginal stakeholders during the exhibition of the EIS and any outcomes would be incorporated into the final version of Technical Paper 4 (Aboriginal Cultural Assessment Report).

13.4 Avoidance and minimisation of impacts

The potential for Aboriginal heritage impacts was considered throughout the design development process. This included:

- Avoiding direct impacts to previously recorded Aboriginal sites where possible
- Locating the majority of the Parramatta metro station construction site outside of the known extent of the Parramatta Sand Body, which is known to contain a higher level of archaeological potential (see Section 13.7)
- Development of a tunnel alignment that avoids potential impacts to Aboriginal archaeological remains through excavation below potential archaeological resources.

13.5 Project-wide impacts

13.5.1 Previously registered Aboriginal heritage sites

A total of 238 registered Aboriginal sites were identified across the extensive search areas. Of these, 18 sites have been listed as destroyed, deleted or 'not a site'. The location and distribution of these sites are shown in Figure 13-1 which highlights that:

- Most of the recorded Aboriginal sites are located within the Parramatta CBD area and surrounds
- With the exception of the Westmead metro station and Parramatta metro station construction sites, the construction sites are located away from areas with high concentrations of AHIMS sites.

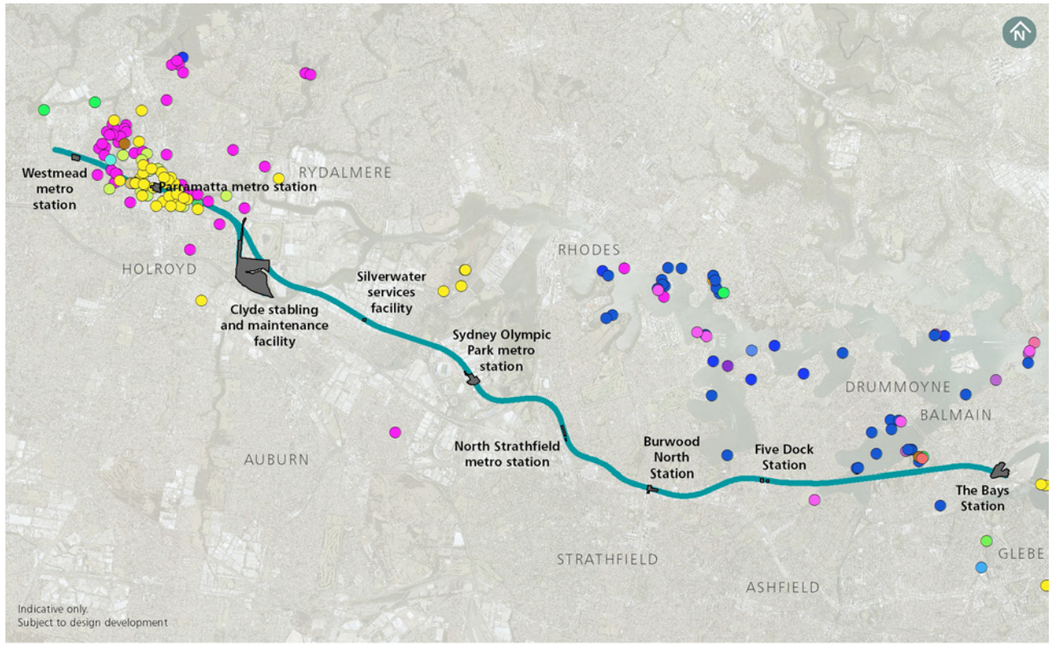

Figure 13-1: Distribution of AHIMS registered sites within the study area

13.5.2 Archaeological potential

While the study area may have been a site of Aboriginal occupation in the past, the likelihood of evidence of this occupation surviving to the present is largely dependent on the nature and extent of disturbance associated with historical construction works, including the durability of the material and the impact of the works. Historical subsurface disturbance such as the removal of topsoil and other bulk earthworks would have substantially lowered the potential for intact archaeological deposits in those areas. This is especially relevant in areas of relatively shallow residual soil, which includes the majority of Stage 1 construction sites. However, surviving portions of deeper soil profiles within Stage 1 may provide stratified evidence of occupation.

Archaeological data gathered in the study area has demonstrated the widespread and varying use of the area by Aboriginal people. Stage 1 is located across a broad range of contexts, including areas in close proximity to marine and estuarine resources, fresh water, varying terrestrial subsistence resources, and areas where sandstone platforms and overhangs may have originally occurred.

The distribution of recorded Aboriginal sites in built environments is largely limited to areas that have been subject to archaeological excavation and/or not impacted by development. The distribution of identified and recorded Aboriginal sites identifies that higher concentrations of stone artefacts tends to be associated with high order watercourses and creek confluences. Aboriginal sites are also associated with sandstone outcrops, including sandstone platforms where engravings are typically identified, and sandstone overhangs that were used for art, subsistence activities and artefact manufacture.

13.5.3 Significance assessment

An assessment of the cultural heritage significance of an item or place is required to form the basis of its management. In accordance with the former Office of Environment and Heritage guidelines and the Burra Charter, significance assessments are required to consider the social value, historic value, scientific value, and aesthetic value of an item or place.

Social values

Aboriginal cultural knowledge was traditionally passed on through oral traditions from generation to generation. Within all Aboriginal communities there was a time of dislocation and upheaval associated with the arrival of colonial settlers. This widespread disruption resulted in much of the detailed knowledge and understanding of many of the elements of the cultural landscape being lost from the Aboriginal community, nonetheless many Aboriginal people maintain a strong connection to the land of their ancestors and collectively possess a wealth of knowledge passed down through the generations.

Consultation has shown that the study area is part of a wider cultural landscape of high cultural significance to many of the registered Aboriginal parties.

Consultation carried out by Sydney Metro during development of Sydney Metro West identified the key people, event and themes related to cultural values within the study area. These are summarised in Table 13-2.

Table 13-2: Identified cultural values within the study area

Theme	Description	Relevant construction sites
Resistance – Pemulwuy & Tedbury	Pemulwuy was a prominent Bedigal warrior who became the leader of a resistance movement across the Cumberland Plain. Tedbury was Pemulwuy's son who continued his resistance campaign following his death.	Parramatta metro station
Bennelong	Influential Wangal man who acted as an envoy between the colonial administration and the Sydney Aboriginal community.	Parramatta metro station
Parramatta Sand Body	Provides a tangible cultural link to the past environment of Parramatta and pre-colonial use of the site. The known Pleistocene deposits provide the opportunity to investigate change in use over time.	Parramatta metro station
Parramatta Road	Originally a Wangal walking track.	Parramatta metro station, Burwood North Station
Maria Lock	Member of the Boorooberongal admitted to the Parramatta Native Institute on 28 December 1814. Married Robert Lock in the first sanctioned marriage between a convict and an Aboriginal woman. Ancestral connection to many Aboriginal families in New South Wales.	Parramatta metro station
Native Institute, Parramatta	Institutional system established by Governor Macquarie following the recommendation of William Shelley. Aboriginal children were removed from their parents to study at the institution.	Parramatta metro station
Native Feasts	A meeting between Governor Macquarie and the local Aboriginal people occurring regularly until 1835.	Parramatta metro station
Parramatta Park	Contains several scarred trees and believed to be a major camping place for the Burramattagal.	Parramatta metro station
Duck River	Known as the border between the Wangal and the Burramattagal.	Clyde stabling and maintenance facility

Historical values

Sydney Metro will seek comment from registered Aboriginal stakeholders with respect to the historic cultural values identified the study area during the public exhibition of the environmental impact statement (refer to Section 13.3.2). The outcomes of this will be documented within the final version of Technical Paper 4 (Aboriginal Cultural Assessment Report).

Indicative archaeological (scientific) values

Scientific value refers to the importance of a landscape, area, place or object because of its rarity, representativeness and the extent to which it may contribute to further understanding and information.

The scientific value of potential Aboriginal archaeology has been considered for each construction site as discussed in sections 13.6 to 13.14.

Aesthetic values

Aesthetic value refers to the sensory value of place, which may include form, texture and colour, and can also include smell and sound elements associated with use or experience of a site (Australia ICOMOS, 2000).

Stage 1 largely comprises a heavily modified residential landscape, which includes substantial modification from its former landscape features. Areas of landscape significance near Stage 1 (such as the Parramatta River) are not considered to maintain a direct connection. Stage 1 is generally considered to contain low aesthetic significance.

13.5.4 Tunnel impacts

There is no potential for Aboriginal objects to be located within the tunnel alignment sections of the route as the tunnels would be excavated through bedrock.

13.5.5 Power supply routes

For most sites, the archaeological potential associated with the power supply routes is considered to be low. The power supply routes between substations and the construction sites are largely located within existing road reserves. These areas have generally undergone a high degree of disturbance or modification as a result on landform modification, road development and installation of existing services. In the majority of these cases, the level of identified disturbance is considered to have removed intact natural soil deposits reducing the archaeological potential of these areas.

Portions of the Parramatta power supply route are located within the identified extent of the Parramatta Sand Body as well as the registered site extent of AHIMS ID 45-5-4097. While substantial disturbances are considered likely to have occurred within the proposed power supply route, it is possible that areas of intact natural soils are present. Intact sands across the power supply route are considered to be archaeologically sensitive. As a result, the Parramatta power supply route has been assessed as demonstrating moderate archaeological potential.

A summary of the indicative scientific significance of the power supply routes is provided in Table 13-3.

Table 13-3: Summary of indicative scientific significance of the power supply routes

Power supply route	Research potential	Scientific value	Representative value	Rarity value	Overall indicative significance assessment
Westmead	Low	Low	Low	Low	Low
Parramatta	Moderate	Moderate	Moderate	Moderate	Moderate
Clyde	Low	Low	Low	Low	Low
The Bays	Low	Low	Low	Low	Low

13.6 Westmead metro station

13.6.1 Archaeological context and recorded sites

The Westmead metro station construction site is located on the broad crest of a low-lying ridge, which is bordered to the north and east by Parramatta River. Large portions of the surface context of the Westmead metro station construction site have been modified through residential and commercial development, as well as road construction and installation of below ground services.

Previous Aboriginal heritage assessments in the area have highlighted the significance of contexts closer to Parramatta River and those areas associated with the Parramatta Sand Body. The generally shallow residual soil across the raised shale and sandstone landform context of the Westmead metro station construction site are susceptible to significant disturbance from residential and commercial development, as well as construction of transport and service infrastructure.

The closest recorded Aboriginal site to the Westmead metro station construction site is an artefact site about 385 metres to the east, in Parramatta Park.

13.6.2 Aboriginal sites recorded during investigations

No areas of surface visibility or intact ground surface were observed during the investigations of the Westmead metro station construction site. No Aboriginal sites were identified during the site inspection.

13.6.3 Impact assessment

No identified Aboriginal sites would be impacted by the proposed works at the Westmead metro station construction site.

The archaeological potential of the Westmead metro station construction site is low. The site has been subjected to substantial levels of surface disturbance, due to the construction of commercial and residential buildings and infrastructure. The site is also located on a crest landform away from major watercourses.

Table 13-4 assesses the indicative scientific significance of the Westmead metro station construction site. Any Aboriginal objects that might be located within the construction site are likely to be within a disturbed context and would therefore be considered to be of low overall scientific significance.

Table 13-4: Summary of indicative scientific significance of the Westmead metro station construction site

Research potential	Scientific value	Representative value	Rarity value	Overall indicative significance assessment
Low	Low	Low	Low	Low

13.7 Parramatta metro station

13.7.1 Archaeological context and recorded sites

The Parramatta metro station construction site is located across a flat landform context within the Parramatta CBD. Extensive commercial development has occurred across the construction site, which is intersected by Horwood Place.

The Parramatta River is located about 290 metres to the north, and Clay Cliff Creek is located about 465 metres to the south-east. Clay Cliff Creek is a significant freshwater watercourse in the Parramatta CBD area, and a tributary of Parramatta River.

Portions of the Parramatta CBD are underlain by a significant geological feature, the Parramatta Sand Body. The Parramatta Sand Body is a significant archaeological resource with evidence of historical Aboriginal activities. The sand body is also relatively deep, increasing the possibility of portions of the sand body surviving beneath phases of previous development.

Previous assessments of the nature and distribution of the Parramatta Sand Body indicate that it may overlap with the eastern portion of the Parramatta metro station construction site.

Previous archaeological investigations demonstrate that the former natural ground surface in the Parramatta metro station construction site may remain in situ, with varying degrees of truncation and mixing from historical activities. Previous investigations also suggest the potential for contact archaeology, but artefact density is likely to vary across the site.

One Aboriginal site is recorded within the Parramatta metro station construction site (AHIMS ID 45-6-3582), described as an area of potential archaeological deposit covering 48 Macquarie Street and 220-230 Church Street. The recorded item has been identified as having moderate to high archaeological (scientific) significance. The item, and the surrounding area, has also been identified as being significant to Aboriginal people.

13.7.2 Aboriginal sites recorded during investigations

No areas of surface visibility or intact ground surface were observed during the Stage 1 investigations. No Aboriginal sites were identified during the site inspection.

13.7.3 Impact assessment

One recorded area of archaeological potential is located within the Parramatta metro station construction site (AHIMS ID 45-6-3582). Stage 1 construction works could result in direct impact to this item, resulting in a total loss of value of the item.

A program of archaeological testing and salvage excavation, prepared in consultation with registered Aboriginal parties, would need to be undertaken at Parramatta metro station construction site (including AHIMS ID 45-6-3582) prior to works that may impact the natural ground surface beneath the extant built structures. If Aboriginal archaeological remains are recovered during this process, results would be incorporated into Aboriginal heritage interpretation for the Concept.

The assessed archaeological potential is moderate to high. The location of Parramatta, adjacent to a permanent watercourse, and with access to a wide range of natural resources, means that archaeological evidence of Aboriginal occupation could be extensive. Levels of previous disturbance are likely to vary across the site depending on the level of surface works undertaken, with historical construction activities potentially resulting in the disturbance or removal of archaeological record. However, the Parramatta Sand Body has the potential to contain a stratified deposit that documents long term Aboriginal occupation and changes in climatic and other environmental conditions.

Table 13-5 assesses the indicative scientific significance of the Parramatta metro station construction site. The works at the Parramatta metro station construction site are within an area of moderate-high archaeological potential and significance, and are therefore likely to impact Aboriginal objects.

Table 13-5: Summary of indicative scientific significance of the Parramatta metro station construction site

Research potential	Scientific value	Representative value	Rarity value	Overall indicative significance assessment
Moderate – high	Moderate – high	Moderate	Moderate	Moderate – high

13.8 Clyde stabling and maintenance facility

13.8.1 Archaeological context and recorded sites

The Clyde stabling and maintenance facility construction site is situated across flat terrain which is bisected by Duck Creek and A'Becketts Creek. Soil landscape mapping suggests the area is largely comprised of disturbed terrain associated with the infill of former estuarine lands.

The Clyde stabling and maintenance facility construction site is currently comprised of mixed industrial and urban services uses. Although the site has generally been subject to extensive landform modification associated with development of these uses, historical aerial photographs suggest that a small portion of the Clyde stabling and maintenance facility construction site has not been subject to substantial disturbance. This area of potentially less disturbance includes the grassed area within the western portion of the NSW Government owned Sydney Speedway site.

Previous archaeological assessments undertaken for sites near the Clyde stabling and maintenance facility have assessed the area as being 'grossly modified' by historical land use activities and concluded the area is heavily disturbed and that potential impacts to Aboriginal objects was considered to be negligible. While the majority of studies in the area have focused on the surrounding heavily modified landscapes, Aboriginal heritage assessments have identified the Duck River and Duck Creek junction as containing some archaeological sensitivity.

The closest recorded Aboriginal site to the Clyde stabling and maintenance facility construction site is AHIMS ID 45-6-2554, an artefact site recorded about 450 metres to the north-west.

13.8.2 Aboriginal sites recorded during investigations

The proposed Clyde stabling and maintenance facility construction site is located across a mixed industrial and urban services environment. Observations of the construction site indicated that the majority of the site was comprised of a heavily disturbed industrial environment.

13.8.3 Impact assessment

No identified Aboriginal sites would be impacted by the proposed works at the Clyde stabling and maintenance facility construction site.

The majority of the construction site has been assessed as having low potential for archaeological as the site has been substantially disturbed by former development.

A small portion of the NSW Government owned Sydney Speedway has been identified as relatively intact landform based on the lack of historical development. In this portion of the site, it is considered that there is a low-moderate potential for Aboriginal objects related to intact or redeposited soils to be present. The archaeological deposit may consist of an intact former ground surface located in close proximity to significant local watercourses, Duck Creek and A'Becketts Creek. Aboriginal sites may be associated with this area of archaeological potential. If intact natural profiles with the potential to contain significant archaeological deposits are encountered in this location, archaeological test excavation (and salvage when required) would be carried out. If Aboriginal archaeological remains are recovered during this process, results would be incorporated into Aboriginal heritage interpretation for the Concept.

Table 13-6 assesses the indicative scientific significance of the Clyde stabling and maintenance facility construction site. The works at the Clyde stabling and maintenance facility construction site are likely to impact areas of low-moderate archaeological potential and moderate archaeological significance. Works may therefore impact unknown Aboriginal objects.

Table 13-6: Summary of indicative scientific significance of the Clyde stabling and maintenance facility construction site

Research potential	Scientific value	Representative value	Rarity value	Overall indicative significance assessment
Low – moderate	Moderate	Moderate	Moderate – high	Moderate

13.9 Silverwater services facility

13.9.1 Archaeological context and recorded sites

The Silverwater services facility construction site is located on a gently sloped landform associated with a low-lying shale ridgeline. The construction site is located within the vicinity of several watercourses including Duck River and Haslams Creek.

The construction site is within an industrial and commercial area with the construction site formerly used as a warehouse facility. Historical aerial photographs indicate the former warehouse was demolished between 2007 and 2009. Following this, fill material was placed across the surface of the site with additional fill stockpiled in the north east corner. There is also evidence that excavation was undertaken related to pipe installation.

Archaeological implications of the soil landscape within the construction site are that the residual Blacktown soils represent a moderately deep soil with limited erosion characteristics in areas with ground cover, so unless removed or disturbed through commercial/road/infrastructure development or by extreme erosion events, archaeological material is likely to remain relatively intact.

The closest recorded Aboriginal site to the Silverwater services facility construction site is AHIMS ID 45-6-2786, potential archaeological deposit about 1.5 kilometres to the north-east in the Millennium Parklands, Sydney Olympic Park.

13.9.2 Aboriginal sites recorded during investigations

The Silverwater services facility construction site is comprised of a vacant lot with evidence of earthworks and filling across the site. No Aboriginal sites were identified during the site investigation.

13.9.3 Impact assessment

No identified Aboriginal sites would be impacted by the proposed works at the Silverwater services facility construction site.

The combination of landform context and likely disturbance indicates the overall archaeological potential of the Silverwater services facility construction site is low. The construction of warehouse facilities across the construction site, as well as recent demolition and pipeline works is likely to have significantly impacted or removed the former ground surface context. The construction site is 770 metres away from its closest water source and does not exhibit other archaeologically sensitive landscape features.

Table 13-7 assesses the indicative scientific significance of the Silverwater services facility construction site. Any Aboriginal objects that might be located within the impact area are likely to be within a disturbed context and would therefore be considered to be of low archaeological significance.

Table 13-7: Summary of indicative scientific significance of the Silverwater services facility construction site

Research potential	Scientific value	Representative value	Rarity value	Overall indicative significance assessment
Low	Low	Low	Low	Low

13.10 Sydney Olympic Park metro station

13.10.1 Archaeological context and recorded sites

Sydney Olympic Park is located on broad and gently undulating ridge crest landform context. The ridge is bordered by Haslams Creek to the west, Powells Creek to the east, and Homebush Bay to the north. Both creek corridors were likely to have originally been associated with surrounding creek flats and tidally influenced mangrove areas. However, large portions of each watercourse south of Homebush Bay have been in-filled, canalised and modified. Mangrove areas and associated creek flats have been restored around Powells Creek as part of Bicentennial Park.

The Sydney Olympic Park metro station construction site has been heavily modified for commercial development. Large-scale landform modification is evident around the periphery of the existing buildings and structures, with raised accessways and landscaped set-backs for each building.

Previous archaeological investigations in the area indicate the potential for generally high levels of surface disturbance to the former natural ground surface from historical land-use activities, including extensive bulk earthworks and construction of built infrastructure.

The closest recorded Aboriginal site to the Sydney Olympic Park metro station construction site is about 1.8 kilometres to the south-west in Phillips Park, Lidcombe.

13.10.2 Aboriginal sites recorded during investigations

Areas of surface visibility were observed within modified garden areas in the vicinity of commercial buildings. No Aboriginal sites were identified during the site investigation.

13.10.3 Impact assessment

No identified Aboriginal sites would be impacted by the proposed works at the Sydney Olympic Park metro station construction site.

The combination of landform and likely disturbance indicates that the overall archaeological potential of the Sydney Olympic Park metro station construction site is low. The Sydney Olympic Park metro station construction site is located on a crest landform context away from major watercourses. The construction of commercial structures across the construction site, as well as associated road and underground services, is likely to have significantly impacted or removed the former ground surface context.

Table 13-8 assesses the indicative scientific significance of the Sydney Olympic Park metro station construction site. Any Aboriginal objects that might be located within the impact area are likely to be within a disturbed context and would therefore be considered to be of low archaeological significance.

Table 13-8: Summary of indicative scientific significance of the Sydney Olympic Park metro station construction site

Research potential	Scientific value	Representative value	Rarity value	Overall indicative significance assessment
Low	Low	Low	Low	Low

13.11 North Strathfield metro station

13.11.1 Archaeological context and recorded sites

North Strathfield metro station is located on a gently sloping landform context bordering a broad and low-lying sandstone ridge about 200 metres to the east. The North Strathfield metro station construction site is divided into two sites (the northern construction site and southern construction site), both within the eastern margin of the existing rail line corridor.

The northern construction site consists mainly of a raised artificial embankment and cleared landing created during construction of the North Strathfield underpass portion of the Northern Sydney Freight Corridor project. The southern construction site is a paved facilities area that was also constructed for the North Strathfield underpass.

Tidally influenced areas are located about 300 metres to the west of the North Strathfield metro station construction site. This area has however been heavily modified and partially in-filled for industrial and residential development.

Previous archaeological investigations in the broader area indicate the potential for previous significant disturbance to archaeologically sensitive areas from historical land-use activities, including reclamation and construction of built infrastructure.

The closest recorded Aboriginal site to the North Strathfield metro station is AHIMS ID 45-6-2324, a shell site located about 2.2 kilometres to the north-east.

13.11.2 Aboriginal sites recorded during investigations

The North Strathfield metro station construction site consists of modified flat surfaces used for access to the rail corridor, car parking, and stockpiling. No Aboriginal sites were identified during the site investigation.

13.11.3 Impact assessment

No identified Aboriginal sites would be impacted by the proposed works at the North Strathfield metro station construction site.

The combination of landform context and likely disturbance indicates that the overall archaeological potential of the North Strathfield metro station construction site is low. The North Strathfield metro station construction site is located on a crest landform context away from major watercourses. The construction of commercial structures across the construction site, as well as associated road and underground services, is likely to have significantly impacted or removed the former ground surface context.

Table 13-9 assesses the indicative scientific significance of the North Strathfield metro station construction site. Any Aboriginal objects that might be located within the impact area are likely to be within a disturbed context and would therefore be considered to be of low archaeological significance.

Table 13-9: Summary of indicative scientific significance of the North Strathfield metro station construction site

Research potential	Scientific value	Representative value	Rarity value	Overall indicative significance assessment
Low	Low	Low	Low	Low

13.12 Burwood North Station

13.12.1 Archaeological context and recorded sites

Burwood North Station construction site is divided into two sites (northern construction site and southern construction site) which are both located at the eastern base of a low-lying sandstone and shale ridgeline, immediately west of a low-lying area that would likely have consisted of tidally influenced estuarine lowlands prior to in-filling and levelling to create playing fields and open recreational space. The tidally influenced watercourse through the low-lying area has been canalised, directing water north into Canada Bay from Parramatta Road near the intersection with Luke Avenue.

Areas near the Burwood North Station construction sites may contain archaeological evidence relating to Aboriginal land-use activities, including areas adjacent to watercourses and foreshore areas, such as Canada Bay and the former tidally influenced area to the east and north-east, prior to reclamation and creation of St Luke's Park, and areas that have not been heavily developed and modified.

However, previous archaeological investigations in the area indicate the potential for significant disturbance to archaeologically sensitive areas from historical land-use activities, including reclamation and construction of built infrastructure.

The closest recorded Aboriginal site to the Burwood North Station construction sites is about 1.5 kilometres to the north-east, on the foreshore of Hen and Chicken Bay.

13.12.2 Aboriginal sites recorded during investigations

No areas of surface visibility or intact ground surface were observed during the investigation of the Burwood North Station construction sites. No Aboriginal sites were identified during the site investigation.

13.12.3 Impact assessment

No identified Aboriginal sites would be impacted by the proposed works at the Burwood North Station construction sites.

The combination of landform context and likely disturbance indicates the overall archaeological potential of the Burwood North Station construction sites is low.

The construction of commercial structures and associated infrastructure across the construction sites is likely to have impacted or removed the former ground surface context.

Prior to the current phase of commercial development across the northern and southern construction sites, the area consisted of 20th century detached houses. Construction of early 20th century houses on detached blocks is not likely to have significantly modified the natural landform context, with disturbance generally limited to foundation excavation, drainage, and landscaping activities. The subsequent phase of commercial development is likely to have significantly impacted natural soil contexts.

An exception to this potential disturbance is the existing car park of the Pine Inn within the northern construction site. The rear car park extends across a former residential block to Burton Street, however the impacts to the original ground surface associated with demolition of the former residential structure and ground preparation for construction of the car park is unknown. As such, there is potential for undisturbed natural ground to remain underneath the sealed car park surface.

Table 13-10 assesses the indicative scientific significance of the Burwood North Station construction sites. Any Aboriginal objects that might be located within the impact area are likely to be within a disturbed context and would therefore be considered to be of low archaeological significance.

Table 13-10: Summary of indicative scientific significance of the Burwood North Station construction sites

Research potential	Scientific value	Representative value	Rarity value	Overall indicative significance assessment
Low	Low	Low	Low	Low

13.13 Five Dock Station

13.13.1 Archaeological context and recorded sites

Five Dock Station construction site comprises two sites (the western construction site and the eastern construction site) located on the upper slopes of a low-lying ridge. The ridge line extends to the north-west, forming the Drummoyne peninsula, and is bordered to the east by Iron Cove and the west by Canada Bay. Large portions of the surface context of the Five Dock Station western construction site have been modified through commercial development, road construction and installation of below ground services. The Five Dock Station eastern construction site has similarly been modified through substantial residential development.

The closest watercourse is Iron Cove Creek, located about 615 metres to the south of the Five Dock Station construction sites. Iron Cove Creek is canalised in this area. There is also a canalised watercourse that flows north into Kings Bay via an infilled estuarine area about one kilometre to the west.

Previous archaeological investigations carried out for the M4 East Motorway generally indicate the land has been subject to significant disturbance from residential development, and construction of transport and service infrastructure, and therefore has low ground integrity.

The closest recorded Aboriginal site to the Five Dock Station construction sites is a midden site recorded on the foreshore of Hen and Chicken Bay, and about 770 metres to the north-west.

13.13.2 Aboriginal sites recorded during investigations

No areas of surface visibility or intact ground surface were observed during the investigation of the Five Dock Station construction sites. No Aboriginal sites were identified during the site investigation.

13.13.3 Impact assessment

No identified Aboriginal sites would be impacted by the proposed works at the Five Dock Station construction sites.

The Five Dock Station construction sites are located on a crest landform context away from watercourses. For these reasons, the assessed archaeological potential is low.

The construction of buildings and associated infrastructure across the construction sites is likely to have impacted or removed the former ground surface context. The relatively shallow residual soil at the Five Dock Station construction sites are susceptible to minor surface disturbance associated with building or road construction. The former ground surface is likely to have been significantly impacted by works at the site.

Table 13-11 assesses the indicative scientific significance of the Five Dock Station construction sites. Any Aboriginal objects that might be located within the impact area are likely to be within a disturbed context and would therefore be considered to be of low archaeological significance.

Table 13-11: Summary of indicative scientific significance of the Five Dock Station construction sites

Research potential	Scientific value	Representative value	Rarity value	Overall indicative significance assessment
Low	Low	Low	Low	Low

13.14 The Bays Station

13.14.1 Archaeological context and recorded sites

At the time of European colonisation, White Bay was likely formed of estuarine mudflats which were mostly inundated at high tide. Maps from the 1850s and earlier describe much of the natural edge of White Bay as 'marsh covered at spring tide'. The southern part of the construction site, occupied by Glebe Island, had a rocky foreshore. The Balmain peninsula is formed of Hawkesbury Sandstone and was typically characterised by stepped ridges leading away from the foreshore. Hawkesbury Sandstone areas, such as the Balmain Peninsula, are valuable resources for flaked stone artefacts, as conglomerate quartz pebbles are frequent. Silcrete and basalt, which are widely used for the construction of stone tools, are also frequently available in coastal areas.

From 1851, the Balmain peninsula was subdivided and extensive development occurred. Prior to the subdivision much of the land would have been cleared. Simultaneously, maritime and noxious industries began along White Bay and Glebe Island. In 1912, the Mullens Street resumption area was resumed by the government, and White Bay foreshore was developed in the area. Extensive land reclaiming occurred, with the former White Bay Power Station, ports, and a rail line constructed primarily on reclaimed land. The foreshore outline was heavily modified during this time. Large portions of the sandstone headland of Glebe Island's northern side were quarried and the ground was levelled across the area to become only slightly above sea level. Successive phases of foreshore reclamation involved significant infilling to create a level surface on top of largely intertidal land.

Within areas of reclaimed land, the natural soil has typically been removed, buried, or greatly disturbed. Geotechnical investigations however have shown that when infilling has occurred, the natural foreshore soils can be preserved at considerable depths of up to 2.8 metres below current ground level.

The closest recorded Aboriginal site to The Bays Station construction site is AHIMS ID 45-6-2278, a PAD site located approximately 650 metres to the east.

Numerous Aboriginal sites are recorded around the less disturbed sandstone foreshores of Sydney Harbour, including the northern margin of Balmain Peninsula, Balls Head, and the foreshore of Cremorne and Mosman. Site types include shell midden in both open and closed (shelter) contexts, and art (pigment or engraved) features.

The White Bay area has been subject to significant landform modification, including the almost complete reduction of Glebe Island and a large program of reclamation to modify the shoreline and create new level ground for the Glebe Island Container Terminal and the former White Bay Power Station.

The lack of recorded Aboriginal sites associated with the White Bay and Johnstons Bay foreshores may be a result of the heavily modified nature of the shoreline in this area, and the subsequent lack of natural ground surface exposures. Particularly, large-scale modification of the foreshore area has the potential to remove, mix, or bury archaeological remains beneath layers of fill. Previous archaeological assessments in the area therefore confirm the potential effects of historical landform modification activities on the archaeological record.

13.14.2 Aboriginal sites recorded during investigations

The Bays Station construction site is largely located within a modified flat landform adjacent to the White Bay foreshore. The majority of the construction site is comprised of hardstand and grassed areas. A large earth stockpile is located in the southern portion of the construction site. No Aboriginal sites were identified during the site investigation.

13.14.3 Impact assessment

There is no archaeological potential for Aboriginal remains within much of The Bays Station construction site, including the entirety of the northern and eastern parts of the construction site. This assessment is due to much of the site being reclaimed land, and while there may have been Aboriginal remains on the south-eastern parts of the construction site, within the natural foreshore of Glebe Island, extensive quarrying and land modification would have destroyed the archaeological potential.

The White Bay region would have been a suitable location for Aboriginal occupation, surrounded by valuable marine and plant resources, close to reliable water sources, near ridges and cliffs, and close to raw materials suitable for the construction of stone tools. Despite these environmental landscape factors that could suggest high potential, the preservation of in situ artefactual deposits associated with Aboriginal occupation is dependent on the degree of ground disturbance in the area since European colonisation.

Extensive historical occupation after European colonisation of Sydney has resulted in phases of demolition, construction, land clearance and modification which has had a significant impact on Aboriginal cultural heritage. However, there is also potential for reclamation fills during the 19th and 20th centuries to be present, and archaeological research has demonstrated that particular soils, particularly alluvial deposits and sand bodies, may retain archaeological and artefactual deposits if found intact. While there is still potential for Aboriginal archaeological remains to be found out of context in these disturbed areas and retain their cultural value, their scientific research potential is diminished.

There is low to moderate archaeological potential for Aboriginal remains to be preserved in the south-western part of the construction site, where infilling associated with the land reclamation may have preserved intact archaeological deposits. In the area of the natural estuarine foreshore of White Bay, Aboriginal occupation would not have occurred, however if preserved alluvial soils are found intact, they could provide further evidence about the resources available to Aboriginal people in the area. Furthermore, the area immediately beyond the marsh areas, where the White Bay Hotel was later built, would have been an area of high likelihood for Aboriginal occupation. The construction of the White Bay Hotel would have disturbed the ground surface, however, there remains a moderate potential for reclamation fills from this period to be present, and these fills would be rich in artefacts. If intact natural profiles with the potential to contain significant archaeological deposits are encountered in this location, archaeological test excavation (and salvage when required) would be carried out. If Aboriginal archaeological remains are recovered during this process, results would be incorporated into Aboriginal heritage interpretation for the Concept.

Table 13-12 assesses the indicative scientific significance of The Bays Station construction site. The Bays Station construction site includes an identified area of low to moderate archaeological potential and an area of moderate archaeological significance, and construction works therefore may impact unknown Aboriginal objects.

Table 13-12: Summary of indicative scientific significance of The Bays Station construction site

Research potential	Scientific value	Representative value	Rarity value	Overall indicative significance assessment
Low – moderate	Moderate	Moderate	Moderate – high	Moderate

13.15 Cumulative impacts

Potential cumulative impacts were considered for assessment based on the likely interactions of Stage 1 with other projects and plans that met the adopted screening criteria. The approach to assessment and the other projects considered are described further in Appendix G (Cumulative impacts assessment methodology – Stage 1).

A cumulative impact takes into consideration incremental impacts to Aboriginal cultural heritage values resulting from past, present and foreseeable future actions in a particular area or region. Where Aboriginal objects are identified in association with intact contexts, such as the intact foreshores at The Bays Station construction site, the cumulative impacts in the local setting would be higher. This is because the recorded Aboriginal archaeological resource in these areas is generally very limited. The identification of Aboriginal objects associated with intact contexts would possibly demonstrate high research potential, rarity values and representative values in the local setting, and potentially in a regional context depending on the nature of the archaeological resource.

A review of other projects that could affect Aboriginal objects or areas of archaeological potential identified the potential for cumulative impacts to occur at the following Stage 1 construction sites:

- Parramatta metro station and the proposed power supply route
- The Bays Station.

Parramatta metro station

Areas of high archaeological potential within Parramatta are largely associated with areas near watercourses and the mapped extent of the Parramatta Sand Body. A large area of high potential is located within the Parramatta CBD approximately bound by the Parramatta River in the north and Hunter Street in the south. High levels of redevelopment within this area, including development of Parramatta Square, Parramatta Leagues Club and Parramatta Light Rail, has resulted in the continued reduction of the potential archaeological resource. Further proposed development including the New Powerhouse Museum, as well as development at 89 George Street, 116 Macquarie Street and 7 Charles Street would, if carried out, result in further depletion of this resource.

Construction works at the Parramatta metro station construction site and the proposed power supply route would result in a further reduction in the archaeological potential of the region. The nature of the cumulative impact would be dependent on the scientific cultural significance of the Aboriginal objects identified.

The Bays Station

The Bays area is undergoing significant development, including transport links and industrial development. The existing environment surrounding the construction site is a combination of industrial and maritime development with much of the land within The Bays Station construction site comprising reclaimed foreshore.

There are a number of other projects near The Bays Station construction site. While most of these assessments have not identified Aboriginal heritage within their assessment areas, the environmental impact assessment of the Western Harbour Tunnel and Warringah Freeway Upgrade project has identified areas of Aboriginal archaeological potential.

A Preliminary Aboriginal Heritage Assessment was also prepared to inform The Bays Precinct Urban Transformation, and identified areas of Aboriginal archaeological potential near The Bays Station construction site.

If Aboriginal objects are identified during further investigations for The Bays Station construction site and the Western Harbour Tunnel and Warringah Freeway Upgrade or The Bays Precinct Urban Transformation projects then there may be a cumulative impact. The nature of the cumulative impact would be dependent on the scientific and cultural significance of the Aboriginal objects identified.

13.16 Management and mitigation measures

13.16.1 Approach to management and mitigation

Aboriginal heritage impacts from Stage 1 would be managed in accordance with the Construction Environmental Management Framework. Of relevance, the Construction Environmental Management Framework includes heritage management objectives to minimise impacts on items or places of heritage value, avoid accidental impacts on heritage items, and maximise workers' awareness of Aboriginal and non-Aboriginal heritage.

The Construction Environmental Management Framework also requires the preparation and implementation of a Heritage Management Plan, including as a minimum:

- Procedures for undertaking any recordings of heritage items prior to works commencing
- Procedures for unexpected heritage finds
- Heritage monitoring requirements.

More details of the Construction Environmental Management Framework are provided in Chapter 27 (Synthesis of the Environmental Impact Statement).

13.16.2 Mitigation measures

The mitigations measures that would be implemented to address potential Aboriginal heritage impacts are described in Table 13-13.

Table 13-13: Mitigation measures – Aboriginal heritage Stage 1

Reference	Impact/issue	Mitigation measure	Application location(s)[1]
AH1	Consultation	Aboriginal stakeholder consultation would be carried out in accordance with the NSW Department of Planning, Industry and Environment's (Environment, Energy and Science Group), Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010.	All
AH2	Test excavation	Archaeological test excavation (and salvage when required) would be carried out where intact natural profiles with the potential to contain significant archaeological deposits are encountered at the specified construction sites and the Parramatta power supply route. Excavations would be conducted in accordance with the methodology outlined in the Aboriginal cultural heritage assessment report.	PMS, CSMF, TBS and PSR
AH3	Aboriginal heritage interpretation	If Aboriginal archaeological remains are recovered during Stage 1, results would be incorporated into Aboriginal heritage interpretation for the Concept in consultation with registered Aboriginal parties.	All
AH4	Unexpected finds	In the event that a potential burial site or potential human skeletal material is exposed during construction, the Sydney Metro Exhumation Management Plan would be implemented.	All

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (eg tunnel boring machine works); PSR: Power supply routes.

13.16.3 Interactions between mitigation measures

Mitigation measures in other chapters that are relevant to the management of Aboriginal heritage impacts include:

- Chapter 12 (Non-Aboriginal heritage), specifically measures which address the management of interaction of Aboriginal and non-Aboriginal archaeological resources
- Chapter 20 (Contamination - Stage 1), specifically measures which address the management of contamination during Aboriginal archaeological investigations.

Together, these measures would minimise the potential Aboriginal heritage impacts of Stage 1.

There are no mitigation measures identified in the assessment of other environmental aspects that are likely to affect the assessment of Aboriginal heritage impacts.

14 Property and land use – Stage 1

14 Property and land use – Stage 1

This chapter assesses the potential impacts of Stage 1 on property and land use and identifies mitigation measures to minimise these impacts.

14.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relevant to property and land use, and reference to where they are addressed in this chapter and in the Environmental Impact Statement, are provided in Table 14-1.

Table 14-1: Secretary's Environmental Assessment Requirements – Property and land use Stage 1

Reference	Secretary's Environmental Assessment Requirements	Where addressed
3. Social and Economic (including property, land use and business impacts)		
3.4	Commitments made in Section 9.5.2 of the Scoping Report; and land use compatibility (including potential restrictions on future development, both above-ground and sub-surface);	This chapter Sections 14.5 to 14.14
3.5	permanent and temporary property acquisition, including easement acquisition; and temporary or permanent leasing arrangements;	Section 14.5 Section 14.6 to 14.14
3.6	temporary loss of public open space; and	Chapter 17 (Social impacts – Stage 1)
3.7	disruption to utilities and services.	Chapter 9 (Stage 1 description)

14.2 Legislative and policy context

Relevant legislation and planning instruments (including the *Environmental Planning and Assessment Act 1979*, State environmental planning policies and local environmental plans) are described in Chapter 4 (Planning and assessment process). NSW Government land use planning strategies relevant to the study area and Stage 1 are described in Chapter 2 (Strategic need and justification), with further discussion provided in Section 8.8 (Concept environmental assessment – Property and land use).

14.3 Assessment approach

This assessment involved:

- Describing the existing environment with reference to existing land uses and planning controls based on a review of aerial photography, land use zones specified by applicable local environmental plans and a land use and business survey
- Reviewing key strategy and policy documentation relevant to each study area, in order to identify planned future land use priorities and developments
- Assessing the potential impacts of Stage 1 on property and land use in and around the construction footprint, including:
  - Permanent property acquisition to enable Stage 1
  - Temporary acquisition or leasing of property for Stage 1
  - Direct impacts on other infrastructure during construction including utilities and Sydney Trains property
- Identifying mitigation measures to avoid or manage potential impacts.

This assessment builds on the existing environment and concept level impact assessment provided in Section 8.8 (Concept environmental assessment – Property and land use).

14.4 Avoidance and minimisation of impacts

The design development of Stage 1 has included a focus on avoiding or minimising potential impacts on property and land use. This has included:

- Minimising the extent of construction sites and the need for private property acquisition
- Where possible, using existing Government owned land to avoid or reduce the need for private property acquisition. For example, the sites at North Strathfield and The Bays are wholly located on existing Government owned land
- Locating construction sites where permanent operational infrastructure would also be required, to minimise temporary property impacts and residual land at the completion of construction
- Designing construction sites within existing cadastral boundaries where possible to minimise the need for partial acquisitions
- Adopting an east-west orientation for the station and tunnel alignment at Westmead to help safeguard future development in the health and education precinct to the north of the existing Westmead Station. An alternative north-south station alignment would have potentially constrained development to the north due to the presence of underground metro infrastructure
- Adopting an east-west orientation for the station and tunnel alignment at Parramatta to ensure the station would integrate with the future Civic Link, connecting Parramatta Square to Parramatta River
- Aligning Sydney Olympic Park metro station with future land use planning as outlined in the Sydney Olympic Park Master Plan 2030 (Sydney Olympic Park Authority, 2018) and positioning the construction site to minimise delaying adjacent developments
- Adopting an east-west alignment of the station at Burwood North to minimise residential property acquisition
- Use of a mined binocular cavern design and construction method for Five Dock Station to minimise residential property acquisition
- Aligning The Bays Station with land use planning and directions set out in The Bays Precinct Sydney Transformation Plan (Urban Growth NSW, 2015).

Key design aspects that have avoided or minimised property and land use impacts are highlighted for each Stage 1 construction site in Sections 14.6 to 14.14.

14.5 Project-wide impacts

14.5.1 Aboveground construction sites

During Stage 1, the main property impact would be the acquisition of property for construction sites proposed for tunnel and station excavation, service facilities and the stabling and maintenance facility. Most of the sites required to support construction are also associated with the permanent operational footprint of the Concept (included in future stages).

Property Acquisition is currently underway across all sites between Westmead and The Bays. Property acquisition is managed in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and the land acquisition reforms announced by the NSW Government, which can be viewed online at (www.propertyacquisition.nsw.gov.au/).

Sydney Metro has appointed Personal Managers to offer residents and small businesses assistance and support throughout the acquisition process.

Where Stage 1 requires the permanent use of NSW Government owned land (including Crown land) or council owned land, Sydney Metro would enter into agreements with the relevant NSW Government departments or the relevant council regarding the permanent use of this land – including acquisition or lease arrangements.

Sections 14.6 to 14.14 provide a description of the land use context for each construction site.

Construction activities could result in potential temporary amenity related impacts to adjacent land uses. These impacts have been assessed in the relevant chapters of this Environmental Impact Statement including Chapter 10 (Transport and traffic – Stage 1), Chapter 11 (Noise and vibration – Stage 1), Chapter 15 (Landscape character and visual amenity – Stage 1), and Chapter 23 (Air quality – Stage 1). Impacts on surrounding businesses and the local community more broadly are discussed in Chapter 16 (Business impacts – Stage 1) and Chapter 17 (Social impacts – Stage 1) respectively.

14.5.2 Underground land

It would be necessary to acquire land below the surface of properties for the construction of the tunnels. This is referred to as substratum acquisition and is undertaken in accordance with the *Transport Administration Act 1988*.

Following approval of Stage 1, development applications within the approved corridor would be referred to Sydney Metro for concurrence so that Sydney Metro West infrastructure is not impacted by future development activities. In most cases, subsurface acquisition does not affect the continued existing uses or intended future uses of property at the surface. Subject to Council regulations, landowners would generally be able to excavate foundations for a new dwelling or for second storey additions or carry out improvements such as installing a swimming pool. Based on proposed tunnel depths there would be a minor impact with respect to limiting future development potential above Sydney Metro West infrastructure.

This subsurface layer (or substratum) would be an acquisition envelope around the tunnels, including an allowance for any rock anchors to enable safe construction and long term protection of the tunnels. Figure 14-1 illustrates how subsurface acquisition works. The Stage 1 alignment is generally shallowest at stations and at the tunnel portal with depth typically increasing between stations.

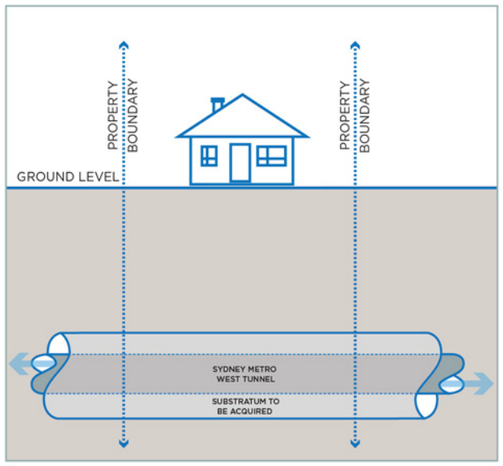

Figure 14-1: Example of substratum acquisition

14.5.3 Commonwealth land

As described in Chapter 4 (Planning and assessment process), impacts to Commonwealth land must be assessed in accordance with the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Commonwealth land includes properties occupied but not owned by Commonwealth agencies under commercial lease arrangements. No Commonwealth land would be impacted by the Stage 1 construction sites.

14.6 Westmead metro station

14.6.1 Land use context

The Westmead metro station construction site is in an area of low and medium density residential development and includes local retail and business premises.

Land uses surrounding the Westmead metro station construction site include the following:

- North of the existing Westmead Station is the Westmead town centre and the health and education precinct including Westmead Hospital. Westmead town centre includes a range of businesses providing commercial and retail services, many which are focussed on medical services such as medical centres, consulting rooms, specialist health services, and health offices and interspersed with retail such as cafes
- North-east of the site, beyond the existing rail corridor, is a medium density residential area with apartments of three to four storeys. North-west of the site is Western Sydney University's Westmead Campus, a tertiary education area which is currently under development
- East of the site predominantly includes medium density residential apartments, with Parramatta Park beyond the residential area
- South of the site is a largely residential area, which includes mostly medium density residential buildings
- West of the site is lower density housing, with the Westmead Public School immediately to the south-west of the site.

Land uses within and surrounding the construction site are shown in Figure 14-2.

Figure 14-2: Westmead metro station construction site – Existing land uses

14.6.2 Planning controls

The existing rail corridor forms the boundary between two local government areas at the Westmead metro station construction site – the City of Parramatta Council to the north and Cumberland Council to the south.

To the north of the existing rail corridor, land use is controlled by the Parramatta Local Environmental Plan 2011 (Parramatta LEP 2011). The Parramatta LEP 2011 defines the land use zoning in this area as a mix of the following zones: B4 Mixed Use, SP2 Infrastructure (Health Services Facility), SP2 Infrastructure (Educational Establishment) and R4 High Density Residential.

To the south of the existing rail corridor, land use is controlled by the Holroyd Local Environmental Plan 2013 (Holroyd LEP 2013), which is within the Cumberland local government area. The Holroyd LEP 2013 defines the land use zoning south of the existing rail corridor as a mix of R2 Low Density Residential and the R4 High Density Residential zones. Land immediately to the west of the construction site is zoned R2 Low Density Residential.

The Westmead metro station construction site is on land zoned SP2 Infrastructure (Rail Infrastructure Facility) and R4 High Density Residential. The zoning of the construction site reflects that the site is suitable for higher density residential development in this location compared to the current low and medium density development.

14.6.3 Impact assessment

Direct property acquisition impacts

The acquisition requirements at Westmead metro station construction site are provided in Table 14-2.

Table 14-2: Westmead Metro Station construction site – Property acquisition

Land use or property type	Zoning	Approximate area of acquisition (square metres)	No. of acquisitions	
			Total[1]	Partial[2]
Public property				
Council land (vacant)	R4 High Density Residential	60	1	0
Road land (unclassified regional road)		3,530	1	0
Private property				
Low density residential (houses)	R4 High Density Residential	5,270	20	0
Medium density residential (apartments)		4,190	4	0
Vacant land		1,020	4	0
Retail and business premises		1,860	6	0
Total		**15,930**	**36**	**0**

Note 1: Property acquisition numbers reflect parent lots. Multiple strata titles may exist within parent lots.
Note 2: Number of partial acquisitions to be confirmed based on further consultation with property owners.

Land use change impacts

As a result of Stage 1 there would be a change in land use from a mix of low and medium density residential, with some local retail and business premises, to a transport infrastructure construction site. This land use change would generally be minor in the context of the existing scale and extent of residential development in the surrounding area. The R4 High Density Residential zoned land to the east and south of the construction site would remain available to provide for additional residential land uses in the future, including transit-oriented development to support the strategic role of Westmead, if required.

14.7 Parramatta metro station

14.7.1 Land use context

Parramatta metro station construction site is located to the north of the existing Parramatta Station, within the commercial core of the Parramatta CBD. The Parramatta CBD commercial core comprises a wide mix of commercial, retail, health, government administration and community uses.

The construction site would occupy a central part of Horwood Place, which contains a range of retail and commercial properties within the existing Greenway Plaza and Parramall Shopping Centre, as well as the multi-storey City Centre car park.

Land uses surrounding the Parramatta metro station construction site include the following:

- North of the construction site are retail and commercial properties, as well as the riverside cultural and entertainment precinct, which is between the construction site and Parramatta River
- East of the construction site along George Street is the Roxy Theatre and various retail and commercial properties of medium density. The Arthur Phillip High School and Parramatta Public School (both currently being redeveloped as multi-storey vertical schools) are located south-east of the site
- South of the site is Parramatta Square, which is being redeveloped around the Parramatta Town Hall and will include a new civic square, public open space, regional community facilities, retail and entertainment facilities, and seven new commercial office towers. Beyond Parramatta Square is the Parramatta transport interchange, which provides access to the existing Parramatta Station and bus services. Beyond the existing rail corridor is the major retail quarter around the Parramatta Westfield
- West of the site is a combination of retail, educational and commercial uses. To the immediate west of the site is the Church Street restaurant destination (known as Eat Street). Beyond Church Street is the Parramatta justice precinct, which includes a police station and several courthouse buildings. Parramatta Park is about 300 metres to the west of the site, with BankWest Stadium about 500 metres to the north-west, across the Parramatta River.

Land uses within and surrounding the construction site are shown in Figure 14-3.

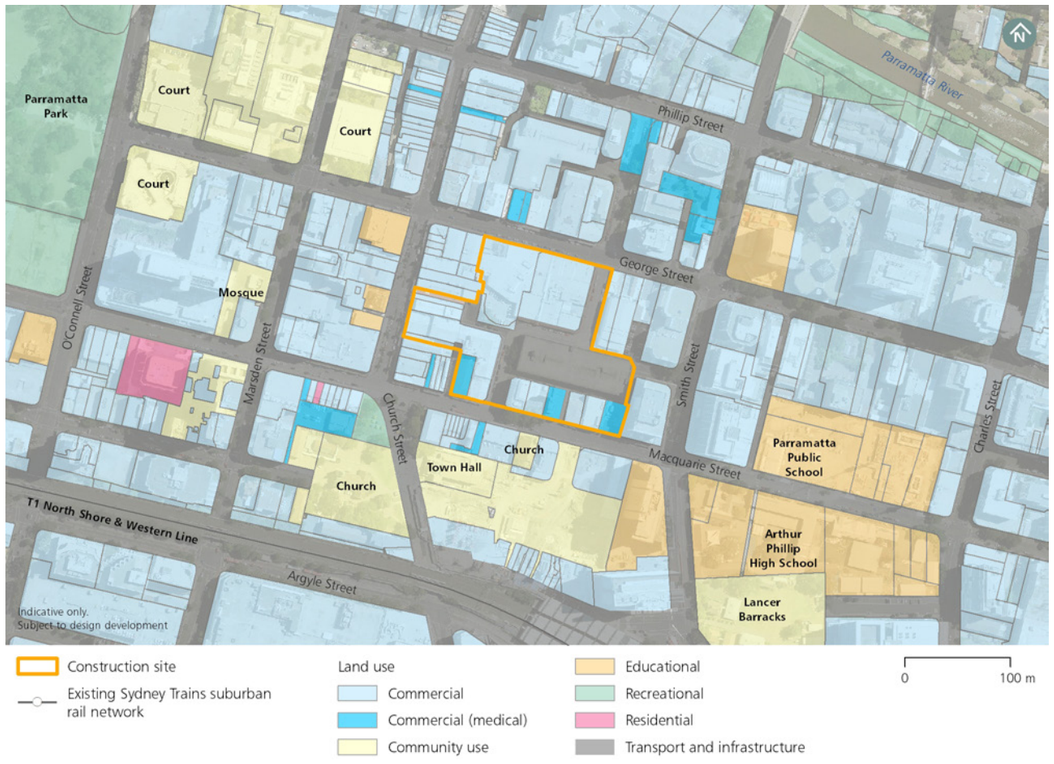

Figure 14-3: Parramatta metro station – Existing land use

14.7.2 Planning controls

Planning controls for the Parramatta metro station construction site are contained within the Parramatta LEP 2011. The Parramatta LEP 2011 defines the land use zoning in this area as a mix of B3 Commercial Core, B4 Mixed Use, RE1 Public Recreation, SP1 Place of Public Worship, SP2 Infrastructure (Defence) and SP2 Infrastructure (Railway Corridor).

The Parramatta metro station construction site is almost entirely zoned B3 Commercial Core, with a small part zoned B4 Mixed Use at the western end of the construction site.

A planning proposal has been submitted for the Parramatta CBD, which seeks to implement a new planning framework to guide the growth and development of the Parramatta CBD. This planning proposal seeks to reinforce the employment focus for the commercial core of the CBD, contemplating the generation of about 20,000 homes and 48,000 jobs in the Parramatta CBD. The planning proposal does not result in any major changes to zoning, however, does result in an increase to the amount of floor space permissible at sites throughout the Parramatta CBD.

14.7.3 Impact assessment

Direct property acquisition impacts

The acquisition requirements at Parramatta metro station construction site are provided in Table 14-3.

Traffic and access impacts associated with the closure Horwood Place have been assessed in Chapter 10 (Transport and traffic – Stage 1).

Table 14-3: Parramatta metro station construction site – Property acquisition

Land use or property type	Zoning	Approximate area of acquisition (square metres)	No. of acquisitions	
			Total[1]	Partial[2]
Public property				
Council land – public car park and road	B3 Commercial core	10,165	2	0
Private property				
Retail and business premises	B4 Mixed use and B3 Commercial core	11,320	8	0
Commercial office buildings		3,450	7	0
Total		**24,935**	**17**	**0**

Note 1: Property acquisition numbers reflect parent lots. Multiple strata titles may exist within parent lots.
Note 2: Number of partial acquisitions to be confirmed based on further consultation with property owners.

The direct impact of acquisition would generally be moderate in the context of the existing scale and extent of retail and commercial development in the surrounding area. The wider commercial and administrative role of Parramatta would not be affected.

The construction site would prevent the delivery of the approved redevelopment of properties within the construction site at 220-222 Church Street and 48 Macquarie Street, and the proposed redevelopment of 61B George Street. As there is significant new commercial floor space being delivered throughout Parramatta, the loss of potential commercial land use associated with these redevelopments would be minor.

Land use change impacts

As a result of Stage 1 there would be a change in land use from retail and commercial properties to a transport infrastructure construction site. This land use change would be minor considering the scale and extent of existing and planned retail and commercial development in the surrounding area.

14.8 Clyde stabling and maintenance facility

14.8.1 Land use context

The Clyde stabling and maintenance facility construction site is characterised by industrial uses and major recreational facilities, and is bisected by Duck Creek and A'Becketts Creek.

Land uses surrounding the Clyde stabling and maintenance facility construction site include the following:

- North of the site is the Rosehill Gardens racecourse
- East of the site is Duck Creek and Shirley Street, beyond which are large warehouses, and the Viva Energy site that was formerly used as part of Clyde oil refinery
- South of the site is the M4 Western Motorway, beyond which the Clyde industrial area continues
- West of the site is a corridor containing James Ruse Drive and the now closed T6 Carlingford Line. Further west are low density residential areas in Rosehill and Granville.

Land uses within and surrounding the construction site are shown in Figure 14-4.

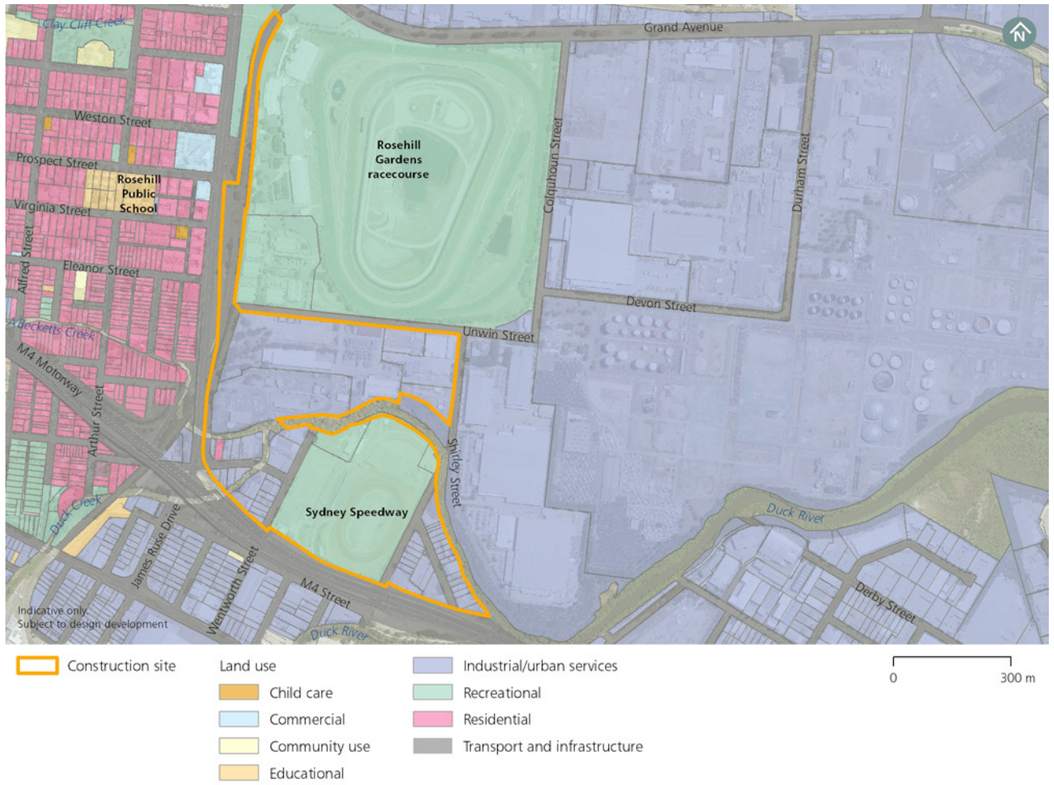

Figure 14-4: Clyde stabling and maintenance facility – Existing land use

14.8.2 Planning controls

The site is subject to the Parramatta LEP 2011. The Parramatta LEP 2011 defines the land use zoning for the construction site as largely IN3 Heavy Industrial, except for the Sydney Speedway (location on NSW Government owned land) which is zoned RE2 Private Recreation, and some land around the speedway which is zoned IN1 General Industrial. Duck Creek is zoned W1 Natural Waterway.

14.8.3 Impact assessment

Direct property acquisition impacts

The acquisition requirements at the Clyde stabling and maintenance facility construction site are provided in Table 14-4.

The construction site would require the acquisition of Crown land. This would be managed in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*.

Table 14-4: Clyde stabling and maintenance facility construction site – Property acquisition

Land use or property type	Zoning	Approximate area of acquisition (square metres)	No. of acquisitions	
			Total[1]	Partial[2]
Crown land				
Crown land	RE2 Private Recreation	117,330	5	0
Public property				
Industrial and commercial premises	IN1 General Industrial	1,830	6	0
Environmental land	W1 Natural Waterway	2,440	4	0
Private property				
Industrial and commercial premises	IN1 General Industrial	222,580	35	0
Residential	IN1 General Industrial	1,100	1	0
Vacant land	IN1 General Industrial	2,200	3	0
Total		**347,480**	**54**	**0**

Note 1: Property acquisition numbers reflect parent lots. Multiple strata titles may exist within parent lots.

Note 2: Number of partial acquisitions to be confirmed based on further consultation with property owners.

Land use change impacts

As a result of Stage 1 there would be a change from industrial and recreational land uses to a transport infrastructure construction site. This land use change would be minor considering the scale of surrounding industrial land in Clyde, Camellia, Rosehill and Silverwater. Other developments, once complete, such as the remediation of the western area of the former Viva Energy refinery would also potentially be able to compensate for the loss of industrial zoned land as a result of Stage 1.

The NSW Government is committed to providing an alternative speedway within Sydney.

14.9 Silverwater services facility

14.9.1 Land use context

The Silverwater services facility construction site comprises currently vacant industrial land on the corner of Silverwater Road and Derby Street.

The construction site is surrounded by established industries and warehouse/distribution facilities. Land uses beyond the Silverwater industrial area include the following:

- East and south-east is the residential suburb of Newington
- South and south-west is the residential area of Silverwater.

Land uses within and surrounding the construction site are shown in Table 14-5.

Figure 14-5: Silverwater services facility – Existing land use

14.9.2 Planning controls

The site is contained within the Auburn Local Environmental Plan 2010 (Auburn LEP 2010). The Auburn LEP 2010 defines the land use zoning in this area as being predominantly IN1 General Industrial. Other land uses in this area include R3 Medium Density Residential to the south-east, SP2 Infrastructure (Road), RE1 Public Recreation and B6 Enterprise Corridor to the south-west. The site is zoned IN1 General Industrial.

14.9.3 Impact assessment

Direct property acquisition impacts

The acquisition requirements at the Silverwater services facility construction site are provided in Table 14-5.

Table 14-5: Silverwater services facility construction site – Property acquisition

Land use or property type	Zoning	Approximate area of acquisition (square metres)	No. of acquisitions	
			Total[1]	Partial[2]
Private property				
Industrial premises	IN1 General Industrial	2,600	2	0
Total		**2,600**	**2**	**0**

Note 1: Property acquisition numbers reflect parent lots. Multiple strata titles may exist within parent lots.

Note 2: Number of partial acquisitions to be confirmed based on further consultation with property owners.

Land use change impacts

As a result of Stage 1 there would be a change from unused industrial land to a transport infrastructure construction site. This land use change would be negligible as the site is currently vacant, and is a small footprint in the context of the scale of surrounding industrial land uses.

14.10 Sydney Olympic Park metro station

14.10.1 Land use context

Sydney Olympic Park includes a range of land uses generally related to the major sporting and events facilities. South of the existing Olympic Park Station, the area has a mixed use character including a number of commercial, education, residential, visitor accommodation and entertainment uses.

The Sydney Olympic Park metro station construction site is located south of the existing Olympic Park Station, within the current mixed use area of Sydney Olympic Park. The construction site mostly contains existing commercial and industrial land uses.

Land uses surrounding the Sydney Olympic Park metro station construction site include the following:

- North of the site is the former State Abattoirs and then the existing Olympic Park Station, beyond which are a number of major sporting and events facilities including ANZ Stadium and Sydney Showground
- East of the site are a number of commercial buildings, beyond which are newly completed mixed use high density buildings. Further east is Bicentennial Park, a key area of regional open space in Greater Sydney
- South of the site are a range of commercial uses, an educational facility and a number of sporting facilities, including the Sydney Olympic Park Tennis Centre and the Hockey Centre
- West of the site are visitor accommodation facilities, and the Sydney Olympic Park Aquatic and Athletic Centres.

Land uses within and surrounding the construction site are shown in Figure 14-6.

Figure 14-6: Olympic Park metro station construction site – Existing land use

14.10.2 Planning controls

Sydney Olympic Park is identified as a State significant precinct, with land use controls prescribed under *State Environmental Planning Policy (State Significant Precincts) 2005*. Land uses at Sydney Olympic Park include B4 Mixed Use, E2 Environmental Conservation, E3 Environmental Management, RE1 Public Recreation and SP2 Infrastructure.

The Sydney Olympic Park metro station site is entirely located within land zoned B4 Mixed Use.

14.10.3 Impact assessment

Direct property acquisition impacts

The acquisition requirements at the Sydney Olympic Park metro station construction site are provided in Table 14-6.

Table 14-6: Sydney Olympic Park metro station construction site – Property acquisition

Land use or property type	Zoning	Approximate area of acquisition (square metres)	No. of acquisitions	
			Total[1]	Partial[2]
Public property				
Public road	B4 Mixed Use	1,200	1	0
Private property[3]				
Commercial premises	B4 Mixed Use	20,000	3	0
Total		**21,200**	**4**	**0**

Note 1: Property acquisition numbers reflect parent lots. Multiple strata titles may exist within parent lots.
Note 2: Number of partial acquisitions to be confirmed based on further consultation with property owners.
Note 3: All non-residential property in Sydney Olympic Park is owned by the NSW Government and is subject to long term lease arrangements.

Land use change impacts

As a result of Stage 1, there would be a change from commercial and educational land uses to a transport infrastructure construction site. This land use change would be moderate considering the surrounding commercial land use. Sydney Metro is working with Department of Planning, Industry and Environment to minimise this potential impact and ensure the ability to redevelop surrounding land consistent with the Master Plan 2030.

The location of the construction site is well separated from ANZ Stadium and other major sporting venues. The construction site would not affect the ability of Sydney Olympic Park to continue to host major sporting, entertainment and cultural events.

14.11 North Strathfield metro station

14.11.1 Land use context

The North Strathfield metro station construction site falls within the existing rail corridor and includes part of Queen Street and the landscaped area adjacent to the current station entrance.

Land uses surrounding the North Strathfield metro station construction sites include the following:

- North of the site are residential dwellings of various densities
- East of the site are residential dwellings and the commercial centre of North Strathfield, comprising properties which are used for commercial, retail, and business uses including a number of local restaurants
- South of the site is further residential development, including new higher density residential developments to the south-west. A small collection of businesses, including a childcare centre are located to the south-west
- To the west of the site, beyond the existing rail corridor is Our Lady of the Assumption Catholic Primary School and McDonald College. Beyond this is low density residential housing.

Land uses within and surrounding the North Strathfield metro station construction sites are shown in Figure 14-7.

Figure 14-7: North Strathfield metro station construction site– Existing land use

14.11.2 Planning controls

Planning controls in North Strathfield are contained within the Canada Bay Local Environmental Plan 2013 (Canada Bay LEP 2013). The Canada Bay LEP 2013 defines the land use zoning surrounding the North Strathfield metro station construction site as R2 Low Density Residential, R3 Medium Density Residential, B1 Neighbourhood Centre, B3 Commercial Core, B4 Mixed Use and SP2 Infrastructure (Railway).

The North Strathfield metro station construction site is located within land zoned SP2 Infrastructure (Railway). The construction site would also include a small part of Queen Street, which is zoned R3 Medium Density Residential and B1 Neighbourhood Centre.

14.11.3 Impact assessment

Direct property acquisition impacts

Other than the use of part of Queen Street, the North Strathfield metro station construction site is already in the ownership of the NSW Government for transport infrastructure purposes. As such, there is no private property acquisition for the site.

Land use change impacts

The site is already used for transport infrastructure purposes. As such, the land use would change from a partially vacant section of an existing rail corridor to a transport infrastructure construction site. The construction site is located immediately adjacent to the existing rail corridor and is compatible with this adjoining land use.

The construction site would require exclusive use of the western part of Queen Street, between Pomeroy Street and Wellbank Street, for construction site access and loading/unloading activities. This part of Queen Street would therefore not be available for car parking. Traffic impacts associated with the temporary use of part of Queen Street have been assessed in Chapter 10 (Transport and traffic – Stage 1).

14.12 Burwood North Station

14.12.1 Land use context

The area around the Burwood North Station construction site includes retail, commercial services, commercial and residential developments focussed on the north-south spine of Burwood Road, and the east-west spine of Parramatta Road. Health and education uses are also located in the broader area.

Burwood North Station construction works would involve two construction sites. The northern construction site would occupy part of the block bounded by Burwood Road, Parramatta Road, and Loftus Street. This includes mostly existing shops, residential apartments, a pub/hotel, a hostel, and part of Neichs Lane. The southern construction site would be located south of Parramatta Road, within the block bounded by Burwood Road, Parramatta Road, and Esther Street occupying space currently used for shops, commercial services and an educational facility.

Land uses surrounding the Burwood North Station construction sites include the following:

- North and north-west of the site are the residential areas of Concord. Immediately north of Burton Street is St Lukes Anglican Church. Further north across Gipps Street are a range of recreational and sporting facilities such as St Lukes Park and Cintra Park
- East of the site is Concord Oval
- South of the site along the southern side of Parramatta Road land use generally comprises retail, commercial services and commercial premises, including several motor vehicle related premises. South along Burwood Road is a continuation of the commercial and retail uses, often comprising mixed use developments with multi-storey residential buildings above. Further south is Burwood Park, Westfield Burwood and the existing Burwood Station
- South-west of the site is a mix of low density residential housing, and MLC School Burwood. Other the land uses south of the site include commercial and retail premises along Parramatta Road and low density residential dwellings
- West of the site is a mix of uses including residential apartments, student accommodation and retail uses.

Land uses within and surrounding the Burwood North Station construction sites are shown in Figure 14-8.

Figure 14-8: Burwood North Station construction site – Existing land use

14.12.2 Planning controls

Parramatta Road serves as the boundary between the local government areas of Burwood and Canada Bay.

To the north of Parramatta Road, planning controls are contained within the Canada Bay LEP 2013. The Canada Bay LEP 2013 provides for land uses to the north of Parramatta Road including B6 Enterprise Corridor, R2 Low Density Residential and R3 Medium Density Residential.

To the south of Parramatta Road, planning controls are in the Burwood Local Environmental Plan 2012 (Burwood LEP 2012). The Burwood LEP 2012 provides for land uses to the south of Parramatta Road at North Burwood including B6 Enterprise Corridor, B4 Mixed Use, R1 General Residential and R2 Low Density Residential.

The northern Burwood North Station construction site is located within the Canada Bay local government area on land zoned B6 Enterprise Corridor and R3 Medium Density Residential.

The southern Burwood North Station construction site is located within the Burwood local government area on land zoned B6 Enterprise Corridor.

14.12.3 Impact assessment

Direct property acquisition impacts

The acquisition requirements at the Burwood North Station construction site are provided in Table 14-7.

Table 14-7: Burwood North Station construction site – Property acquisition

Land use or property type	Zoning	Approximate area of acquisition (square metres)	No. of acquisitions	
			Total[1]	Partial[2]
Public Property				
Council – public road	B6 Enterprise Corridor	340	0	1
Private Property				
Commercial and retail premises	B6 Enterprise Corridor	11,290	20	0
Residential (houses)	R3 Medium Density Residential	485	1	0
Residential (apartments)	R3 Medium Density Residential	2,380	3	0
Total		**14,495**	**24**	**1**

Note 1: Property acquisition numbers reflect parent lots. Multiple strata titles may exist within parent lots.
Note 2: Number of partial acquisitions to be confirmed based on further consultation with property owners.

Land use change impacts

As a result of Stage 1 there would be a change from commercial and residential land uses to transport infrastructure construction sites. This land use change would be minor, given the low density of existing development, and in the context of the existing scale and extent of retail, commercial and residential development in the surrounding area, especially along the Parramatta Road corridor.

14.13 Five Dock Station

14.13.1 Land use context

The Five Dock Station construction activities would take place across two sites within the Five Dock town centre. The western construction site comprises land currently occupied by retail and commercial services between Great North Road and East Street. The eastern construction site would be located on the corner of Waterview Street and Second Avenue. The current land use on this site involves low density residential dwelling houses and a small public car park.

Land uses surrounding the Five Dock Station construction sites include the following:

- North of the site is a continuation of the retail/mixed use spine of Great North Road. This includes a number of mixed use developments, residential apartments and St Albans church immediately north of the western construction site
- East of the site are residential dwellings of various densities. This includes a number of medium density dwellings with single dwelling houses. Five Dock Park is located about 300 metres to the east of the site and Doremy Catholic College is about 300 metres south-east of the site
- South of the site is a continuation of the Five Dock town centre which includes Fred Kelly Place and a continuation of the retail/mixed use spine along Great North Road and Ramsay Road. Residential apartment buildings, medium density dwellings and detached dwelling houses are located further to the south of the site
- West of the site is Five Dock Public School, the Five Dock Police Station, childcare services, health services, commercial premises and residential areas.

Land uses within and surrounding the Five Dock Station construction site are shown in Figure 14-9.

Figure 14-9: Five Dock Station – Existing land use

14.13.2 Planning controls

Planning controls in Five Dock are contained within the Canada Bay LEP 2013. The Canada Bay LEP 2013 defines the land use zoning at Five Dock including B4 Mixed Use, R2 Low Density Residential, R3 Medium Density Residential and B1 Neighbourhood Centre.

The Five Dock Station construction site is within land zoned B4 Mixed Use and RE1 Public Recreation. The RE1 zoned land is currently occupied by a local branch of Westpac Bank.

14.13.3 Impact assessment

Direct property acquisition impacts

The acquisition requirements at the Five Dock Station construction site are provided in Table 14-8.

Table 14-8: Five Dock Station construction site – Property acquisition

Land use or property type	Zoning	Approximate area of acquisition (square metres)	No. of acquisitions	
			Total[1]	Partial[2]
Public property				
Car park	B4 Mixed Use	370	1	0
Private property0				
Retail and business premises	RE1 Public Recreation	680	1	0
Retail and business premises	B4 Mixed Use	3,450	10	0
Residential	B4 Mixed Use	1,780	5	0
Total		**6,280**	**17**	**0**

Note 1: Property acquisition numbers reflect parent lots. Multiple strata titles may exist within parent lots. Includes Lots within properties.
Note 2: Number of partial acquisitions to be confirmed based on further consultation with property owners.

Land use change impacts

As a result of Stage 1 there would be a change from commercial, retail and residential land uses to transport infrastructure construction sites. This change in land use would be minor in the broader context of the existing scale and extent of commercial, retail and residential development around the town centre and given the relatively small area of the construction sites.

14.14 The Bays Station

14.14.1 Land use context

The Bays Station construction site would be located at the head of White Bay, between Robert Street, Victoria Road and the Anzac Bridge and is partially used for port related activities.

Land uses surrounding The Bays Station construction site include:

- North of the site are a number of retail, commercial, and industrial and urban services uses along Robert Street. Beyond this is the residential areas of Rozelle and Balmain
- East of the site is White Bay, including the associated maritime uses within the Glebe Island and White Bay ports. This includes the Glebe Island cement and grain silos, and the multi-use berths at Glebe Island. The White Bay Cruise Terminal is located on the northern side of White Bay, to the north-east of the construction site
- South of the site is the intersection of the City West Link, Western Distributor and Victoria Road. Beyond this is an area of maritime uses along James Craig Road, and Rozelle Bay
- West of the site is the White Bay Power Station, which is currently unused. Further to the west, across Victoria Road are residential dwellings in Rozelle. The future Westconnex (Stage 3) Rozelle Interchange is located to the south-west of the site, immediately adjacent to the City West Link. This site will feature a public park, with road traffic infrastructure located beneath.

Land uses within and surrounding the construction site are shown in Figure 14-10.

Figure 14-10: The Bays Station – Existing land use

14.14.2 Planning controls

The Bays Precinct is currently subject to Sydney Regional Environmental Plan No. 26 – City West, which prescribes the land use zone of the site as being 'port and employment'.

The site is also subject to the White Bay and Glebe Island Masterplan (Sydney Ports, 2000), which informs development at White Bay and Glebe Island.

14.14.3 Impact assessment

Direct property acquisition impacts

The Bays Station construction site would be located on land currently owned by the NSW Government. The site is largely unused, except for the Port Access Road, and includes areas associated with port-related leases.

Land use change impacts

The land use change would comprise the introduction of a transport infrastructure construction site within the port area. As the land is generally unused, or used for temporary port-related activities, this land use change would be negligible.

14.15 Cumulative impacts

Potential cumulative impacts were considered for assessment based on the likely interactions of Stage 1 with other projects and plans that met the adopted screening criteria. The approach to assessment and the other projects considered are described further in Appendix G (Cumulative impacts assessment methodology – Stage 1). Cumulative land use impacts may result where the area around a Stage 1 construction site is already subject to land use change arising from other infrastructure projects, or from broader strategic planning processes. Stage 1 construction sites located within areas already subject to broader strategic planning led land use changes are:

- Westmead
- Parramatta
- Sydney Olympic Park
- Burwood North
- The Bays.

The cumulative land use changes occurring around these construction sites present an opportunity for future transit-oriented integrated station precincts and improved public domain outcomes, as discussed in Chapter 7 (Placemaking). Final public domain outcomes are subject to future stages of Sydney Metro West, and any development realising these opportunities would be subject to separate approval processes.

Westmead

The Greater Parramatta Interim Land Use and Infrastructure Implementation Plan (Department of Planning and Environment, 2017) identifies growth in employment uses in Westmead, in line with the continued growth of healthcare, education and research uses envisaged for the Westmead health and education precinct. This growth is expected to result in increased development activity and high density land uses throughout the Westmead town centre and around the existing Westmead Station. These cumulative changes in land use present an opportunity for a future transit-oriented integrated station precinct and improved public domain outcomes that are aligned with the evolution of the Westmead centre.

Parramatta

The Greater Parramatta Interim Land Use and Infrastructure Implementation Plan identifies significant residential and commercial growth commensurate with the role of Parramatta as the core of the Central River City. This growth is expected to result in increased development activity and high density land uses throughout the Parramatta CBD. These cumulative changes in land use present an opportunity for a future transit-oriented integrated station precinct and improved public domain outcomes that are aligned with the vision for a new Civic Link between Parramatta Square and Parramatta River to support the liveability, sustainability and productivity of the Parramatta CBD.

Sydney Olympic Park

The Sydney Olympic Park Master Plan 2030 (Sydney Olympic Park Authority, 2018) provides for the revitalisation of Sydney Olympic Park with a new town centre. These cumulative changes in land use present an opportunity for a future transit-oriented integrated station precinct and improved public domain outcomes that are aligned with the Master Plan 2030 vision.

Burwood North

The Parramatta Road Corridor Urban Transformation Strategy (Urban Growth NSW, 2016) identifies the area around the Burwood North construction sites as an area for mixed use urban renewal. This renewal is expected to result in increased development activity and high density land uses along the Parramatta Road corridor. These cumulative changes in land use present an opportunity for a future transit-oriented integrated station precinct and improved public domain outcomes that are aligned with the evolution of the area around Burwood North with a more diverse range of social services, businesses and/or recreational activities.

The Bays

The cumulative land use changes envisaged around the Bays Precinct present an opportunity for a future transit-oriented integrated station precinct and improved public domain outcomes that are aligned with the Bays Precinct Sydney Transformation Plan (Urban Growth NSW, 2015).

14.16 Mitigation and management

14.16.1 Approach to mitigation and management

Stage 1 property acquisitions would be managed in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and the land acquisition reforms described above in Section 14.5.1.

Impacts on adjacent land use arising from amenity related impacts such as noise, dust, visual and traffic would be managed in accordance with the Construction Environmental Management Framework, which includes environmental management procedures, and a communications and consultation strategy. More details of the Construction Environmental Management Framework are provided in Chapter 27 (Synthesis of the Environmental Impact Statement).

14.16.2 Mitigation measures

The mitigation measures that would be implemented to minimise potential impacts on land use and property are listed in Table 14-9.

Table 14-9: Mitigation measures – Property and land use Stage 1

Reference	Impact/issue	Mitigation measures	Applicable locations(s)[1]
LU1	Temporary use	Except where required for subsequent construction activities associated with future stages of the Concept, temporary use areas for construction purposes would be stabilised and appropriately rehabilitated as soon as feasible and reasonable following completion of construction. This would be carried out in consultation with the relevant landowner.	All

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (e.g. tunnel boring machine works); PSR: Power supply routes.

14.16.3 Interactions between mitigation measures

Mitigation measures in other chapters that are relevant to the management of potential land use and property impacts include:

- Chapter 10 (Transport and traffic – Stage 1), specifically measures which address maintaining access to existing properties during construction
- Chapter 11 (Noise and vibration – Stage 1), specifically measures which address management of potential noise impacts and vibration during construction
- Chapter 15 (Landscape character and visual amenity – Stage 1), specifically measures which address the management of potential visual impacts during construction
- Chapter 16 (Business impacts – Stage 1), specifically measures which address business visibility and local amenity impacts during construction
- Chapter 17 (Social impacts – Stage 1), specifically measures to minimise social disruption during construction
- Chapter 23 (Air quality - Stage 1), specifically measures which address management of potential air quality impacts (including dust, other emissions and odour) during construction.

Together, these measures would minimise the potential land use and property impacts of Stage 1.

There are no mitigation measures identified in the assessment of other environmental aspects that are likely to affect the assessment of property and land use impacts.

15 Landscape character and visual amenity – Stage 1

15 Landscape character and visual amenity – Stage 1

This chapter provides an assessment of the potential landscape character and visual amenity impacts as a result of Stage 1 and identifies mitigation measures to address these impacts. This chapter draws on information provided in Technical Paper 5 (Landscape and visual impact assessment).

15.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to landscape character and visual amenity and where they have been addressed in the Environmental Impact Statement are outlined in Table 15-1.

Table 15-1: Secretary's Environmental Assessment Requirements – Landscape character and visual amenity Stage 1

Reference	Secretary's Environmental Assessment Requirements	Where addressed
Place and Design		
1.1	Visual and related amenity impacts of construction including on streetscapes, key sites and buildings (including existing landscape works, greenspace and tree canopy).	Sections 15.5 to 15.13
1.2	Open space and tree impacts, including: a. estimating the number of trees to be cleared that will not be covered by a biodiversity offset strategy; and	
	b. for areas where trees are to be cleared before construction, investigate means to increase the number of trees and canopy within proximity of the impacted areas by providing additional planting before construction.	

15.2 Legislative and policy context

The landscape character and visual impact assessment was undertaken with reference to the following guidelines, policies and standards:

- Transport for NSW Guidance note EIA-N04 Guidelines for Landscape Character and Visual Impact Assessment (2018)
- Guidance for Landscape and Visual Impact Assessment (Landscape Institute and Institute of Environmental Management & Assessment, 2013)
- Guidance Note for Landscape and Visual Assessment (Australian Institute of Landscape Architects, 2018)
- Guidance for the reduction of obtrusive light (United Kingdom Institution of Lighting Engineers, 2011)
- AS4282-1997 Control of the obtrusive effects of outdoor lighting.

A range of legislation, policies and planning strategies from international, federal, State and local government agencies were also considered in the assessment of potential landscape character and visual impacts.

15.3 Assessment approach

Landscape character and visual amenity were assessed to identify the likely impacts arising from Stage 1. The assessment methodology for landscape and visual impacts is outlined below and generally involved:

- A review of the relevant legislative and policy framework
- Identification of the existing environmental conditions
- Description of the components and character of Stage 1 works
- An assessment of landscape character impact during construction (refer to section 15.3.1)
- An assessment of the daytime visual impact during construction (refer to section 15.3.2)
- An assessment of night-time visual impact during construction (refer to section 15.3.3)
- Identification of mitigation measures.

The assessment of landscape character considers the impacts of Stage 1 on the built, natural and cultural character or sense of place of the surrounding area, whereas the visual impact assessment considers the impacts of Stage 1 on views.

Where acoustic measures are proposed at construction sites, the assessment has assumed the presence of an acoustic shed to assess the likely worse case visual impact. However, other acoustic measures (of a similar or smaller scale) could be implemented instead of acoustic sheds. Acoustic sheds are not proposed at Parramatta, Clyde, Silverwater or North Strathfield.

Photomontages from selected viewpoints are provided for most construction sites where acoustic sheds are proposed. Additional figures for all construction sites are provided in Technical Paper 5 (Landscape and visual impact assessment) showing the extent of each construction site from a range of viewpoints.

15.3.1 Landscape character impact assessment

The Transport for NSW 2018 guidance defines landscape as 'all aspects of a tract of land, including landform, vegetation, buildings, villages, towns, cities and infrastructure' and landscape character is defined as the 'combined quality of built, natural and cultural aspects which make up an area and provide its unique sense of place'.

In an urban context, landscape refers not only to trees and areas of open space, but also the character and function of a place. This includes all elements within the public realm and the interrelationship between these elements and the people who use it.

Landscape sensitivity refers to the value placed on a landscape element or place and the level of service it provides to the community. The sensitivity of a landscape can reflect the frequency and volume of people that use the location but it can also be valued for characteristics such as visual relief or tranquillity. Council and State government master plans and planning guidance documents also reflect the value and importance of landscapes to the local, regional and state-wide community. There are no landscapes of Aboriginal cultural heritage value that would affect the landscape sensitivity levels. Non-Aboriginal cultural heritage values have been considered in the landscape sensitivity ratings as they contribute to landscape character and community values. Complete assessments of the impacts of Stage 1 on non-Aboriginal heritage are presented in Technical Paper 3 (Non-Aboriginal heritage).

Considering the broadest context of possible landscapes, the degree of sensitivity of each landscape element to change was identified as either neighbourhood, local, regional, State or national (see Table 15-2).

Table 15-2: Landscape sensitivity levels

Landscape sensitivity	Description
National	Landscape feature protected under national legislation or international policy, for example the World Heritage Listed Parramatta Park.
State	Landscape feature that is heavily used and/or is iconic to the State, for example Sydney Olympic Park stadium plaza.
Regional	Landscape feature that is heavily used and valued by residents of a major portion of the city or a non-metropolitan region, for example Centenary Square Parramatta.
Local	Landscape feature valued and experienced by concentrations of residents and/or local recreational users. Provides a considerable service to the community. For example, it provides a place for local gathering, recreation, sport, street use by cafes and/or shade and shelter in an exposed environment, for example the Five Dock Town Centre area and Fred Kelly Place.
Neighbourhood	Landscape feature valued and appreciated primarily by a small number of residents, for example street trees in a local street. Provides a noticeable service to the community. For example, it provides a seat or resting place, passive recreation and/or some shade and shelter in a local street.

To assess the changes to the landscape as a result of Stage 1, the proposed changes are assigned a 'magnitude of change' level. The magnitude assigned considers direct impacts on the landscape such as the removal of trees and tree canopy, open space and public realm areas, as well as indirect impacts such as changes to the function of an area of open space or the public realm. The magnitude of change can result in adverse or beneficial effects and is defined in Table 15-3.

Table 15-3: Landscape magnitude of change

Landscape magnitude of change	Description
Considerable reduction or improvement	Substantial portion of the landscape is changed. This may include substantial changes to vegetation cover (trees and canopy), the area of open space or public realm area, accessibility, permeability, legibility and wayfinding, comfort and amenity, activation and safety, and diversity of the public realm.
Noticeable reduction or improvement	A portion of the landscape is changed. This may include some alteration to vegetation cover (trees and canopy), the area of open space or public realm area, accessibility, permeability, legibility and wayfinding, comfort and amenity, activation and safety, and diversity of the public realm.
No perceived reduction or improvement	Either the landscape quality is unchanged or if it is, it is largely mitigated by proposed public realm improvements. Does not alter or not noticeably alter the vegetation cover (trees and canopy), the area of open space or public realm area, accessibility, permeability, legibility and wayfinding, comfort and amenity, activation and safety, and diversity of the public realm.

To assess the landscape character impact of Stage 1, the sensitivity of the landscape (see Table 15-2) and the likely landscape magnitude of change (see Table 15-3) are combined (see Table 15-4).

Table 15-4: Landscape impact levels

Landscape magnitude of change	Landscape sensitivity				
	National	**State**	**Regional**	**Local**	**Neighbourhood**
Considerable reduction	Very high adverse	Very high adverse	High adverse	Moderate adverse	Minor adverse
Noticeable reduction	Very high adverse	High adverse	Moderate adverse	Minor adverse	Negligible
No perceived change	Negligible	Negligible	Negligible	Negligible	Negligible
Noticeable improvement	Very high beneficial	High beneficial	Moderate beneficial	Minor beneficial	Negligible
Considerable improvement	Very high beneficial	Very high beneficial	High beneficial	Moderate beneficial	Minor beneficial

15.3.2 Daytime visual amenity impact assessment

The daytime visual amenity impact assessment considers visual amenity as experienced by people (referred to as receivers) and aims to identify the range of views to the site that may be impacted, including views from residential areas, offices, parks and streets.

To address the potential impact of Stage 1 on visual amenity, assessments were carried out by identifying the:

- Existing visual conditions around the Stage 1 sites
- Views that are representative of these visual conditions
- Sensitivity of the view
- Magnitude of change to the view as a result of Stage 1
- Overall level of impact.

Stage 1 would occur for a temporary period and the level of visual magnitude of change assessed would only apply for the duration of Stage 1 and does not consider the subsequent stages of construction or operation. The sensitivity of a viewpoint is considered in the broadest context of possible views, ranging from national to neighbourhood importance (Table 15-5). The magnitude of change describes the extent of change expected from Stage 1 (Table 15-6). To assess the overall impact on daytime visual amenity, the visual sensitivity and magnitude of change assessments are combined (Table 15-7).

Table 15-5: Visual sensitivity levels – Daytime

Visual sensitivity	Description
National	Heavily experienced view to a national icon, for example the view to the Sydney Opera House from Circular Quay. There are no nationally sensitive views within Stage 1.
State	Heavily experienced view to a feature or landscape that is iconic to the State, for example views to Old Government House from within Parramatta Park.
Regional	Heavily experienced view to a feature or landscape that is iconic to a major portion of a city or a non-metropolitan region, or an important view from an area of regional open space, for example view to St John's Anglican Cathedral Church in Centenary Square, view to Abattoir Heritage Precinct in Sydney Olympic Park.
Local	High quality view experienced by concentrations of residents and/or local recreational users, local commercial areas and/or large numbers of road or rail users, for example view along Macquarie or George Street in Parramatta, view to a prominent corner building on Parramatta Road in Burwood North, or the view to the landscaped gardens and palm grove within the Abattoir Heritage Precinct in Sydney Olympic Park.
Neighbourhood	Views where visual amenity is appreciated by a small number of residents, not particularly valued by the wider community.

Table 15-6: Visual magnitude of change – Daytime

Visual magnitude of change	Description
Considerable reduction or improvement	Substantial part of the view is altered. Stage 1 contrasts substantially with the surrounding landscape.
Noticeable reduction or improvement	A small to moderate part of the view is altered. Stage 1 contrasts with the surrounding landscape.
No perceived reduction or improvement	Either the view is unchanged or if it is, the change in the view is generally unlikely to be perceived by viewers. Stage 1 does not contrast with the surrounding landscape.

Table 15-7: Visual impact levels – Daytime

Visual magnitude of change	Visual sensitivity (daytime)				
	National	State	Regional	Local	Neighbourhood
Considerable reduction	Very high adverse	Very high adverse	High adverse	Moderate adverse	Minor adverse
Noticeable reduction	Very high adverse	High adverse	Moderate adverse	Minor adverse	Negligible
No perceived change	Negligible	Negligible	Negligible	Negligible	Negligible
Noticeable improvement	Very high beneficial	High beneficial	Moderate beneficial	Minor beneficial	Negligible
Considerable improvement	Very high beneficial	Very high beneficial	High beneficial	Moderate beneficial	Minor beneficial

15.3.3 Night-time visual amenity impact assessment

The assessment of night-time visual amenity impacts was carried out with a similar methodology to the daytime assessment. The guidance note for the reduction of obtrusive light (United Kingdom Institution of Lighting Engineers, 2011) identifies environmental zones, useful for the categorising of night-time landscape settings. This broader approach to the assessment of obtrusive light is consistent with the detail available at a planning approval application of Stage 1 and is therefore the basis for the method applied to the night-time visual assessment contained within this report.

The first step includes identifying the environmental zone which best describes the existing night-time visual conditions for each site. These zones are typical night-time settings and reflect the predominant light levels of each site. Each environmental zone has an inherent level of sensitivity as described in Table 15-18. The visual magnitude of change that would be expected within the study area during night-time are described in Table 15-9 and are associated with sky glow (the brightening of the night sky), glare or brightness of a light source, and the extent of light intrusion on a sensitive receiver.

Table 15-10 shows the visual impact matrix used to assess the impact of Stage 1.

Table 15-8: Visual sensitivity levels – Night-time

Environmental zone	Description and level of sensitivity
E0/E1: Dark/Intrinsically dark landscapes	Very high sensitivity visual settings at night including national parks, state forests etc.
E2: Low district brightness areas	Highly sensitive visual settings at night including rural, small village, or relatively dark urban locations.
E3: Medium district brightness areas	Moderately sensitive visual settings at night including small town centres or urban locations.
E4: High district brightness areas	Low sensitivity visual settings at night including town/city centres with high levels of night-time activity.

Table 15-9: Visual magnitude of change – Night-time

Magnitude of change	Description
Considerable reduction or improvement	Substantial change to the level of skyglow, glare or light intrusion would be expected. The lighting of Stage 1 contrasts substantially with the surrounding landscape at night.
Noticeable reduction or improvement	Alteration to the level of skyglow, glare or light intrusion would be clearly visible. The lighting of Stage 1 contrasts with the surrounding landscape at night.
No perceived reduction or improvement	Either the level of skyglow, glare and light intrusion is unchanged or if it is altered, the change is generally unlikely to be perceived by viewers. Stage 1 does not contrast with the surrounding landscape at night.

Table 15-10: Visual impact levels – Night-time

Visual magnitude of change	Visual sensitivity (daytime)				
	National	State	Regional	Local	Neighbourhood
Considerable reduction	Very high adverse	Very high adverse	High adverse	Moderate adverse	Minor adverse
Noticeable reduction	Very high adverse	High adverse	Moderate adverse	Minor adverse	Negligible
No perceived change	Negligible	Negligible	Negligible	Negligible	Negligible
Noticeable improvement	Very high beneficial	High beneficial	Moderate beneficial	Minor beneficial	Negligible
Considerable improvement	Very high beneficial	Very high beneficial	High beneficial	Moderate beneficial	Minor beneficial

15.4 Avoidance and minimisation of impacts

The design development of Stage 1 has included a focus on avoiding or minimising potential landscape character and visual amenity impacts. This has included:

- Locating the construction footprints at all sites to be broadly within the area that would be required for the operational footprint, where feasible and reasonable. This reduces the associated landscape character and visual impacts by minimising additional disturbance of land to establish construction sites
- Locating the stabling and maintenance facility construction site within an industrial area, where the landscape and visual sensitivity of receivers would be lower.

15.5 Westmead metro station construction site

15.5.1 Existing environment

The existing suburban and intercity rail corridor generally divides the landscape character of Westmead, running east-west through the suburb. The existing Westmead Station is located at the centre of Westmead. The character south of the rail corridor consists of a leafy low to medium density residential area. Streets are generally tree lined and include mature trees within larger residential garden frontages. Small scale commercial and community uses are scattered through this area, generally along or near Hawkesbury Road. This includes a strip of shops on the corner of Alexandra Avenue and Hawkesbury Road, and also at the corner of Alexandra Avenue and Hassall Street, with shopfronts also on Hassall Street. The locally heritage listed Westmead Public School (c1917) is also located on Hawkesbury Road. The former Parramatta Golf Club is located to the east of the site and forms part of the visual setting and green space buffer of Parramatta Park.

The character north of the rail corridor consists of a mixed use area with more intensive retail and office development, concentrated opposite Westmead Station and along Hawkesbury Road. A predominantly medium density residential area is located between the commercial area and Parramatta Park in the east. The character of Westmead is also currently affected by a number of key construction projects throughout the centre. Western Sydney University is currently redeveloping its Westmead campus site, transforming it into a retail, business and residential hub to support the surrounding health, medical and innovation district. Health Infrastructure NSW also plans to redevelop the Westmead Hospital precinct.

The Westmead metro station construction site is parallel to the rail corridor, south of the existing Westmead Station, and would be seen from the surrounding adjacent streets including Hawkesbury Road, Alexandra Avenue, Hassall Street and Bailey Street. Longer views to the site would be possible from Grand Avenue in the east and Bailey Street in the east, as a narrow view corridor. There are views from Railway Parade, south across the existing Westmead Station and the rail corridor, where existing vegetation and the station buildings do not intervene. This would include elevated views from the upper levels of residential and commercial medium rise buildings along Railway Parade, facing south towards the site. Further east, intervening built form and vegetation contain and obstruct views towards the site from Parramatta Park and the former Parramatta Golf Course.

As part of Parramatta Light Rail Stage 1, a future light rail terminus stop will be constructed at the northern corner of Hawkesbury Road and Railway Parade, opposite and to the north of Westmead Station. The light rail alignment will extend north along Hawkesbury Road which will alter the streetscape of the local area north of the rail corridor.

The landscape character and visual sensitivity of the area surrounding the Westmead metro station construction site is summarised in Table 15-11.

Table 15-11: Westmead metro station construction site – Landscape and visual sensitivity

Location	Landscape and visual sensitivity level
Westmead Station, Hawkesbury Road, Alexandra Avenue, Hassall Street and Bailey Street streetscapes	Local

15.5.2 Potential impacts

Westmead metro station construction site would cover about 15,750 square metres within the block bound by the rail corridor, Hawkesbury Road, Bailey Street and Hassall Street. The site would be used to carry out the excavation of Westmead metro station and as a launch and support site for the two tunnel boring machines for the tunnel drive east to the Sydney Olympic Park metro station construction site.

The key elements that would be seen would include:

- Demolition of retail, mixed use and residential buildings
- Removal of vegetation and about 100 trees within the construction footprint and some street trees
- A metal clad acoustic shed (about 15 metres in height) or other acoustic measures
- Material, plant and spoil storage areas, although these may be screened by the acoustic shed or other measures
- A car park, laydown area, workshops, dangerous goods storage, wheel wash, site offices and staff amenities
- Tunnel boring machine launch
- Segment storage
- Roadworks, road closures, footpath and bus stop relocation within the area surrounding the site
- Hoardings surrounding the construction sites, about three metres high.

Six representative viewpoints to assess potential visual amenity impacts of the Westmead metro station construction site are shown in Figure 15-1.

Figure 15-1: Westmead metro station construction site – Representative viewpoints

Landscape character impacts

The Westmead metro station construction site would require the demolition of low and medium-density residential buildings and some small scale commercial properties which contribute to the streetscape. The loss of the existing built form and vegetation, and the closure of Alexandra Avenue, would result in a substantial change to the urban form and character of these streetscapes, changing the streetscape of the residential areas to the south and south-east of the station. Vegetation removal within the rail corridor, which would be required to maintain existing pedestrian access to Westmead Station, would reduce the level of comfort and amenity for pedestrians approaching the station from the south.

Following completion of Stage 1, Alexandra Avenue would be realigned between Hassall Street and Hawkesbury Road with a new signalised intersection at Hawkesbury Road and Grand Avenue resulting in improved pedestrian permeability. During the closure of Alexandra Avenue, temporary alterations to footpaths and bus stops and loss of a locally prominent building at the corner of Hawkesbury Road and Alexandra Avenue would affect wayfinding and legibility within the neighbourhood.

The landscape character impact of Stage 1 on the Westmead Station, Hawkesbury Road, Alexandra Avenue, Hassall Street and Bailey Street streetscape is provided in Table 15-12.

Table 15-12: Westmead metro station construction site – Landscape character impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Westmead Station, Hawkesbury Road, Alexandra Avenue, Hassall Street and Bailey Street streetscapes	Local	Considerable reduction	**Moderate adverse**

Daytime visual amenity impacts

The anticipated daytime visual impacts on representative viewpoints as a result of Stage 1 are summarised in Table 15-13. A comparison of the existing view from Viewpoints 4 and 6 with the indicative views resulting from Stage 1 are provided in Figure 15-2 to Figure 15-5.

Generally, there would be minor and moderate visual impacts due to the proposed demolition and construction activities associated with Stage 1. This is considered in context of the construction site location, which is to the south of the existing Westmead Station. Construction traffic would also be visible entering and leaving the site. There would be a noticeable reduction in the amenity of views from streets, open space and properties which overlook construction of the power supply route.

Potential cumulative impacts are discussed in Section 15.14. Management of potential impacts and mitigation measures are discussed in Section 15.15.

Table 15-13: Westmead metro station construction site – Daytime visual amenity impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Viewpoint 1: View south-east from Hawkesbury Road and Alexandra Avenue	Local	Considerable reduction	**Moderate adverse**
Viewpoint 2: View south-west from the existing Westmead Station entry	Local	Considerable reduction	**Moderate adverse**
Viewpoint 3: View west from Railway Parade	Local	Noticeable reduction	**Minor adverse**
Viewpoint 4: View west from Alexandra Avenue and Hassall Street	Local	Considerable reduction	**Moderate adverse**
Viewpoint 5: View north-west from the corner of Hassall Street and Bailey Street	Local	Considerable reduction	**Moderate adverse**
Viewpoint 6: View north-east from Hawkesbury Road	Local	Considerable reduction	**Moderate adverse**
Viewpoint 7: View east along Alexandra Avenue	Neighbourhood	Noticeable reduction	**Negligible**
Power supply: View to Westmead power supply route - Hassell Street and Alexandra Avenue'	Local	No perceived change	**Negligible**
Power supply: Views to Westmead power supply route - Park Parade, Pitt Street and Macquarie Street	Regional	No perceived change	**Negligible**

Figure 15-2: Westmead metro station construction site – Existing view from viewpoint 4, west from Alexandra Avenue and Hassall Street

Figure 15-3: Westmead metro station construction site – Photomontage from viewpoint 4, west from Alexandra Avenue and Hassall Street

Figure 15-4: Westmead metro station construction site – Existing view from viewpoint 6, north-east from Hawkesbury Road

Figure 15-5: Westmead metro station construction site – Photomontage from viewpoint 6, north-east from Hawkesbury Road

Night-time visual amenity impacts

The anticipated night-time visual impacts as a result of Stage 1 are summarised in Table 15-14.

The area around the Westmead metro station construction site is well lit due to the existing Westmead Station, and lights associated with the town centre, which means construction works would generally be absorbed into the surrounding area. In this location, Stage 1 would result in a negligible night-time visual impact.

In residential areas which are removed from and less well-lit than Westmead Station, night works would contrast with the existing lower levels of light. Night works in this location would result in considerable reduction in the amenity of these areas and moderate adverse night-time visual impacts. Management of potential impacts and mitigation measures are discussed in Section 15.15.

Table 15-14: Westmead metro station construction site – Night-time visual amenity impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Westmead Station and Alexandra Avenue	E4: High district brightness	Noticeable reduction	**Negligible**
Bailey Street, Hawkesbury Road and Hassall Street residential area	E3: Medium district brightness	Considerable reduction	**Moderate adverse**

15.6 Parramatta metro station construction site

15.6.1 Existing environment

The Parramatta CBD comprises a diverse mix of contemporary and historic building forms and uses, reflective of the colonial settlement history of Parramatta. The Parramatta CBD is generally flat and features a grid street pattern with north-south aligned streets that channel views to the Parramatta River and east-west streets that channel views to Parramatta Park.

Church Street provides north-south access through the Parramatta CBD, connecting Prince Alfred Square and Parramatta River in the north with Centenary Square in the south. Distinctive architectural features assist in wayfinding along the street, including several heritage buildings with decorative facades. Along the activated street, several features such as awnings, an overhead art installation, trees and garden beds, and high-quality furnishings provide comfort and amenity to the pedestrian areas of the streetscape.

George Street and Macquarie Street run east-west through the Parramatta CBD and contain a mix of contemporary and historic character built form. The streets are activated in parts and include intermittent street trees and awnings improving the amenity to pedestrians. Smith Street contains a series of tall and bulky commercial buildings although the street is generally less activated than Macquarie and Church Streets. Construction works for Parramatta Square have resulted in the demolition of large areas of built form which has reduced building continuity along the street.

Connecting laneways such as Horwood Place, Macquarie Lane and United Lane have limited activation and generally include commercial driveways and access to parking. The laneways contain some street trees however pedestrian amenity is limited.

Centenary Square is an important civic square within the Parramatta CBD, providing a forecourt to the Parramatta Town Hall and St John's Anglican Cathedral. Centenary Square includes a mix of heritage and modern buildings, mature trees and an interactive water feature. Lawn areas, garden beds, fixed and temporary seating areas, colourful shade umbrellas and high quality paving enhance the amenity of the square.

Parramatta Park is a nationally important parkland featuring the World Heritage listed Old Government House and Domain. The park features open lawn and grassland areas, historic formal avenue planting, a rose garden, an open amphitheatre area beside the river (The Crescent), historical monuments, remnants, heritage listed buildings and formal gateway entries to surrounding streets.

The Parramatta metro station construction site would be visible from a limited visual catchment which is contained by the surrounding dense urban form of the city centre. The site would be seen primarily from short distance views from surrounding streets and laneways including Church Street, George Street, Smith Street, Macquarie Street, Horwood Place, United Lane and Macquarie Laneway. There would also be close-range views from Centenary Square, from its frontage on Macquarie Street. There would be possible views from the upper levels of nearby commercial tower developments on surrounding streets.

The landscape character and visual sensitivity of the area surrounding the Parramatta metro station construction site is summarised in Table 15-15.

Table 15-15: Parramatta metro station construction site – Landscape and visual sensitivity

Location	Landscape and visual sensitivity level
Church Street streetscape	Regional
Macquarie Street and George Street streetscapes	Local
Horwood Place, Macquarie Lane and United Lane	Neighbourhood
Centenary Square	Regional
Parramatta Park, including Old Government House and Domain	National

15.6.2 Potential impacts

The Parramatta metro station construction site would cover about 24,150 square metres within the block bounded by George Street, Church Street, Macquarie Street and Smith Street.

The key activities and components that would be seen at this site include:

- Demolition of retail and commercial buildings and structures
- Removal of all vegetation and six trees within the site, including the removal of several trees along Horwood Place and trimming of trees to the front of 60-64 Macquarie Street
- Site offices, site parking, workshops and amenities within the construction footprint
- Water treatment and laydown area to the west
- Temporary spoil storage in the centre of the site
- Road network changes on Horwood Place and adjustments to public transport and footpaths
- Hoardings surrounding the construction site, about three metres high.

Seven representative viewpoints to assess visual amenity impacts from the Parramatta metro station construction site are shown in Figure 15-6.

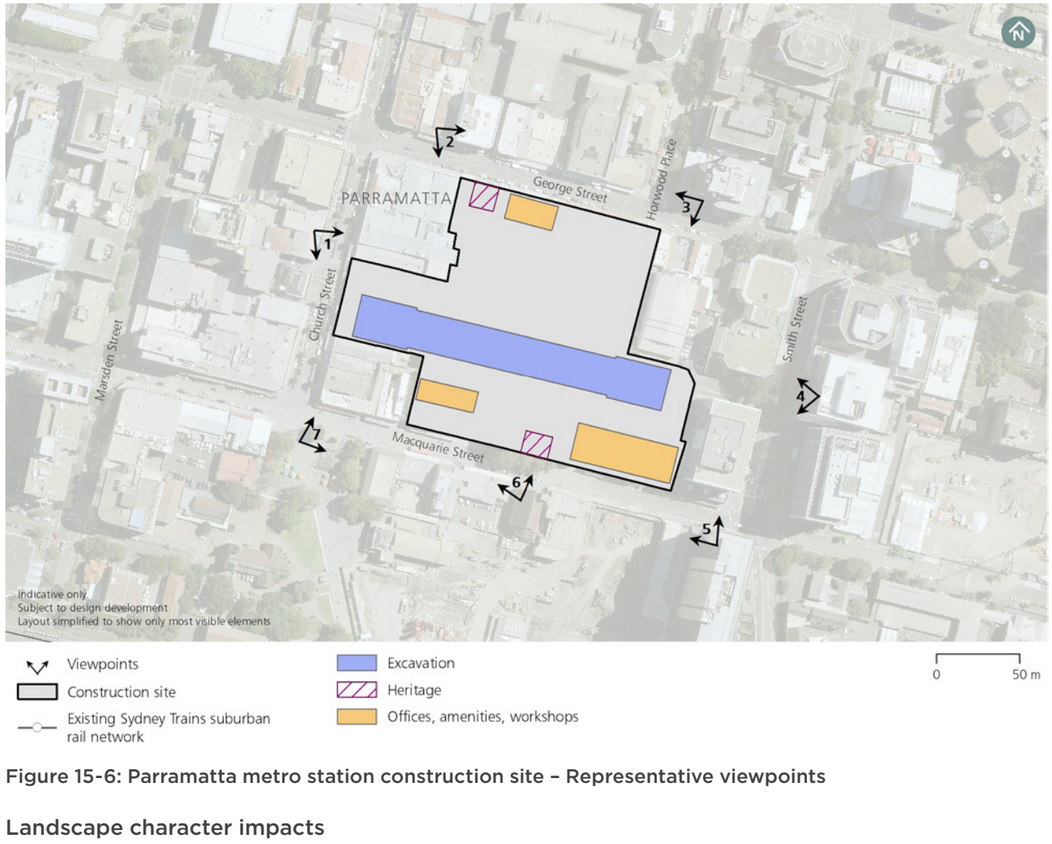

Figure 15-6: Parramatta metro station construction site – Representative viewpoints

Landscape character impacts

There would be changes to the existing streetscape in the Parramatta CBD from Stage 1, including the removal of existing buildings and an existing multi-storey car parking structure, creating a 'gap' in the building form. The heritage building at 45 George Street and Kia Ora on Macquarie Street would remain. However, the buildings adjacent to these heritage items at 220-230 Church Street and 55-67 George Street generally do not represent traditional building character and do not contribute positively to the visual character of the street.

The construction site would also temporarily reduce pedestrian access and permeability within the city by removing laneways and restricting midblock pedestrian movements.

Street trees on George and Smith Streets would not be removed. The removal of isolated trees within the site would not impact on the visual character of the area as only a few trees would be affected that are mostly concealed from surrounding streets.

Construction activity would also be visible from Centenary Square and Parramatta Park however would not result in any direct landscape impacts.

Landscape character impacts anticipated as a result of Stage 1 are summarised in Table 15-16.

Table 15-16: Parramatta metro station construction site – Landscape impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Church Street streetscapes	Regional	No perceived change	**Negligible**
Macquarie Street and George Street streetscapes	Local	Noticeable reduction	**Minor adverse**
Horwood Place, Macquarie Lane and United Lane	Neighbourhood	Considerable reduction	**Minor adverse**
Centenary Square	Regional	No perceived change	**Negligible**
Parramatta Park including Old Government House and Domain	National	No perceived change	**Negligible**

Daytime visual amenity impacts

The anticipated daytime visual amenity impacts on representative viewpoints as a result of Stage 1 are summarised in Table 15-17.

Hoardings would be erected along the property boundary partially blocking views to the construction site, regardless Stage 1 would temporarily result in visible construction activity in Parramatta. Existing buildings would be demolished at the site which would also be noticeable.

The site would also be viewed in the context of Parramatta Light Rail Stage 1, which would occupy views of Church Street and Macquarie Street. Construction traffic would be seen travelling along George Street, accessing the Parramatta metro station construction site. Management of potential impacts and mitigation measures are discussed in Section 15.15.

Table 15-17: Parramatta metro station construction site – Daytime visual amenity impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Viewpoint 1: View south-east along Church Street	Local	Noticeable reduction	**Minor adverse**
Viewpoint 2: View south-east along George Street	Local	Considerable reduction	**Moderate adverse**
Viewpoint 3: View south-west along George Street	Local	Considerable reduction	**Moderate adverse**
Viewpoint 4: View west from Smith Street	Local	Noticeable reduction	**Minor adverse**
Viewpoint 5: View north-west along Macquarie Street at the corner with Smith Street	Local	Noticeable reduction	**Minor adverse**
Viewpoint 6: View north-west along Macquarie Street	Local	Noticeable reduction	**Minor adverse**
Viewpoint 7: View east along Macquarie Street from near Centenary Square	Local	Noticeable reduction	**Minor adverse**
Power supply: Views to the power supply route (areas east of Marsden Street)	Local	No perceived change	**Negligible**
Power supply: Views to the power supply route (areas west of Marsden Street)	Regional	No perceived change	**Negligible**

Night-time visual amenity impacts

The anticipated night-time visual impacts as a result of Stage 1 are summarised in Table 15-18.

The urban context of the Parramatta CBD comprises a high district brightness, featuring brightly lit buildings and public domain areas, as well as light from traffic.

Although there would be night works requiring the use of lighting, the impacts of the lighting would generally be screened by surrounding buildings. The well-lit nature of the surrounding area would mean that Stage 1 would result in a negligible night-time visual impact, however it is expected there would potentially be some noticeable impacts. Management of potential impacts and mitigation measures are discussed in Section 15.15.

Table 15-18: Parramatta metro station construction site – Night-time visual amenity impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Parramatta metro station construction site	E4: High district brightness	Noticeable reduction	Negligible

15.7 Clyde stabling and maintenance facility construction site

15.7.1 Existing environment

The Clyde stabling and maintenance facility construction site is divided generally into north and south by A'Becketts Creek and Duck Creek which flows into the Duck River. There is limited visibility to these creeks from public and pedestrian areas, with visual access limited to where public roads cross the creeks and private properties. Due to the limited visibility and industrial nature of the surrounding land uses, these creeks do not contribute to the character of the landscape.

The southern part of the site is mainly currently leased by Sydney Speedway on NSW Government owned land. The speedway is surrounded by noise attenuation mounds and embankments, enclosing the raceway site from surrounding industrial areas and limiting views into the venue from surrounding areas.

The northern part of the site generally includes several large scale manufacturing plants. Streets within the area have an industrial streetscape character being generally broad with wide vehicle crossovers, overhead power lines and grassed verges. Dense mature sheoak trees along the western side of Unwin Street provide a landscape screen of views to and from James Ruse Drive.

Views would be available from the immediate surrounding industrial areas including Unwin and Shirley Streets to the north and east of the site. There would also be glimpses to the site along Wentworth and Deniehy Streets, in the south, through the bridges of the M4 Western Motorway. There are elevated views to the site, partly filtered by existing vegetation, from the elevated bridges of the M4 Western Motorway and James Ruse Drive, to the south and west of the site. There are also likely to be elevated views from the mid and high rise hotels and residential apartment buildings located at distance to the north-west within Rosehill, near James Ruse Drive. To the north the buildings and spectator stands within Rosehill Gardens racecourse would potentially have long range views across the site. These views would be screened in part by the existing vegetation and mounding along the perimeter of the Rosehill Gardens racecourse.

The landscape character and visual sensitivity of the area surrounding Clyde stabling and maintenance facility construction site is summarised in Table 15-19.

Table 15-19: Clyde stabling and maintenance facility construction site – Landscape and visual sensitivity

Location	Landscape and visual sensitivity level
Rosehill Gardens racecourse	Regional
Sydney Speedway	Neighbourhood
A'Becketts Creek and Duck Creek	Neighbourhood
The site and streetscapes including Unwin, Kay and Shirley Streets	Neighbourhood

15.7.2 Potential impacts

The Clyde stabling and maintenance facility construction site would cover about 380,000 square metres between the M4 Motorway, James Ruse Drive and Rosehill Gardens racecourse.

The key activities and components that would be seen at this site include:

- The demolition of buildings and structures within the site excluding the façade of the heritage listed RTA Depot building
- Removal of vegetation and about 300 trees including several street trees in Unwin Street West and trees within the site and removal of vegetation along some sections of A'Becketts Creek and Duck Creek to the south-east of the site
- Realignment of Duck Creek and A'Becketts Creek (to be partly enclosed in proposed culverts and remainder to be retained as a naturalised channel)
- Contamination and ground improvement works as required
- Establishment of a concrete segment production facility, segment laydown, site offices and spoil storage along Unwin Street to the north of the site
- Construction of an open dive structure (about 250 metres long)
- Earthworks and fill to raise the stabling and maintenance facility site to about 8.3 metres Australian Height Datum (AHD), including batters and retaining walls to support filling
- Construction of structures over A'Becketts Creek in the vicinity of the stabling area
- Works to realign Kay and Unwin Street
- Works would include the use of machinery and equipment such as mobile cranes, excavators, concrete pumps and piling rigs
- Hoardings and/or fencing surrounding the construction site, about three metres high.

Five representative viewpoints to assess visual amenity impacts from the Clyde stabling and maintenance facility construction site are shown in Figure 15-7.

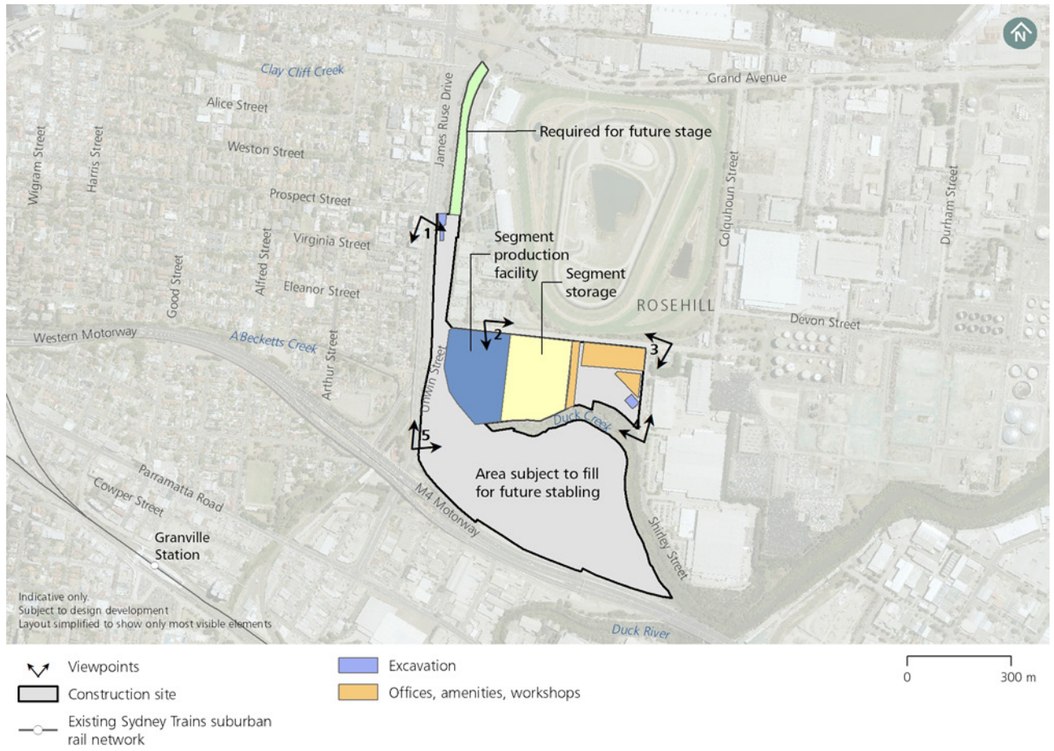

Figure 15-7: Clyde stabling and maintenance facility construction site – Representative viewpoints

Landscape character impacts

A'Becketts Creek and Duck Creek, where they pass through the site would be altered during construction. The vegetation would be removed and structures would be installed over both watercourses resulting in a noticeable reduction in the quality of A'Becketts Creek and Duck Creek landscape which is generally not publicly accessible.

The NSW Government owned land currently leased by Sydney Speedway, includes a substantially modified landscape and does not contribute positively to the landscape character of surrounding areas. Stage 1 would not result in a perceived change in the quality of this landscape.

Extensive, large scale earthworks would be carried out across the Unwin Road and Shirley Road streetscapes including the removal of structures, buildings and vegetation. Embankments and retaining walls would be constructed along the perimeter of the site substantially changing the landscape character and transforming the scale and relationship of the site to the adjacent streets, Rosehill Gardens racecourse and Duck River.

Landscape character impacts anticipated as a result of Stage 1 are summarised in Table 15-20.

Table 15-20: Clyde stabling and maintenance facility construction site – Landscape character impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Rosehill Gardens racecourse	Regional	No perceived change	**Negligible**
Sydney Speedway	Neighbourhood	No perceived change	**Negligible**
A'Becketts Creek and Duck Creek	Neighbourhood	Considerable reduction	**Minor adverse**
The site and streetscapes including Unwin, Kay and Shirley Streets	Neighbourhood	Considerable reduction	**Minor adverse**

Daytime visual amenity impacts

The anticipated daytime visual impacts on representative viewpoints as a result of Stage 1 are summarised in Table 15-21.

The Stage 1 construction works are generally in character with the existing and former heavy industrial character of the site and generally visual impacts would be minor. However, the proposed works would result in a changed visual amenity at the site, particularly in the context of the scale of works in this location.

Removal of vegetation within the site would open up views from James Ruse Drive to the construction site. Works to realign Unwin Street including the construction of a bridge structure over the proposed future rail tracks to the stabling and maintenance facility would be visible from James Ruse Drive. Management of potential impacts and mitigation measures are discussed in Section 15.15.

Table 15-21: Clyde stabling and maintenance facility construction site – Daytime visual amenity impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Viewpoint 1: View south-east from James Ruse Drive	Local	Considerable reduction	**Moderate adverse**
Viewpoint 2: View south-east from Unwin Street	Local	Noticeable reduction	**Minor adverse**
Viewpoint 3: View south-west from corner of Unwin and Shirley Street	Local	Noticeable reduction	**Minor adverse**
Viewpoint 4: View north from Shirley Street	Neighbourhood	Noticeable reduction	**Negligible**
Viewpoint 5: View north-east from M4 Western Motorway onramp	Local	Considerable reduction	**Moderate adverse**
Viewpoint 6: Views from Rosehill Gardens racecourse	Local	No perceived change	**Negligible**
Power supply: Views to the power supply route	Neighbourhood	No perceived change	**Negligible**

Night-time visual amenity impacts

The anticipated night-time visual impacts as a result of Stage 1 are summarised in Table 15-22.

Lighting visible at night would be associated with security lighting, lighting from deliveries and the concrete segment production facility. This would be readily absorbed into the existing moderately lit setting of adjacent industrial facilities.

Table 15-22: Clyde stabling and maintenance facility construction site – Night-time visual amenity impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Clyde stabling and maintenance facility construction site	E3: Medium district brightness	No perceived change	**Negligible**

15.8 Silverwater services facility construction site

15.8.1 Existing environment

Silverwater Road is a heavily trafficked road, six lanes wide and with concrete footpaths in a grassed verge near the site. Derby Street is a two-lane road, with a left in left out access, from Silverwater Road, providing access to the surrounding industrial areas of Silverwater. There are no footpaths along Derby Street. The site includes two mature gum trees and some smaller saplings, which provides some visual amenity to the adjacent areas.

Where there are street trees and landscaped areas along these streets, the streetscape of commercial buildings is softened and visual amenity is improved. In other areas, the streetscape is dominated by the character of commercial buildings and heavy vehicle traffic with limited pedestrian amenity. The flat land and consistent building design reduces pedestrian wayfinding within the industrial areas of Silverwater.

Due to the flat topography of Silverwater and visual containment provided by the large scale built form, views to the construction site would generally be limited to short and medium distance views from the street, footpaths and properties adjacent to the site on Derby Street or Silverwater Road.

The landscape character and visual sensitivity of the area surrounding Silverwater services facility construction site is summarised in Table 15-23.

Table 15-23 Silverwater services facility construction site – Landscape and visual sensitivity

Location	Landscape and visual sensitivity level
Trees within the site, Silverwater Road and Derby Street streetscapes	Neighbourhood

15.8.2 Potential impacts

The Silverwater services facility construction site would cover about 2,700 square metres on the corner of Silverwater Road and Derby Street. The site is currently a vacant lot.

The key activities and components that would be seen at this site include:

- Removal of five trees including three street trees on Derby Street and vegetation within the site including one of the two mature gum trees
- Establishment of hoardings surrounding the construction site, about three metres high
- Service facility shaft excavation adjacent to Derby Street at the north-east corner of the site
- Temporary plant and material storage at the south-east corner of the site
- Site office, amenities and workshop at the south and south-west corner of the site adjacent to Silverwater Road
- Adjustments to parking, public transport and pedestrian access
- The use of machinery and equipment such as mobile cranes, excavators, concrete pumps, piling rigs.

Three representative viewpoints to assess visual amenity impacts from the Silverwater services facility construction site are shown in Figure 15-8.

Figure 15-8: Silverwater services facility construction site – Representative viewpoints

Landscape character impacts

Landscape impacts anticipated as a result of Stage 1 are summarised in Table 15-24.

Stage 1 would require the removal of one of the two mature gum trees and three street trees on Derby Street resulting in a reduction in amenity for pedestrians and road users. Excavation of the shaft, adjacent material storage, site amenities and workshop would transform the character of this property into a construction site. These changes would be localised and affect only a small part of these streetscapes.

Table 15-24: Silverwater services facility construction site – Landscape impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Trees within the site, Silverwater Road and Derby Street streetscapes	Neighbourhood	Noticeable reduction	Negligible

Daytime visual amenity impacts

The anticipated daytime visual impacts on representative viewpoints as a result of Stage 1 are summarised in Table 15-25.

The removal of vegetation and establishment of a construction site would introduce a construction character to views along Silverwater Road and Derby Street. This would largely be absorbed into the scale and character of the area which has an industrial urban form with considerable traffic movement.

Table 15-25: Silverwater services facility construction site – Daytime visual amenity impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Viewpoint 1: View north-east along Silverwater Road	Neighbourhood	Noticeable reduction	Negligible
Viewpoint 2: View south along Silverwater Road	Neighbourhood	Noticeable reduction	Negligible
Viewpoint 3: View south-west along Derby Street	Neighbourhood	Noticeable reduction	Negligible

Night-time visual amenity impacts

The anticipated night-time visual impacts as a result of Stage 1 are summarised in Table 15-26.

While most work at the services facility site would be carried out during standard construction hours, there may be some after hours delivery of large plant and equipment. Security, vehicle and task lighting would be visible within the site at night, however it is expected that the additional light sources and skyglow would be absorbed into the night scene, where similarly lit industrial complexes exist. Surrounding land uses are primarily industrial and commercial properties where there would be little activity at night, and therefore few receivers, which reduces the night-time visual sensitivity of this location.

Table 15-26: Silverwater services facility construction site – Night-time visual amenity impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Silverwater services facility construction site	E3: Medium district brightness	No perceived change	Negligible

15.9 Sydney Olympic Park metro station construction site

15.9.1 Existing environment

The legacy of the Sydney 2000 Olympic and Paralympic Games at Sydney Olympic Park resulted in the creation of a series of iconic sporting and recreational facilities, including ANZ Stadium, formerly known as the Olympic Stadium. The major event facilities are arranged around two principle axes; Olympic Boulevard and Dawn Fraser Avenue which provide grand ceremonial vistas between the various destinations.

Herb Elliot Avenue, running adjacent to Dawn Fraser Avenue, contains mature native street trees that contribute to a leafy streetscape character and visually softens adjacent commercial buildings that are set back from and include generous garden areas. The streetscape and built form pattern along Herb Elliott Avenue will be transformed into a high density mixed use town centre in the future as part of the Sydney Olympic Park Master Plan 2030.

The Abattoir Heritage Precinct located off Herb Elliot Avenue, is designed in a Federation style with a collection of buildings set within landscaped gardens and lawns. The gardens provide an important setting to the buildings and include formal rose gardens, a palm grove, avenue planting and succulent gardens. The heritage buildings, landscaped gardens and a heritage listed palm grove within the Abattoir Heritage Precinct provide a visual contrast to the surrounding urban setting.

Figtree Drive is a narrow local traffic street with two traffic lanes, indented parking areas, planted verges and footpaths on both sides. Trees form a consistent landscape element and contribute to the amenity and sense of place of the streetscape and provide shade and comfort for pedestrians. Land uses along Herb Elliott Avenue are intended to be transformed into a high density mixed use town centre as shown by the current construction of a mixed use tower development at 2 Figtree Drive.

The Sydney Olympic Park metro station construction site would be visible from the immediate surrounding streets within the south-east part of the urban renewal area where views would not be screened by large scale built form and mature vegetation within private properties and public realm areas. This includes parts of Herb Elliott Avenue, Figtree Drive and Showground Road. More distant views would be available from near Dawn Fraser Avenue along Showground Road, due to the wide, open nature of this street and heritage curtilage of the adjacent Abattoir Heritage Precinct.

Possible elevated views are available from the upper levels of nearby hotels, tall commercial buildings and residential towers. Views may also be available from the Gantry Walk at the ANZ Stadium and Bicentennial Marker on Australia Avenue.

The landscape character and visual sensitivity of the area surrounding the Sydney Olympic Park metro station construction site is summarised in Table 15-27.

Table 15-27: Sydney Olympic Park metro station construction site – Landscape and visual sensitivity

Location	Landscape and visual sensitivity level
Herb Elliott Avenue and Showground Road streetscape	Local
The Abattoir Heritage Precinct gardens	Local
Figtree Drive streetscape	Local

15.9.2 Potential impacts

The Sydney Olympic Park Station construction site would cover about 23,900 square metres between Herb Elliot Avenue and Figtree Drive.

The key activities and components that would be seen at this site include:

- Demolition of buildings at 8 Herb Elliott Avenue, and 5 and 7 Figtree Drive
- Removal of part of the Abattoir Heritage Precinct gardens adjacent to Buildings A and E (Administration building and Gatehouse), including part of the carriage loop planting and mature palm grove. Sydney Metro is investigating the feasibility of design and construction options to avoid direct impacts to this heritage item
- Removal of about 100 trees and shrubs within the construction site, including within the car parks, site boundaries and entrance gardens and two trees on Figtree Drive, located at the south-east and south-west corner of the construction site
- Two metal clad acoustic sheds (around 15 metres high) or other acoustic measures on Figtree drive and on Herb Elliot Avenue, temporary spoil storage and laydown areas and tunnel boring machine retrieval site
- Establishment of site offices, parking area, amenities, workshops, material/plant storage areas, dangerous goods storage and water treatment plant.

Five representative viewpoints to assess visual amenity impacts from the Sydney Olympic Park metro station construction site are shown in Figure 15-9.

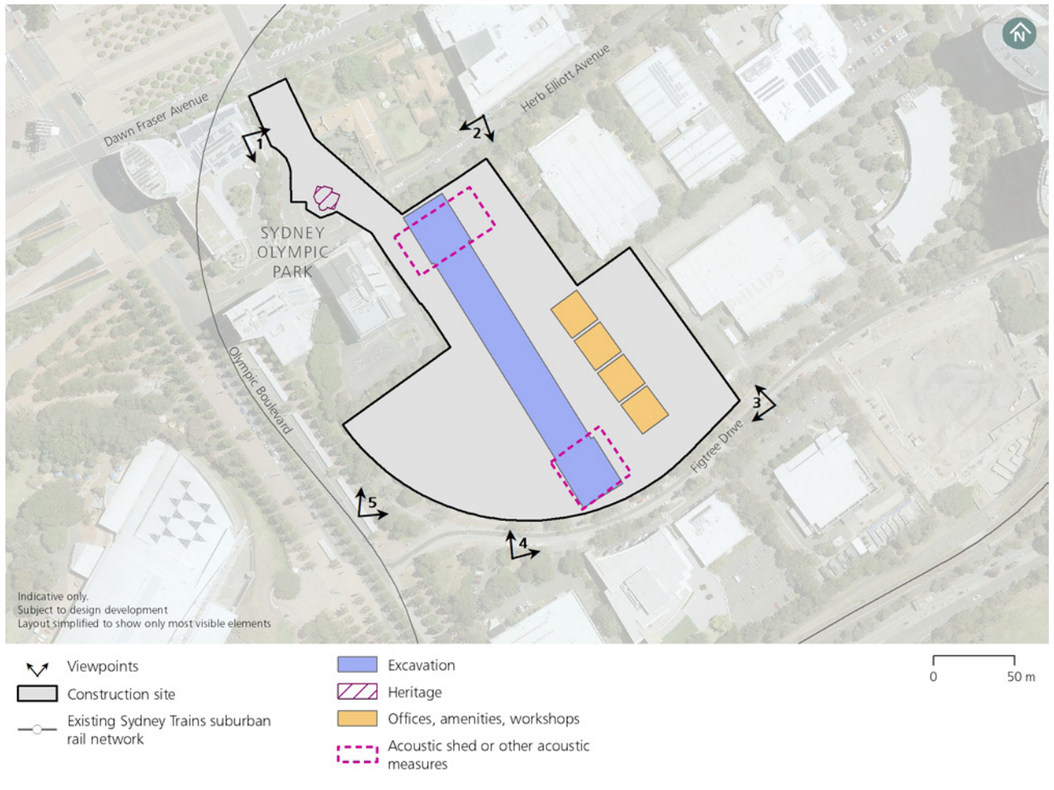

Figure 15-9: Sydney Olympic Park metro station construction site – Representative viewpoints

Landscape character impacts

The landscape character of the site would be altered by the proposed Stage 1 works. Key changes surrounding the site include the closure of Showground Road at the intersection with Dawn Fraser Avenue. The proposed construction site would be established over part of the Abattoir Heritage Precinct, and would involve the removal of a number of mature trees and shrubs from within the site.

The extension of the construction site to the north and south through the Abattoir Heritage Precinct gardens would have a considerable impact on landscape character. The heritage buildings would be retained, however the gardens separating them would be partially removed. This includes the southern portion of the palm grove and surrounding carriage loop gardens. The impact of the construction works would be that the symmetrical design of the garden would be lost, although parts of the garden would also be retained. This impact could be lessened with the reinstatement of the gardens with appropriate similar species and plantings in keeping with the provisions of the Conservation Management Plan. Sydney Metro is also investigating the feasibility of design and construction options to avoid direct impacts to this heritage item.

Landscape character impacts anticipated as a result of Stage 1 are summarised in Table 15-28. Management of potential impacts and mitigation measures are discussed in Section 15.15.

Table 15-28: Sydney Olympic Park metro station construction site – Landscape character impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Herb Elliott Avenue and Showground Road streetscape	Local	Considerable reduction	Moderate adverse
The Abattoir Heritage Precinct gardens	Local	Considerable reduction	Moderate adverse
Figtree Drive streetscape	Local	Noticeable reduction	Negligible

Daytime visual amenity impacts

The anticipated daytime visual impacts on representative viewpoints as a result of Stage 1 are summarised in Table 15-29. A comparison of the existing view from viewpoints 2 with the indicative view from Stage 1 is provided in Figure 15-10 and Figure 15-11.

The proposed construction site would occupy much of the centre of views across Showground Road and Herb Elliott Avenue. The removal of trees would change the leafy streetscape character of viewpoints 1 and 2.

Temporary construction vehicles and access points, as well as acoustic sheds (or other acoustic measures) and barriers in the construction area would substantially change the character of the area within the site. This would also be affected by the closure of Showground Road at Dawn Fraser Avenue. However, these changes would occur in the context of ongoing development and changes within Sydney Olympic Park. The visual bulk of temporary structures is generally consistent with the changing visual context of the town centre more broadly, including other construction works. Management of potential impacts and mitigation measures are discussed in Section 15.15.

Table 15-29: Sydney Olympic Park metro station construction site – Daytime visual amenity impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Viewpoint 1: View south-east along Showground Road	Local	Considerable reduction	Moderate adverse
Viewpoint 2: View south-west along Herb Elliott Avenue	Local	Considerable reduction	Moderate adverse
Viewpoint 3: View north-west along Figtree Drive	Neighbourhood	Noticeable reduction	Negligible
Viewpoint 4: View east along Figtree Drive	Neighbourhood	Noticeable reduction	Negligible
Viewpoint 5: View north-east from Olympic Boulevard	Local	Noticeable reduction	Minor adverse

Figure 15-10: Sydney Olympic Park metro station construction site – Existing view from viewpoint 2, south-west from Herb Elliott Avenue

Figure 15-11: Sydney Olympic Park metro station construction site – Photomontage from viewpoint 2, south-west from Herb Elliott Avenue

Night-time visual amenity impacts

Night works would be required at the site during construction. Although most works would be contained and underground there would be some lighting required outside these areas. This includes lighting associated with site offices, car parking and construction support areas. The proposed screening, as well as street trees and some adjacent buildings would provide screening of the site lighting. In the case of the Abattoir Heritage Precinct, this lighting would contrast with the lower light levels of the precinct.

Removal of some vegetation would also contribute to impact through the loss of natural screening, however overall, the impact would be absorbed into the existing moderately lit night scene.

The anticipated night-time visual impacts as a result of Stage 1 are summarised in Table 15-30. Management of potential impacts and mitigation measures are discussed in Section 15.15.

Table 15-30: Sydney Olympic Park metro station construction site – Night-time visual amenity impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Sydney Olympic Park metro station construction site	E3: Medium district brightness	Noticeable reduction	Minor adverse

15.10 North Strathfield metro station construction site

15.10.1 Existing environment

The North Strathfield local centre is centred on Queen Street, which runs north-south adjacent to the existing North Strathfield Station and the rail corridor. The local centre includes a block of early twentieth century two-storey commercial terrace buildings, with retail and offices at street level and some residences above. Queen Street is characterised by an avenue of mature Brushbox trees that have a local heritage listing and create a strong north south visual boundary, screening the station and rail corridor from the adjacent residential area. The trees contribute to a leafy streetscape character enhancing the amenity of the surrounding residential area. Pedestrian connectivity to the existing station is provided by footpaths to both sides of Queen Street and a centrally located pedestrian crossing near the station entrance.

A heritage listed garden is located on Queen Street, at the eastern entrance to the existing North Strathfield Station. This small ornamental garden contributes to the local identity of the North Strathfield neighbourhood centre, providing a visual feature that marks the entry to the existing railway station. The garden has a formal layout with straight pathways forming triangular garden areas, lined with low manicured hedges and containing roses and other decorative plants. The gardens are framed by semi-mature trees. South of this garden is a row of heritage street trees.

Legibility of North Strathfield Station and the gardens is reinforced by the grid pattern of the surrounding residential streets, which channels views towards Queen Street and the station.

The North Strathfield metro station construction site is located on elevated land which falls in a westerly direction towards Powells Creek. The visual catchment is mostly contained by surrounding urban built form and vegetation adjacent to the rail corridor. There would be short range views to the construction site from the adjacent North Strathfield Station and residential streets on the eastern side including Queen, Beronga, Wellbank and Waratah Streets.

From the west, some views would be possible from Hamilton Street East, and there would be elevated views from nearby residential, educational and commercial multi-storey buildings which overlook the rail corridor.

The landscape character and visual sensitivity of the area surrounding the North Strathfield metro station construction site is summarised in Table 15-31.

Table 15-31: North Strathfield metro station construction site – Landscape and visual sensitivity

Location	Landscape and visual sensitivity level
Railway heritage gardens	Local
Queen Street streetscape	Local

15.10.2 Potential impacts

The construction of North Strathfield metro station would require two sites:

- The North Strathfield metro station northern construction site would cover about 6,500 square metres between the existing North Strathfield Station and Queen Street, bounded by Pomeroy Street to the north and the pedestrian entrance to the existing North Strathfield Station to the south
- The North Strathfield metro station southern construction site would cover about 1,000 square metres and occupy land between the existing North Strathfield Station and Queen Street, bounded by Shipley Avenue to the south and the pedestrian entrance to the existing North Strathfield Station to the north.

The key activities and components that would be seen at the North Strathfield metro station construction sites would include:

- Removal of about 30 trees and vegetation including the northern garden bed and trees within the heritage listed ornamental gardens and street trees along the west side of Queen street and all vegetation within the northern construction site
- A workshop, material and plant storage area, dangerous goods storage and water treatment plant
- Adjustments to parking, pedestrian and public transport access
- Use of machinery and equipment such as mobile cranes, excavators, concrete pumps and piling rigs
- Site fencing and hoarding surrounding the construction site, about three metres high
- Construction site parking
- Double stacked site offices and amenities.

Four representative viewpoints to assess visual amenity impacts from the North Strathfield metro station construction site are shown in Figure 15-12.

Figure 15-12: North Strathfield metro station construction site – Representative viewpoints

Landscape character impacts

Stage 1 would result in the northern half of the railway heritage gardens being removed, including the clipped hedges and ornamental plantings. This would change the sense of place in this location, as well as the accessibility and level of shade and comfort at the railway station entrance.

Temporary changes would also be made to Queen Street, including the relocation of the existing pedestrian crossing to the south of Wellbank Street. The extension of the construction site to the Queen Street kerb would also include the removal of existing mature street trees. Additional construction activity, including traffic movements to and from the site would also affect the landscape character.

Landscape character impacts anticipated as a result of Stage 1 are summarised in Table 15-32. Management of potential impacts and mitigation measures are discussed in Section 15.15.

Table 15-32: North Strathfield metro station construction site – Landscape character impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Railway heritage gardens	Local	Considerable reduction	**Moderate adverse**
Queen Street streetscape	Local	Considerable reduction	**Moderate adverse**

Daytime visual amenity impacts

The anticipated daytime visual impacts on representative viewpoints as a result of Stage 1 are summarised in Table 15-33.

The North Strathfield metro station construction site would require the removal of existing trees and would extend to the kerb resulting in visual impacts along Queen Street and for residences or businesses fronting Queen Street opposite the construction site. The proposed works would also include the partial removal of the railway heritage gardens. This would affect the leafy context of these existing areas.

Temporary noise hoardings would be installed along the site boundary and partially screen the view of the site from the surrounding areas. The linear nature of this construction site would create a strong horizontal wall. Construction traffic would also be visible entering and exiting the site near the Pomeroy Street bridge. Management of potential impacts and mitigation measures are discussed in Section 15.15.

Table 15-33: North Strathfield metro station construction site – Daytime visual amenity impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Viewpoint 1: View south along Queen Street and Beronga Street	Local	Considerable reduction	**Moderate adverse**
Viewpoint 2: View west along Waratah Street	Local	Considerable reduction	**Moderate adverse**
Viewpoint 3: View north-west from the corner of Queen and Wellbank Streets	Local	Noticeable reduction	**Minor adverse**
Viewpoint 4: View north-west from Queen Street	Local	Noticeable reduction	**Minor adverse**

Night-time visual amenity impacts

The anticipated night-time visual impacts as a result of Stage 1 are summarised in Table 15-34.

There would generally be no night works required at the North Strathfield metro station construction site. There may, however, be some oversized deliveries at night and there would be some security lighting at the northern site. While the removal of the mature street trees and vegetation along Queen Street, would open up views to the site from the residential properties opposite the site, this lighting would be somewhat contained by perimeter site fencing and/or hoarding. There would also be some security lighting at the southern site for the site offices and parking area, although this would generally be screened by existing vegetation.

Table 15-34: North Strathfield metro station construction site – Night-time visual amenity impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
North Strathfield metro station site	E3: Medium district brightness	Noticeable reduction	**Minor adverse**

15.11 Burwood North Station construction site

15.11.1 Existing environment

The Burwood North Station construction site is situated on two sites, generally between Burwood Road and Loftus Street. One construction site would be to the north of Parramatta Road (northern construction site) and the second to the south of Parramatta Road (southern construction site). Parramatta Road is a six lane thoroughfare linking the Parramatta CBD to Sydney CBD. This heavily trafficked road physically and visually separates the urban communities of Burwood and Concord. The Parramatta Road corridor includes retail, commercial, light industrial, medium density residential and open space uses. At North Burwood, Parramatta Road presents a visually harsh streetscape with few street trees, poor pedestrian environments and vehicle-dominated uses.

The urban form along this section of Parramatta Road is largely fragmented. It contains some remnant buildings that show a traditional main street character such as the local heritage listed Bath Arms Hotel on the corner of Parramatta Road and Burwood Road.

Burwood Road runs north-south, providing a direct link between North Burwood and Burwood town centre. A number of different mixed use buildings have also been recently constructed along Burwood Road in the vicinity of Parramatta Road, which has resulted in changes to the visual character of the street. This changing character continues along the Parramatta Road corridor.

Nearby, the local heritage listed St Luke's Anglican Church forms a notable local visual feature. The church is located in an attractive landscaped setting and contributes to the amenity of the residential area to the north of the site.

Concord Oval provides an important sporting facility and greenspace for the highly developed urban area. Concord Oval contains a locally heritage listed gateway and five mature fig trees which were once the entrance to St Luke's Park. Canada Bay Council is currently planning a redevelopment of Concord Oval including the construction of a new indoor recreation centre and passive recreation areas.

Views to the Burwood North Station construction site would be limited to the immediate surrounding major roads and streets due to the visual containment provided by built form, particularly along the Parramatta Road corridor, and due to visual screening from mature vegetation within Concord Oval.

Short distance views to the northern construction site would be possible from Parramatta Road, Burwood Road, Burton Street, Loftus Street, Neichs Lane and Esher Street.

The southern construction site would be seen from Parramatta Road, Burwood Road, Webster Lane and Esher Lane. It is also possible that there would be elevated views from nearby multi-storey residential buildings on Burwood and Parramatta Roads.

The landscape character and visual sensitivity of the area surrounding the Burwood North Station construction site is summarised in Table 15-35.

Table 15-35: Burwood North Station construction site – Landscape and visual sensitivity

Location	Landscape and visual sensitivity level
Parramatta Road and Burwood Road streetscapes	Local
Burton Street, Loftus Street and Niches Laneway streetscapes	Local

15.11.2 Potential impacts

Construction of Burwood North Station would require two construction sites:

- The Burwood North Station northern construction site would cover about 13,100 square metres and would be located on Parramatta Road between Burwood Road and Loftus Street
- The Burwood North Station southern construction site would cover about 1,400 square metres bound by Burwood Road, Parramatta Road, Esher Lane and commercial properties west of Esher Street.

The key activities and components that would be seen at the Burwood North Station north construction site include:

- The demolition of commercial and residential buildings
- The removal of about 60 trees and vegetation within the site and trimming of trees that overhang the site on Neichs Lane and at 18 Burton Street
- Site offices and amenities on the northern boundary of the site
- Metal clad acoustic sheds (about 15 metres high) (or other acoustic measures)
- Station excavation works and support
- Site laydown area
- Adjustments to parking, public transport and pedestrian access
- Water treatment plant along Parramatta Road
- Noise barriers and hoardings surrounding the construction site about three metres high.

The key activities and components that would be seen at the Burwood North Station south construction site include:

- Demolition of commercial buildings
- A metal clad acoustic shed (about 15 metres high) (or other acoustic measures)
- Adjustments to parking, public transport and pedestrian access
- Noise barriers and hoardings surrounding the construction site about three metres high.

Six representative viewpoints to assess visual amenity impacts from the Burwood North Station construction site are shown in Figure 15-13.

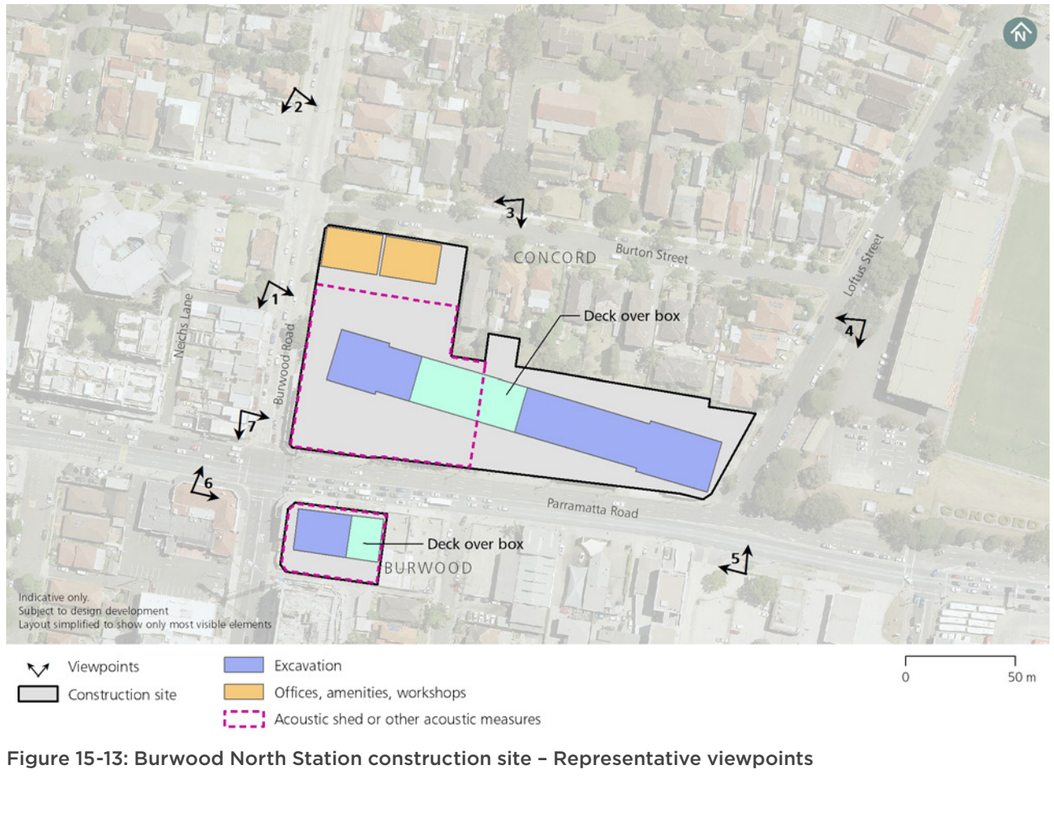

Figure 15-13: Burwood North Station construction site – Representative viewpoints

Landscape character impacts

Stage 1 would result in the demolition of an entire block of buildings along the northern side of Parramatta Road, as well as a smaller number of buildings on the southern side of Parramatta Road. The construction site would create a gap in the built form around North Burwood. This has the potential to affect sense of place and identity.

The scale of an acoustic shed (or other acoustic measures) on the southern site would result in some temporary overshadowing of the existing medium density residential property located directly to the south of the construction site. This overshadowing would extend to a greater number of properties than the existing overshadowing by the current building on this site, but would be consistent with what could be expected with further medium density buildings being developed as a part of the area's urban renewal.

The proposed works may also include temporary alterations to footpaths, and the removal of some trees inside the construction site. Heavy vehicle haulage to and from the site would also be noticeable.

Establishment of the northern construction site would require removal of all trees and shrubs within the site including several residential gardens facing Burton Street near the intersection with Burwood Road. While this would reduce the leafy streetscape character, the level of comfort and amenity of the adjacent footpaths in this section of Burton Street, the remainder of the street would remain unchanged.

Landscape character impacts anticipated as a result of Stage 1 are summarised in Table 15-36. Management of potential impacts and mitigation measures are discussed in Section 15.15.

Table 15-36: Burwood North Station construction site – Landscape character impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Parramatta Road and Burwood Road streetscapes	Local	Considerable reduction	**Moderate adverse**
Burton Street, Loftus Street and Niches Laneway streetscapes	Local	Noticeable reduction	**Minor adverse**

Daytime visual amenity impacts

The anticipated daytime visual impacts on representative viewpoints as a result of Stage 1 are summarised in Table 15-37. A comparison of the existing view from viewpoints 2 and 6 with the indicative views resulting from Stage 1 are provided in Figure 15-14 to Figure 15-17.

Visual impacts would result from the demolition of existing buildings along Burwood Road and Parramatta Road. The removal of these buildings would create a gap in the streetscape, including the removal of two prominent corner buildings.

The erection of temporary acoustic sheds (or other acoustic measures) would alter the streetscape from the existing one and two storey fine grain commercial character of Parramatta Road in this area.

Heavy vehicles would also be seen travelling along Parramatta Road to and from the site, and using entrance points to the site. Management of potential impacts and mitigation measures are discussed in Section 15.15.

Table 15-37: Burwood North Station construction site – Daytime visual amenity impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Viewpoint 1: View south along Burwood Road	Local	Considerable reduction	**Moderate adverse**
Viewpoint 2: View south across the intersection of Burwood Road and Burton Street	Local	Considerable reduction	**Moderate adverse**
Viewpoint 3: View south-west along Burton Street	Local	Considerable reduction	**Moderate adverse**
Viewpoint 4: View south-west along Loftus Street	Local	Noticeable reduction	**Minor adverse**
Viewpoint 5: View north-west along Parramatta Road	Local	Noticeable reduction	**Minor adverse**
Viewpoint 6: View east across the intersection of Parramatta Road and Burwood Road	Local	Considerable reduction	**Moderate adverse**
Viewpoint 7: View south-east from the intersection of Parramatta Road and Burwood Road	Local	Considerable reduction	**Moderate adverse**

Figure 15-14: Burwood North Station construction site – Existing view from viewpoint 2, south across the intersection of Burwood Road and Burton Street

Figure 15-15: Burwood North Station construction site – Photomontage from viewpoint 2, south across the intersection of Burwood Road and Burton Street

Figure 15-16: Burwood North Station construction site – Existing view from viewpoint 6, east across the intersection of Parramatta Road and Burwood Road

Figure 15-17: Burwood North Station construction site – Photomontage from viewpoint 6, east across the intersection of Parramatta Road and Burwood Road

Night-time visual amenity impacts

The anticipated night-time visual impacts as a result of Stage 1 are summarised in Table 15-38.

Works would be required at night at the Burwood North Station construction site. Although the work would largely be contained by barriers and the acoustic sheds (or other acoustic measures such as acoustic panels over excavations) at the site, some lighting would be required outside of the covered areas including lighting associated with construction support areas and haulage on Parramatta Road, Burwood Road and Loftus Street.

Due to the removal of mature vegetation, there is potential for adjacent residential buildings to view the night-time construction activity.

Works may also be visible from Parramatta Road, however it is expected the lighting impact from these works would generally be absorbed into the surrounding context. Management of potential impacts and mitigation measures are discussed in Section 15.15.

Table 15-38: Burwood North Station construction site – Night-time visual amenity impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Burwood North Station construction site	E3: Medium level brightness	Noticeable reduction	Minor adverse

15.12 Five Dock Station construction site

15.12.1 Existing environment

Five Dock has a vibrant town centre located on Great North Road, including a mix of commercial, retail, community, residential and civic open space uses. The mix of different low rise buildings in the town centre creates a continuous building form, with similar setbacks and building scales. Great North Road comprises a mix of modern and heritage buildings with distinctive decorative façades that assist in wayfinding along the street. Wide footpaths on both sides of the street, intermittent street trees and continuous awnings provide shade and comfort for pedestrians. The road is highly activated with retail frontages, street cafes and alfresco dining areas.

East Street adjoins the western construction site and is a narrow neighbourhood street with footpaths on either side but no street trees. This street provides service access and carparking areas for developments fronting Great North Road and contains visually sensitive residential receivers.

Fred Kelly Place is on the southern boundary of the western construction site and forms a major activity hub for the town centre and is activated by adjoining cafes, shops and commercial uses including the Five Dock Library which is located at the western end of the square. A small playground area, mature trees, garden beds in raised planters, high-quality urban furnishings and quality paving provide comfort and amenity to the square. Sculptural art with the signage 'Fred Kelly Place' beside the main street provides a visual focus.

Second Avenue forms the northern boundary of the eastern construction site and comprises a mixed use and residential development. It has continuous footpaths within narrow grassed verges and intermittent street trees on the northern side of the road across from the site.

Waterview Street adjoins the eastern construction site to the west and is lined by predominantly one to two-storey detached properties and low rise multi storey residential apartment blocks with limited street trees.

Streetscape improvements are also proposed for Great North Road by Canada Bay Council including landscape and pavement improvements. The 'Five Dock Streetscape upgrade' project is a direct outcome from the Five Dock Town Centre Urban Design Study Recommendations study (2014). The streetscape works are expected to commence in early 2020 and take 12 months to complete.

Views to the Five Dock Station western construction site are generally confined to short distance views from adjacent streets due to the density of the surrounding urban form within the Five Dock town centre. The western construction site would be visible from East Street, Great North Road, Fred Kelly Place and Second Avenue. There would also be elevated views across the site from the forecourt area surrounding the first floor level library, and nearby multi-storey residential buildings which currently overlook Fred Kelly Place and the construction site.

The eastern construction site would be seen from Waterview Street, Second Avenue and parts of Great North Road. There may also be elevated views across the site from the nearby multi-storey residential buildings.

The landscape character and visual sensitivity of the area surrounding the Five Dock Station construction site is summarised in Table 15-39.

Table 15-39: Five Dock Station construction site – Landscape and visual sensitivity

Location	Landscape and visual sensitivity level
Great North Road streetscape	Local
East Street, Second Avenue and Waterview Street streetscape	Local
Fred Kelly Place and Australia Post open space	Local

15.12.2 Potential impacts

Construction of Five Dock Station would require two construction sites:

- The Five Dock Station western construction site would cover about 4,150 square metres and would be located between Great North Road and East Street, to the north of Fred Kelly Place and south of St Albans Anglican Church
- The Five Dock Station eastern construction site would cover about 2,150 square metres and be located to the east of Great North Road at the corner of Second Avenue and Waterview Street.

The key activities and components that would be seen at the Five Dock Station western construction site include:

- Demolition of commercial buildings, structures and a car park
- Removal of about 15 trees and all other vegetation within the site including several small trees facing East Street and seven trees within 23 and 25 Waterview Street
- Possible trimming of some trees which overhang the site
- Car parking, laydown area and a water treatment plant
- A metal clad acoustic shed (about 15 metres in height) (or other acoustic measures)
- Station shaft excavation works and support
- Station cavern excavation and temporary storage
- Hoarding surrounding the construction site, about three metres in height.

The key activities and components that would be seen at the Five Dock Station eastern construction site include:

- Demolition of residential buildings and a car park
- Removal of about seven trees within the site and the trimming of some trees overhanging the site
- Office and staff amenities double stacked along Waterview Street
- Water treatment plant along Waterview Street, a workshop and dangerous good storage
- A metal clad acoustic shed (about 15 metres in height) (or other acoustic measures)
- Station shaft excavation works and support
- Station cavern excavation and temporary storage
- Adjustments to parking, public transport and pedestrian access
- Hoarding surrounding the construction site, about three metres in height.

Eight representative viewpoints to assess visual amenity impacts from the Five Dock Station construction site are shown in Figure 15-18.

Figure 15-18: Five Dock Station construction site – Representative viewpoints

Landscape character impacts

The location of Stage 1 close to Great North Road, which acts as the main north-south spine through Five Dock would result in impact to the existing landscape character in the vicinity of the western construction site. The extended street frontage of the site and the need for construction vehicles to enter the site from Great North Road would impact pedestrian connectivity. Wayfinding may also be temporarily impacted by the disruption to the building form.

There would be no direct impacts on Fred Kelly Place, although the proximity of Fred Kelly Place to the western construction site would have the potential to temporarily impact on the level of comfort and amenity enjoyed by park users and pedestrians.

While the existing buildings on the site would currently cause some overshadowing of Fred Kelly Place, particularly during mid-winter, the proposed additional height of the acoustic shed (or other acoustic measures) would likely temporarily increase the existing overshadowing, particularly during winter. This effect would most likely be experienced in areas towards the centre of the plaza, as the western end of the site would be overshadowed by the existing buildings to the west during the afternoon. The western construction site would involve the removal of one tree.

The temporary acoustic shed (or other acoustic measures) on the eastern site is set back from the Australia Post open space and would not be likely to cause any overshadowing of this open space. Existing trees bordering the Australia Post open space would assist with screening possible views to the eastern construction site from within the park, however, the large acoustic shed (or other acoustic measures) may be visible from street views, rising about double the height of the existing two storey built form. There may also be some trees within the site removed and trimming of trees that overhang the construction site, which would partly reduce the leafy skyline.

Landscape character impacts anticipated as a result of Stage 1 are summarised in Table 15-40. Management of potential impacts and mitigation measures are discussed in Section 15.15.

Table 15-40: Five Dock Station construction site – Landscape impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Great North Road streetscapes	Local	Considerable reduction	**Moderate adverse**
East Street, Second Avenue and Waterview Street streetscape	Local	Noticeable reduction	**Minor adverse**
Fred Kelly Place and Australia Post open space	Local	Noticeable reduction	**Minor adverse**

Daytime visual amenity impacts

The anticipated daytime visual impacts on representative viewpoints as a result of Stage 1 are summarised in Table 15-41. A comparison of the existing view from viewpoints 3 and 6 with the indicative views resulting from Stage 1 are provided in Figure 15-19 to Figure 15-22.

There would be minor and moderate visual impacts as a result of the proposed works. This would include visual impacts from the removal of existing buildings and the construction of temporary acoustic sheds (or other acoustic measures), particularly in the context of heritage buildings in the vicinity of the site.

The retention of most vegetation would assist in mitigating this impact and screening construction works. Management of potential impacts and mitigation measures are discussed in Section 15.15.

Table 15-41: Five Dock Station construction site – Daytime visual amenity impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Viewpoint 1: View south-east along East Street	Local	Noticeable reduction	**Minor adverse**
Viewpoint 2: View south-west along Great North Road	Local	Considerable reduction	**Moderate adverse**
Viewpoint 3: View north along Great North Road	Local	Considerable reduction	**Moderate adverse**
Viewpoint 4: View east towards Australia Post open space	Local	No perceived change	**Negligible**
Viewpoint 5: View south-east from the corner of Great North Road and Second Avenue	Local	Noticeable reduction	**Minor adverse**
Viewpoint 6: View south-west along Waterview Street	Local	Considerable reduction	**Moderate adverse**
Viewpoint 7: View north-west along Waterview Street	Local	Considerable reduction	**Moderate adverse**
Viewpoint 8: View west along Second Avenue from Five Dock Park	Local	Noticeable reduction	**Minor adverse**

Figure 15-19: Five Dock Station construction site – Existing view from viewpoint 3, north along Great North Road

Figure 15-20: Five Dock Station construction site – Photomontage from viewpoint 3, north along Great North Road

Figure 15-21: Five Dock Station construction site – Existing view from viewpoint 6, south from Waterview Street

Figure 15-22: Five Dock Station construction site – Photomontage from viewpoint 6, south from Waterview Street

Night-time visual amenity impacts

The anticipated night-time visual impacts as a result of Stage 1 are summarised in Table 15-42.

Some night works would be required and the majority of these works would be contained in the acoustic sheds (or other acoustic measures such as acoustic panels over excavations). However, site activities such as security, vehicle and task lighting may occur outside of the sheds. Construction vehicle movements are also likely to introduce additional lighting to this area. This would potentially impact residential areas on First Avenue and Waterview Street and multi-storey residential buildings along Great North Road. Management of potential impacts and mitigation measures are discussed in Section 15.15.

Table 15-42: Five Dock Station construction site – Night-time visual amenity impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Five Dock Station construction site	E3: Medium district brightness	Noticeable reduction	Minor adverse

15.13 The Bays Station construction site

15.13.1 Existing environment

Stage 1 works at The Bays would be within the existing south-west foreshore area of White Bay. The Bays comprises 5.5 kilometres of foreshore land about two kilometres to the east of the Sydney CBD and includes White Bay.

The Bays is planned to undergo significant urban renewal. It is envisaged that the precinct will ultimately become a mixed use employment and residential precinct.

The Bays has been a key maritime, industrial and infrastructure precinct in Sydney, having been used to support maritime trade and industry since European settlement. Key developments in this area include the White Bay Power Station (opened in 1913), the Glebe Island grain silos (constructed in 1975) and the White Bay Cruise Terminal (opened in 2013). The White Bay Power Station and Glebe Island Silos both provide dominant visual landmarks, being reminders of the area's industrial history.

Current uses at The Bays include port freight and logistics services, commercial activities, and the White Bay Cruise Terminal. White Bay Power Station is disused and is surrounded by vacant foreshore land on which the Stage 1 site would be located.

The Stage 1 site is framed by Rozelle, Balmain and Balmain East, located to the north and west. These suburbs are generally elevated, sloping down towards the bay, and are predominantly residential in character. Some other uses, including commercial, retail and public open space is interspersed among these areas.

Public access to the foreshore area at White Bay is restricted due to the maritime nature of the area, however there are public open space areas in the immediate surroundings. Views are also available from the waterfront areas of White Bay to the Sydney Harbour Bridge and Barangaroo. Likewise, the construction site would be visible from ferries and other vessels on Sydney Harbour.

There are several major infrastructure projects planned for the area. The WestConnex M4-M5 Link will involve the construction of a new underground motorway interchange nearby at Rozelle. The M4-M5 Link Rozelle Interchange and Iron Cove Link will provide an underground bypass of Victoria Road between Iron Cove Bridge and Anzac Bridge and provide connectivity to the planned Western Harbour Tunnel. WestConnex M4-M5 would involve the provision of a new open space within the Rozelle Rail Yards, demolition of the existing Victoria Road bridge and replacement with a new structure, realignment, widening and resurfacing of the intersection of The Crescent and Victoria Road, construction of a pedestrian and cycle underpass below Victoria Road, and planting of proposed trees along Victoria Road south of White Bay Power Station. A construction site for Western Harbour Tunnel is proposed to be located in the former Rozelle Rail Yards. Construction sites are also proposed to occupy foreshore areas at Glebe Island and along the northern waterfront area at White Bay.

The planned Western Harbour Tunnel and Warringah Freeway Upgrade project would comprise a new crossing of Sydney Harbour from WestConnex Stage 3 to the Warringah Freeway at North Sydney.

The Port Authority of NSW has obtained planning approval for a Glebe Island multi-user facility to be located on the eastern side of Glebe Island to enable dry bulk materials critical for construction works within Sydney to be imported by water, stored and distributed more easily. A concrete batching plant and aggregate handling facility is also proposed on Glebe Island, which will comprise the construction of silos, warehouses, weigh bridges, ancillary uses and car parking areas. Both proposed facilities on Glebe Island will operate seven days a week and 24 hours per day.

Nearby and adjacent to the Anzac Bridge, a proposed extension to a commercial building (Longitude Office Building) at 36 James Craig Road will involve the addition of a five to eight storey extension with vertical green elements to the facades and roof.

The Bays Station construction site would be visible from a wide visual catchment, which extends from nearby industrial, commercial and portside areas in Rozelle and Glebe Island, residential areas to the north in Rozelle, residential areas along the lower slopes of Balmain and Balmain East. There are distant views from Barangaroo Reserve and elevated areas of Millers Point including from the Sydney Observatory about 2.4 kilometres away.

There would also be elevated views from the south-west facing windows of the high density residential and commercial developments within Barangaroo and Pyrmont.

Water based views to the site can be seen from public ferries travelling between Barangaroo, Pyrmont Bay and Balmain East, and from other watercraft using this part of Sydney Harbour.

From the west and south, views to the site are mostly obstructed by Victoria Road which is on elevated land as it rises to the Anzac Bridge and includes some areas of dense roadside vegetation.

The landscape character and visual sensitivity of the area surrounding The Bays Station construction site is summarised in Table 15-43.

Table 15-43: The Bays Station construction site – Landscape and visual sensitivity

Location	Landscape and visual sensitivity level
The site and Glebe Island portside industrial and commercial areas	Neighbourhood

15.13.2 Potential impacts

The Bays Station construction site would cover about 61,200 square metres in front of the former White Bay Power Station.

The key activities and components that would be seen at The Bays Station construction site include:

- Removal of two industrial buildings and some structures
- Removal of about 30 trees and all other vegetation within the site
- Establishment of parking areas, site offices, amenities, workshops, material/plant storage areas, laydown areas, an elevated conveyor, and water treatment plant and other activities
- A metal clad acoustic shed (around 15 metres in height) (or other acoustic measures) at the south-west part of construction site
- A metal clad acoustic shed (around 15 metres in height) (or other acoustic measures) at the south-east part of construction site
- Station excavation works and support
- Temporary spoil storage
- Tunnel boring machine launch
- Adjustments to the road network
- Noise barriers and hoardings surrounding the construction sites, about three metres high.

Five representative viewpoints to assess visual amenity impacts from The Bays Station construction site are shown in Figure 15-23.

Figure 15-23: The Bays Station construction site – Representative viewpoints

Landscape character impacts

Landscape character impacts anticipated as a result of Stage 1 are summarised in Table 15-44.

All vegetation within the construction site would be removed. However, as there is limited public access to these areas, this change would not affect the level of comfort and amenity for users of the area, including the adjacent streets and parking areas along Robert Street.

Table 15-44: The Bays Station construction site – Landscape character impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
The site and Glebe Island portside industrial and commercial areas	Neighbourhood	No perceived change	Negligible

Daytime visual amenity impacts

The anticipated daytime visual impacts on representative viewpoints as a result of Stage 1 are summarised in Table 15-45.

There would be negligible and minor visual impacts due to the proposed demolition and construction activities associated with Stage 1. This is in the context of the site, which features a generally industrial and construction based visual context.

Construction would be generally visible in the mid ground catchment of surrounding views, with a temporary acoustic shed (or other acoustic measures) rising above the site. This construction would generally be consistent with the industrial and construction visual character of this area.

Temporary works associated with the power supply route would be absorbed into views within the industrial area at White Bay, and within the main commercial areas of Rozelle as these are vehicle dominated locations with dense development and street level activity. Within the residential road corridors the construction activity would be more prominent. In the residential areas, where there is built form of a smaller scale and less busy streets, there would be a noticeable reduction in the amenity of views from the streets and adjacent properties along the power supply route. Management of potential impacts and mitigation measures are discussed in Section 15.15.

Table 15-45: The Bays Station construction site – Daytime visual amenity impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
Viewpoint 1: View south from Mansfield Street Open Space, Rozelle	Local	Noticeable reduction	**Minor adverse**
Viewpoint 2: View south-west from Peacock Point Reserve, Balmain East	Local	No perceived change	**Negligible**
Viewpoint 3: View south-west from Barangaroo Reserve, Barangaroo	Regional	No perceived change	**Negligible**
Viewpoint 4: View north-west from Victoria Road pedestrian path, near Anzac Bridge	Local	No perceived change	**Negligible**
Viewpoint 5: View east from Victoria Road, Rozelle	Neighbourhood	Noticeable reduction	**Negligible**
Power supply: View to the power supply route	Local	Noticeable reduction	**Minor adverse**

Night-time visual amenity impacts

The anticipated night-time visual impacts as a result of Stage 1 are summarised in Table 15-46.

The Bays is already subject to existing night light sources including security lighting and vehicle headlights from the nearby Anzac Bridge and Victoria Road.

During the night, there would be works required at this site during construction. Lighting associated with the works would generally be contained in acoustic sheds (or screened by other acoustic measures such as acoustic panels over excavations), however there would be lighting within the remaining areas of the site to support the works. The natural barriers set by the surrounding landform, major roads and existing industrial buildings would mitigate the amount of light to residential areas in Balmain and Rozelle.

Construction vehicle movements would also introduce additional lighting, however this would be largely imperceptible due to the heavily trafficked nature of the surrounding road network.

Table 15-46: The Bays Station construction site – Night-time visual amenity impacts

Location	Sensitivity rating	Magnitude of change	Impact rating
The Bays Station construction site	E3: Medium district brightness	No perceived change	Negligible

15.14 Cumulative impacts

Potential cumulative impacts were considered for assessment based on the likely interactions of Stage 1 with other projects and plans that met the adopted screening criteria. The approach to assessment and the other projects considered are described further in Appendix G (Cumulative impacts assessment methodology).

Table 15-47 provides a summary of the potential cumulative landscape and visual impacts of Stage 1 in conjunction with other developments. This assessment considers projects that would be in the vicinity of the construction sites for Stage 1 and are likely to have a landscape impact or be in view of Stage 1 activities.

There are no projects identified within view or nearby to the following construction sites and therefore no cumulative landscape or visual impact is anticipated at these locations:

- Silverwater services facility construction site
- North Strathfield metro station construction site.

Table 15-47: Potential cumulative landscape character and visual amenity impacts

Site	Projects	Landscape character impact	Visual impact
Westmead metro station construction site	• Parramatta Light Rail (Stage 1) • 16 storey tower development at 24-26 Railway Parade	The combined removal of vegetation may result in an increased landscape impact due to canopy loss and the resulting effect on the level of comfort and amenity in areas surrounding the existing Westmead Station.	All three construction sites may be visible from the existing Westmead Station, so that views to construction activity may surround the station at times. Similarly, there may be views from adjacent streets, houses, medium rise residential apartment buildings and commercial and retail buildings towards more than one construction site so that the extent of construction seen in these views may be increased.
Parramatta metro station construction site	• Parramatta Light Rail (Stage 1) • 56 storey tower development at 6-7 Parramatta Square • 14 storey mixed use development at 99-119 Macquarie Street	The work at these sites may reduce the level of comfort and amenity for pedestrians using Church and Macquarie Streets due to there being multiple locations where footpaths may be temporarily reduced in width or diverted. The removal of several buildings as part of the commercial and mix use tower developments, in combination with the removal of buildings for Stage 1, would also result in a cumulative effect with the creation of temporary gaps in the built form and reduced visual continuity of streetscapes. While there may be street trees impacted for other projects, Stage 1 would not contribute to this effect as the street trees in the vicinity of the construction site would be retained and protected.	Parramatta metro station construction site would be seen in the context of three other nearby major construction sites, all of which would include large scale construction equipment and activities. Sydney Metro West Stage 1 and construction of Parramatta Light Rail (Stage 1) project would be seen in views from Centenary Square and Macquarie Streets, including from public realm areas, commercial and retail uses at street level, and from elevated medium and high rise residential and commercial buildings. There would be a cumulative visual effect in these views due to the increased extent of the construction activity that would be seen, extending across a large area.
Clyde stabling and maintenance facility construction site	• Clyde Terminal Conversion Project • Viva Energy Clyde Western Area Remediation Project	The removal of the built form on these sites in combination with Stage 1, which may also include the temporary closure and diversion of roads, may have a cumulative effect on accessibility and legibility within this industrial area. There would also be a potential cumulative effect on the level of comfort and amenity within the Rosehill and Clyde industrial areas as a result of the removal of existing vegetation and tree canopy cover across several sites within this area.	There may be a cumulative visual effect in views from adjacent streets and properties, including Unwin, Shirley and Colquhoun streets where works would be seen together and in succession. While this would result in an increased magnitude of change in these views, the existing industrial setting would reduce the overall effect. These projects would also be seen in combination in views from the mid-rise residential properties and hotels on the western side of the James Ruse Drive, from windows and balconies orientated east, overlooking Rosehill Gardens racecourse, and from the grandstands at Rosehill Gardens racecourse.
Sydney Olympic Park construction site	• Multi-storey mixed-use developments for residential, commercial and retail uses • Parramatta Light Rail (Stage 2) (proposed)	Cumulative landscape impact due to the collective loss of trees within Stage 1 and on surrounding projects, which may reduce the leafy character, tree canopy cover, level of comfort and amenity. Temporary footpath diversions and closures during construction may also, reduce accessibility, permeability and legibility within the local area.	Multiple projects would temporarily increase the extent of construction activity seen from surrounding residential and commercial buildings, particularly from elevated locations. Where street trees and trees within these sites are removed, the visibility of these sites would be increased, and a temporary cumulative visual impact may be experienced.
Burwood North Station construction site	• Concord Oval redevelopment site	There may be a cumulative effect from the removal of trees within these sites, reducing the tree canopy cover within both sites. Together this may reduce the level of comfort and amenity of the adjacent footpaths on surrounding residential streets. The combined effect of the temporary construction vehicle haulage along Loftus Street would also adversely affect the level of accessibility and comfort for pedestrians along this suburban residential street.	The Burwood North Station construction site would be seen in the context of the Concord Oval redevelopment site in views from the residential areas on Loftus Street, and from commercial areas and from vehicles and pedestrians along Parramatta Road. When viewed together, these projects would include temporary construction activity potentially extending across a greater portion of views and an increased number of construction vehicle movements.
Five Dock Station construction site	• Five Dock Streetscape Upgrade (Stage 2)	These projects may both require temporary narrowing and diversion of the adjacent footpaths during some periods of construction. In combination this would have a cumulative effect on pedestrian connectivity and legibility along Great North Road between Queens Road and Henry Street at times.	The construction sites would be viewed from the footpaths and adjacent commercial, retail and residential properties on Great North Road, Fred Kelly Place, the Australia Post open space, and St Alban's Church. When viewed in combination, there would be a cumulative effect as temporary construction activity would extend across a greater area of these views, and there may be construction traffic from both projects seen along Great North Road.
The Bays Station construction site	• WestConnex M4-M5 Link surface upgrade works • The Bays – Road Relocation Works proposal • Western Harbour Tunnel and Warringah Freeway Upgrade • Glebe Island concrete batching plant • Glebe Island multi-user facility • Multi-storey office building at 36 James Craig Road	Potential cumulative effect as a result of the removal of vegetation across The Bays by other projects. While there is limited vegetation on the site, there may be a reduction in tree canopy cover and the level of comfort and amenity where these trees are currently in the vicinity or in view of residential and commercial areas, roads and footpaths. The temporary road and footpath diversions and closures, as well as the construction traffic associated with these projects may result in a temporary cumulative effect on accessibility, permeability and legibility.	The Bays Station construction site would be seen in the context of a range of other major infrastructure projects in combination and succession. These sites would be visible from a wide visual catchment, including nearby industrial, commercial and portside areas in Rozelle and Glebe Island, residential areas to the north and west in Rozelle and Balmain, as well as high density residential and commercial developments within Barangaroo, Pyrmont and Millers Point.

15.15 Management and mitigation measures

15.15.1 Approach to management and mitigation

Landscape character and visual amenity impacts from Stage 1 would be managed in accordance with the Construction Environmental Management Framework, which specifies key operational requirements, environmental management procedures, and a communications and consultation strategy. More details of the Construction Environmental Management Framework are provided in Chapter 27 (Synthesis of the Environmental Impact Statement).

The Construction Environmental Management Framework includes visual amenity management objectives to minimise impacts on landscape features and reduce visual impacts.

The Construction Environmental Management Framework specifies that a Visual Amenity Management Plan be prepared and implemented, including:

- Visual mitigation measures (refer to Section 15.15.2)
- Maintenance of outward facing elements of site hoarding, including removal of graffiti and weeds
- Compliance record keeping and management.

15.15.2 Mitigation measures

The mitigation measures that would be implemented to address potential landscape character and visual amenity impacts are listed in Table 15-48.

Table 15-48: Mitigation measures – Landscape character and visual amenity Stage 1

Reference	Impact/issue	Mitigation measure	Application location(s)[1]
LV1	Visual impacts	Where feasible and reasonable, the elements within construction sites would be located to minimise visual impacts (for example storing materials and machinery behind fencing).	All
LV2	Visual impacts	The design and maintenance of construction site hoardings would aim to minimise visual amenity and landscape character impact.	All
LV3	Visual impacts	Graffiti would be removed promptly from hoardings and any other aspects of construction sites.	All
LV4	Visual impacts	All structures (including acoustic sheds or other acoustic measures, site offices and workshop sheds) would be finished in a colour which aims to minimise their visual impact, if visible from areas external to the construction site. This finish is to be applied to all visible fixtures and fittings (including exposed downpipes).	WMS, PMS, SOPMS, SNMS, BNS, FDS
LV5	Lighting impacts	Lighting of construction sites would be orientated to minimise glare and light spill impacts on adjacent receivers.	All
LV6	Public art	Public art would be adopted on temporary hoarding, particularly around future station precincts. Implementation would be as soon as feasible and reasonable after the commencement of construction, and any public art would remain for the duration of the construction period.	All
LV7	Visual impacts affecting events	Works would be coordinated with Department of Planning, Industry and Environment to manage the potential impact of construction on sporting events in other areas of Sydney Olympic Park.	SOPMS
LV8	Visual impacts affecting events	Works would be coordinated with City of Canada Bay Council to manage the potential impact of construction on sporting events at Concord Oval.	BNS
LV9	Overshadowing	Where feasible and reasonable the location and height of the acoustic shed at the Five Dock Station (if required) would be designed to minimise overshadowing of Fred Kelly Place between 10am and 3pm in mid-winter.	FDS
LV10	Activation of streetscapes	Opportunities to provide temporary activation in the vicinity of the Five Dock Station western construction site during construction would be explored in consultation with the City of Canada Bay Council.	FDS
LV11	Trees	Opportunities for the retention and protection of existing street trees and trees within the site would be identified during detailed construction planning.	All
LV12	Trees	Existing trees to be retained would be protected prior to the commencement of construction in accordance with Australian Standard AS4970 the Australian Standard for Protection of Trees on Development Sites and Adjoining Properties.	All
LV13	Trees	Trees removed by Stage 1 would be replaced to achieve no net loss to tree numbers and/or canopy in proximity to the site as a minimum in the long term (and part of future stages of Metro West).	All
LV14	Trees	Opportunities would be investigated with the relevant local council to provide plantings in proximity to the impacted areas prior to construction commencing where feasible and reasonable.	All

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (e.g. tunnel boring machine works); PSR: Power supply routes.

15.15.3 Interactions between mitigation measures

Mitigation measures in other chapters that are relevant to the management of landscape character and visual amenity impacts include:

- Chapter 11 (Non-Aboriginal heritage – Stage 1), measures which address the consideration of the White Bay Power Station Conservation Management Plan in relation to visual impacts at the Bays Station construction site and the retention of view lines.

There are no mitigation measures identified in the assessment of other environmental aspects that are likely to affect the assessment of landscape character and visual impacts.

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Part C | Sydney Metro West Stage 1 – continued

16 Business impacts – Stage 1

16 Business impacts – Stage 1

This chapter provides an assessment of the potential impacts on businesses during Stage 1 and identifies mitigation measures to minimise these impacts.

16.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to business impacts of Stage 1 and where these requirements are addressed in this Environmental Impact Statement are outlined in Table 16-1.

Table 16-1: Secretary's Environmental Assessment Requirements – Business impacts Stage 1

Reference	Secretary's Environmental Assessment Requirements	Where addressed
3. Social and Economic (including property, land use and business impacts)		
3.1	Affected properties, businesses, recreational users and land and water users, including property acquisitions/adjustments, access, amenity and relevant statutory rights.	This chapter

16.2 Legislative and policy context

The *Environmental Planning and Assessment Act 1979* establishes the framework for social and economic impacts to be considered and assessed as part of the environmental planning assessment process. The assessment of business impacts carried out with regard to the aims and objectives of the relevant local environmental plans and strategic plans, are described in Chapter 2 (Strategic need and justification) and Chapter 14 (Property and land use – Stage 1).

The Australian Transport Assessment and Planning Guidelines (Australian Transport Council, 2018) outlines best practice for transport planning and assessment in Australia and has informed the assessment approach as described below.

16.3 Assessment approach

16.3.1 Methodology

This business impact assessment identifies and assesses potential impacts and the extent of these impacts on businesses located within or near Stage 1 construction sites. This includes a qualitative impact assessment of the likelihood and significance of these potential impacts on local businesses. The methodology for the assessment included:

- Defining the local business study area using an approximate 400 metre area around each Stage 1 construction site (i.e. the area within an approximate five minute walk of the construction site). This is consistent with the approach of using Transport Performance and Analytics travel zone data, which generally conforms to an area within a 400 metre radius of existing stations
- Carrying out a desktop survey for each local business study area using NearMap and conducting an on the ground verification to identify business types within 100 metres of each proposed construction site
- Developing a local business profile using Census 2016 data for areas near each construction site. This profiling used the 'destination zone' data associated with the Australian Bureau of Statistics 'Place of Work' data set as relevant to each local business area. In most cases, more than one destination zone was relevant to a local business study area. This profiling also used information gathered from the desktop review and land use and business survey
- Identifying the types of changes (both positive and negative) that could occur to businesses within each local business study area
- Carrying out a qualitative assessment of business impacts that may occur as a result of Stage 1 using the Objective Impacts Table options rating levels from the Australian Transport Assessment and Planning Guidelines (Australian Transport Council, 2018)
- Identifying measures to manage and mitigate any potential impacts on local businesses as a result of Stage 1.

16.3.2 Types of potential business impacts

While potential impacts to local businesses are anticipated, these would be minimised through the implementation of mitigation measures for amenity related issues (such as noise, traffic, visual and air quality) and those identified in Section 16.16. This would include a small business owner's support service to assist small business owners adversely impacted by construction, and measures such as lighting and signage to maintain visibility and access to local businesses.

Potential impacts that may arise from Stage 1 include:

- Direct impacts – where there is a loss of business premises within a construction site
- Indirect impacts – for businesses located near a construction site (usually within about 400 metres) potential indirect impacts could affect a business through a reduction in trade or by increasing the costs of doing business. Changes within the local business area related to Stage 1 could also result in increased trade for some businesses or a beneficial redistribution of trade.

The business impact assessment has considered:

- Description and plans for the proposed Stage 1 construction works
- Technical research undertaken to inform the assessment
- Extent of the proposed works at each construction site
- Business and land use characteristics of each individual local business area.

Table 16-2 outlines both potential direct and indirect business impacts that could arise from Stage 1. An analysis of predicted impacts for each local business study area is included in the following sections.

Table 16-2: Potential types of business impacts

Potential impact	Description
Potential indirect impacts	
Property or land acquisition	• Businesses located on land to be acquired may experience: • Challenges in finding an alternative premises • Potential disruption to trade due to relocation • If unable to relocate, risk of business extinguishment.
Indirect potential impacts	
Temporary traffic congestion and travel time	Construction works including road closures or diversions, and construction traffic (e.g. deliveries and spoil removal), have the potential to cause traffic congestion, potentially impacting businesses by traffic delays and increased travel times. Although construction would be planned so that direct delivery access to businesses is maintained, reduced or delayed accessibility could potentially interrupt daily business operations and potentially increasing delivery costs. This could also affect employee travel times (particularly when using a car) and may cause changes to vehicular or pedestrian travel routes. Businesses most likely to be potentially affected are those within 100 metres of a construction site or near roads subject to temporary closures.
Loss of parking	Potential loss of car parking resulting from construction work could have a flow-on effect to businesses by reducing accessibility and convenience for customers. Businesses most likely to be potentially affected are those within 100 metres of a construction site.
Loss of goods and services	Some businesses within a local business area may supply goods and services to other local businesses. In areas with many businesses, the cost of sourcing alternative inputs may be minor, but in areas with fewer businesses the cost may be comparatively more. Businesses most likely affected are those in smaller local business areas.

Potential impact	Description
Temporary reduced local amenity (arising from noise, vibration, dust and visual impacts)	Noise, vibration, visual impacts or dust generated at construction sites may impact businesses which are more reliant on a specific type of working environment or external environment. Businesses most likely to be impacted are those that have more sensitive uses such as local cinemas, educational establishments, health and social assistance facilities, and therapists or those that are more reliant on a quiet outside environment such as cafes and restaurants. Businesses most likely to be potentially affected are those within 100 metres of a construction site and mitigation measures would be implemented to minimise these impacts. Amenity impacts are expected to reduce the further a business is located from the construction site.
Temporary power and utility interruptions	In the event of planned or accidental power shutdowns, surrounding businesses may be impacted. Prior notice would be given to business owners by the appropriate utility authority in the event of any planned power shutdowns.
Safety and security	Appropriate mitigation measures including signage and hoarding to divert pedestrians and traffic safely around construction sites would be implemented as necessary so that customer/visitor patronage to local business is maintained. Businesses most likely to be potentially affected are those within 100 metres of a construction site.
Potential opportunities	
Increase in passing trade	Some businesses within the local business area may experience an increase in passing trade from Stage 1 construction workers (anticipated to be 10,000 direct and 70,000 indirect jobs during construction) or from changes in pedestrian and vehicular travel patterns as a result of diversions around construction sites. This would depend on the location of businesses and their proximity to the construction site, the nature of surrounding businesses, and the role and function of the local business area. The types of businesses that could expect a net increase in passing trade as a result of Stage 1 include those that sell goods and services and which are close to the construction site or on the travel path to the construction site.
Redistribution of trade	Redistribution of trade refers to the movement of customers and patronage to alternative businesses within the area. This is a positive impact for businesses that may receive an increase in trade as a result of a similar directly impacted business needing to close or relocate.

16.3.3 Qualitative impact assessment

Each potential impact has been assessed using a qualitative and objective based assessment matrix which evaluates impacts based on the 'likelihood' of occurrence (defined in Table 16-3), and the 'significance' of the potential impact on local businesses in the event it does occur (defined in Table 16-4).

Table 16-3: Likelihood categories

Likelihood category	Description
Almost certain	• An estimated greater than 90% chance of occurrence during Stage 1; or • The event is expected to occur in most circumstances.
Likely	• An estimated 75-90% chance of occurrence during Stage 1; or • The event will probably occur in most circumstances.
Possible	• An estimated 50-75% chance of occurrence during Stage 1; or • The event could occur.
Unlikely	• An estimated 25-50% chance of occurrence during Stage 1; or • The event could occur but is not expected.
Rare	• An estimated 10-25% chance of occurrence during Stage 1; or • The event may occur only in exceptional circumstances.
Almost unprecedented	• An estimated less than 10% chance of occurrence during Stage 1; or • Not expected to ever occur during Stage 1 (less than once every 100 years).

Table 16-4: Significance categories

Significance category	Description[1]
Large negative	Major negative impacts with serious, long term and possibly irreversible effects leading to serious damage, degradation or deterioration of the physical, economic or social environment. Requires a major re-scope of concept, design, location and justification, or requires major commitment to extensive management strategies to mitigate the effect.
Moderate negative	Moderate negative impact. Impacts may be short, medium or long term and impacts would most likely reduce in response to management actions
Slight negative	Minimal negative impact, probably short-term, able to be managed or mitigated, and would not cause substantial detrimental effects. May be confined to a small area.
Neutral	Neutral – no discernible or predicted positive or negative impact.
Slight positive	Minimal positive impact, possibly only lasting over the short-term. May be confined to a limited area.
Moderate positive	Moderate positive impact, possibly of short, medium or long term duration. Positive outcome may be in terms of new opportunities and outcomes of enhancement or improvement.
Large positive	Major positive impacts resulting in substantial and long term improvements or enhancements of the existing environment.

Source: Australian Transport Assessment and Planning Guidelines (2018)

Note 1: there is no hard and fast definition of short, medium and long term, the following is an indicative guide: short 1–2 years; medium 3–5 years; long – beyond 5 years

16.4 Avoidance and minimisation of impacts

The design development of Stage 1 aimed to avoid or minimise potential business impacts by limiting the amount of privately owned land needed (wherever possible) for construction sites. The design also aimed to maintain customer and vehicular delivery access for existing businesses. Specific design features to avoid or minimise impacts included:

- At Westmead, locating the station box to the south of the existing rail corridor and adopting an east-west orientation. This avoids direct and indirect impacts (such as noise) to the local business centre immediately north of the existing Westmead Station, and minimises potential noise and vibration impacts on nearby noise sensitive businesses that operate medical equipment
- At North Strathfield, adopting a north-south orientation of the station box which aligns parallel with the existing rail corridor and avoids direct impacts to existing businesses fronting Queen Street.

16.5 Project-wide impacts

Property acquisition would result in potential impacts to occupying businesses (or other negotiated arrangements). All property acquisition is managed in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and the land acquisition reforms announced by the NSW Government, which can be viewed online at (www.propertyacquisition.nsw.gov.au/).

Sydney Metro has appointed Personal Managers to offer residents and small businesses assistance and support throughout the acquisition process.

16.6 Westmead metro station

16.6.1 Existing environment

Local business profile

The main Westmead business area is immediately north of the existing Westmead Station, within the Westmead town centre. Figure 16-1 shows the key business areas around the Westmead metro station construction site, as well as the relevant destination zones for the local business profile.

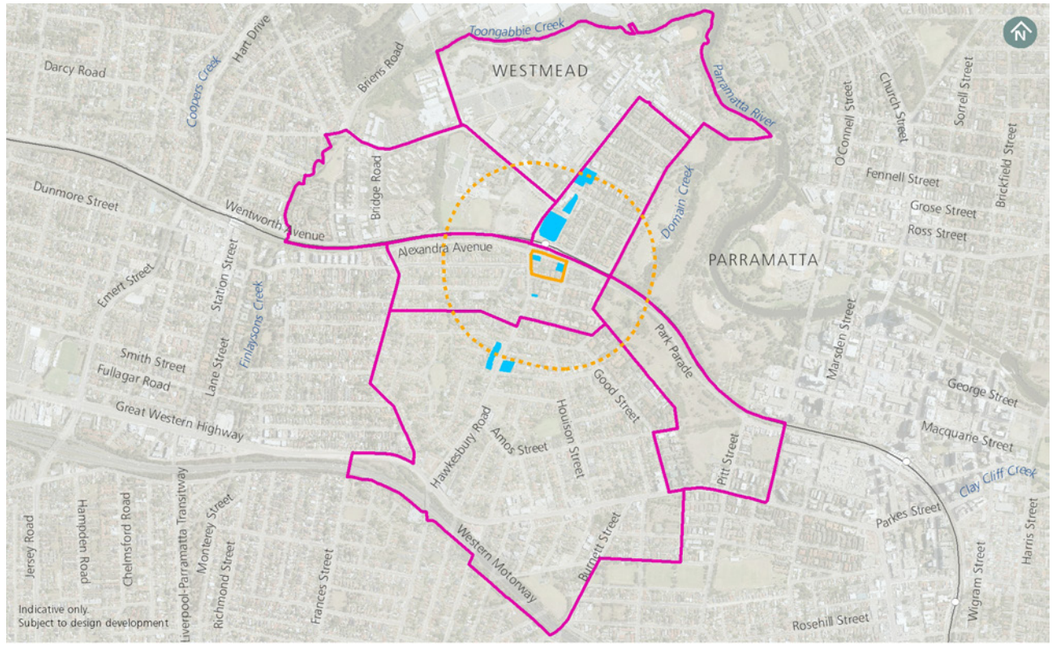

Figure 16-1: Westmead local business study area and relevant destination zones

The Westmead local business study area and surrounding areas has a strong focus on medical and health services and facilities supporting the broader Westmead Health and Education Precinct, one of the largest health, education, research and training locations in Australia and a key provider of jobs for the region. The Westmead local business study area also serves the local population via the Westmead Shopping Village which fronts Railway Parade to the immediate north of Westmead Station, comprising a range of local shops including a supermarket, tavern, cafes and restaurants. The Westmead Shopping Village is about 100 metres north of the construction site. The Western Sydney University Westmead Campus is opposite the Westmead Shopping Village on the western side of Hawkesbury Road.

The local business study area continues north of the Westmead Shopping Village, along the eastern side of Hawkesbury Road, with a range of retail, commercial services, and cafes and restaurants, generally aimed at servicing the local population, together with a small number of healthcare service businesses. These businesses are located up to about 400 metres from the construction site. The southern edge of Westmead Hospital is also located about 400 metres north of the construction site.

Fewer businesses are located to the south of the existing Westmead Station. Businesses in this area include a small number of stand-alone healthcare service businesses scattered along Hawkesbury Road within 400 metres, and the Oaks Centre, a neighbourhood business centre about 400 metres south of the construction site (Oakes Centre), with local retail, shops, services, cafes and restaurants, fronting a service road along the western side and parallel to Hawkesbury Road. A service station is located at the Hawkesbury Road/Ralph Street intersection and additional healthcare service businesses are further to the south along Hawkesbury Road.

The proposed Westmead metro station construction site is parallel and to the south of the existing Westmead Station and is separated from the main Westmead business area by the rail corridor.

Table 16-5 identifies the types of existing businesses within the local business study area. A number of vacant retail premises were observed during the land use and business survey and include some premises throughout the Westmead town centre that have been acquired and vacated for the construction of the Parramatta Light Rail project.

Table 16-5: Businesses within Westmead local business study area

Impact area	Types of businesses	Approximate number of businesses
Within construction site	Retail; healthcare services; personal care services; automobile services	Up to 10
Within 100 metres of the construction site	Healthcare services; commercial – service industries	20 to 30
Between 100 and 400 metres of the construction site	Healthcare services, banks, cafes and restaurants	40 to 60

Employment

At the 2016 Census, about 13,450 people were employed within the destination zones relevant to the Westmead local business study area, making it the second largest business precinct. As shown in Figure 16-2, employment within the business precinct was highly concentrated in household services, which accounted for around 11,710 jobs or 90 per cent of all jobs. This indicates the local economy is specialised in providing services for local and regional populations such as education and health care services. A number of businesses within the household services sector are primarily destination businesses and less reliant on passing trade.

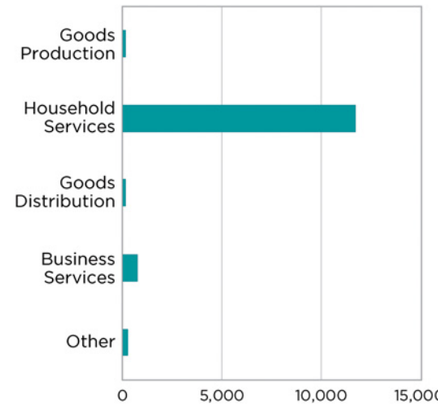

Figure 16-2: Employment by business categories – Westmead destination zones[1]

Source: Australian Bureau of Statistics, 2016, Ethos Urban

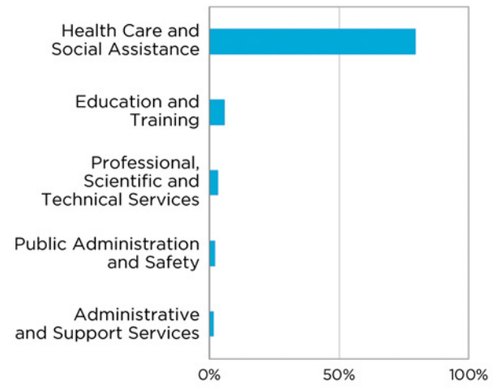

Figure 16-3: Top five industries – Westmead destination zones

Source: Australian Bureau of Statistics, 2016, Ethos Urban

Note 1: Goods production includes: Mining, Manufacturing; Electricity, Gas, Water and Waste Services; and Construction.

Household Services includes: Accommodation and Food Services; Education and Training; Health Care and Social Assistance; Arts and Recreation Services; and Other Services.

Goods Distribution includes: Wholesale Trade; Retail Trade; and Transport, Postal and Warehousing.

Business Services includes: Information Media and Telecommunications; Financial and Insurance Services; Rental, Hiring and Real Estate Services; Professional, Scientific and Technical Services; and Administration and Support Services.

Other includes: Agriculture, Forestry and Fishing, and Public Administration and Safety.

As shown in Figure 16-3, at an industry level, employment within the Westmead local business study area and surrounds is highly concentrated in the health care and social assistance industry. At the 2016 census, employment within this industry comprised 79 per cent of all jobs within the area, reflecting that most of the jobs are associated with Westmead Hospital and its related medical facilities. The second most common industry for employment was education and training, which accounted for five per cent of jobs, with these jobs primarily located north-west of the construction site. Most of the employment in the local business study area is concentrated north of Westmead Station, within and around Westmead Hospital about 400 metres from the construction site.

Travel patterns

Methods of travel to work by workers within the local business study area and surrounding area are highlighted in Table 16-6. Workers within the area are highly dependent on cars to get to and from work, with 71.2 per cent of residents using a car (as driver). Compared to other locations, this proportion is relatively high, suggesting that businesses are dependent on good access to the road network to access labour markets within the region. Despite there being an existing Sydney Trains suburban train station within the precinct, only 15.2 per cent workers used this method of travel.

Table 16-6: Top five methods of travel to work – Westmead destination zones

Methods of travel to work	Number	Proportion
Car, as driver	8,227	71.2%
Train	1,762	15.2%
Car, as passenger	500	4.3%
Walked only	500	4.3%
Bus	403	3.4%

Source: Australian Bureau of Statistics, 2016; Ethos Urban

16.6.2 Potential impacts

A qualitative assessment of the potential impacts relevant to the Westmead local business study area is provided in Table 16-7. Overall, the highly specialised nature of the Westmead local business study area (focussed on medical and health facilities) suggests that most of the local businesses would be more resilient to potential construction impacts, as demand for health related services is more inelastic and less affected by local changes.

Potential impacts to local businesses would be minimised through the implementation of mitigation measures for amenity related issues (such as noise, traffic, visual and air quality) and those identified in Section 16.16. This would include a small business owner's support service to assist small business owners adversely impacted by construction.

Table 16-7: Westmead – Local business impacts

Potential impact	Risk assessment	
	Likelihood	Significance
Potential indirect impacts		
Temporary traffic congestion and increased travel times Potential impacts associated with traffic congestion and increased travel times would be unlikely for the majority of business around the site. Workers within the precinct are highly car dependent. The extent to which they would be affected by construction works would largely depend on which direction they drive from. Workers driving from the north, east or west, would be less affected by temporary construction traffic than workers driving from a southerly direction towards the construction site (along Hawkesbury Road), which is the main construction site haul route. Similarly, temporary traffic and travel time impacts for business servicing deliveries would be minimal for businesses north of the site in the Westmead town centre. About 10-20 businesses would be located along the haul route on Hawkesbury Road, including business within the Oakes Centre about 400 metres south of the construction site. This is a neighbourhood centre generally servicing the local population, and does not require direct access to and from Hawkesbury Road. No road diversions or traffic control measures would be required around these businesses, further minimising any impacts.	Unlikely (north of the construction site) Possible (south of the construction site)	Slight negative
Loss of parking The potential temporary impact to parking availability for local businesses, from the presence of a construction workforce is expected to be minimal. There is currently no on-street parking on the part of Alexandra Avenue that would be closed, and while some on-street parking may be lost on Hassall Street and Bailey Street, those parking locations would be less important for local businesses within the main town centre north of the existing rail corridor. Construction workers would be encouraged to access the site using nearby public transport options.	Unlikely	Neutral
Loss of goods and services Flow-on impacts to other businesses (from the closure or relocation of directly affected businesses) is expected to be very limited given the small number of directly impacted businesses, and the nature of these businesses being focussed towards providing goods and services primarily to households rather than as inputs to other businesses.	Rare	Neutral
Temporary reduced local amenity Business in the vicinity are generally sufficiently separated from the construction site minimising any potential temporary amenity related impacts. There are no businesses immediately surrounding the construction site which would be affected by temporary amenity impacts. Businesses within 100 metres of the construction site are located within the Westmead Shopping Village and adjacent businesses fronting Railway Parade, north of the existing Westmead Station. Business within the Westmead Shopping Village are mostly located within a partially enclosed centre, providing some protection from the external environment and mitigating temporary amenity impacts. These businesses are also separated from the construction site by the existing rail corridor further mitigating amenity impacts. As the business precinct extends further northwards, away from the construction site and fronting Hawkesbury Road, the distance, positioning and siting of these businesses would help to minimise amenity impacts. The local businesses about 400 metres south of the site (Oakes Centre), fronting a service road parallel to Hawkesbury Road may experience some temporary reduced amenity from the increase in construction heavy vehicles along Hawkesbury Road.	Possible	Slight negative
Temporary power and utility interruptions Given the physical separation between the construction site and the businesses within the business precinct, any significant impact from unplanned power and utility interruptions is very unlikely.	Almost unprecedented	Slight negative
Safety and security Safety and security associated with the construction site is unlikely to affect any businesses north of the existing Westmead Station due to their separation from the construction site by the existing rail corridor. Businesses south of the construction site along Hawkesbury Road are subject to existing impacts (such as from heavy vehicles and buses) associated with being positioned on an arterial road. As such, the use of this road for heavy vehicle movements is unlikely to affect these businesses.	Rare	Neutral
Potential opportunities		
Increase in passing trade Businesses located immediately north of the existing rail corridor and south along Hawkesbury Road (the Oakes Centre) may benefit from an increase in the number of customers (construction workers), buying goods and services from retail, cafes and restaurants.	Possible	Slight positive

Potential impact	Risk assessment	
	Likelihood	Significance
Redistribution of trade Some local customers could redistribute their trade towards similar locally serving businesses within other parts of the business precinct or the surrounding area which would be positive for those businesses that potentially experience an increase in trade.	Possible	Slight positive

16.7 Parramatta metro station

16.7.1 Existing environment

Local business profile

Parramatta is the second largest commercial office centre outside the Sydney CBD. The Parramatta CBD is located north of the existing Parramatta Station. Figure 16-4 shows the key business areas around the Parramatta metro station construction site, as well as the relevant destination zones for the local business profile.

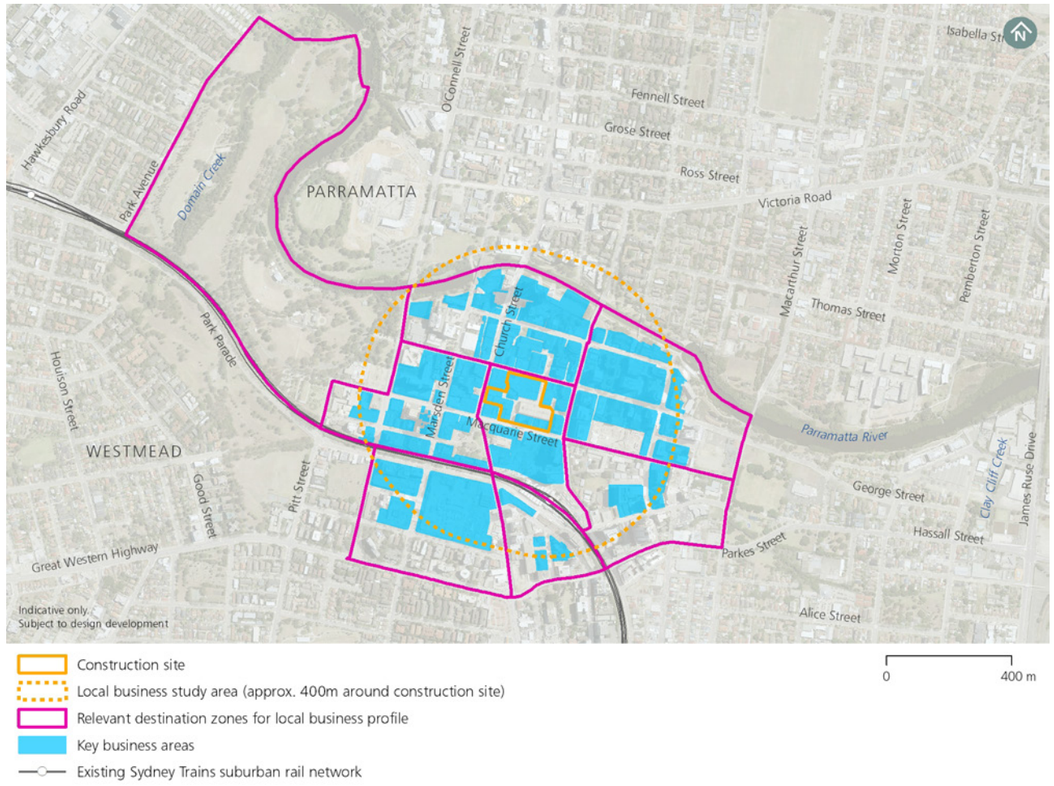

Figure 16-4: Parramatta local business study area and relevant destination zones

The Parramatta local business study area contains the Parramatta CBD, which includes a highly developed commercial core, with a wide range of commercial, retail, health, education, community and government administration uses.

Within 400 metres of the construction site businesses remain primarily involved in commercial, retail and education activities, with a number of cafes and restaurants located along the retail strips of Church Street (known as 'Eat Street') and George Street. The frontage along Macquarie Street contains more commercial office premises with businesses such as tax accountants, lawyers, real estate agents, and banks as well as health care consulting rooms and education/training premises.

In addition to the ground level retail and restaurant businesses, higher density commercial office buildings are also located around the construction site, particularly to the north-east. Westfield Shopping Centre is the largest shopping mall for Parramatta and is situated around 220 metres south of the proposed Parramatta metro station.

The large number and diverse range of businesses reflect Parramatta's status as a metropolitan centre and Sydney's second CBD.

Businesses within the proposed Parramatta metro station construction site primarily provide commercial, retail and educational/training services from two to three storey business premises. A number of cafes and restaurants, a gym and a Council owned multi storey car park are also located within the proposed construction site. Two retail shopping malls, servicing customers in the northern part of Parramatta, are located within the proposed construction site:

- Parramall Shopping Centre (55-67 George Street), includes around 30 retail businesses with a diverse range of businesses including restaurants and cafes, health and beauty, speciality shops, and business / administration services
- Greenway Plaza (222 Church Street), includes around 40 retail businesses with a diverse range of services including restaurants and cafes, health and beauty, clothing and accessories, and business / administration services.

The land use and business survey identified there are a significant number of businesses located within the construction site, and potentially up to 500 businesses within a 400 metre radius of the site as shown in Table 16-8.

Table 16-8: Businesses within the Parramatta local business study area

Impact area	Types of businesses	Approximate number of businesses
Within construction site	Commercial, retail, cafes and restaurants, education, commercially operated car park	80 to 100
Within 100 metres of the construction site	Commercial, retail, cafes and restaurants, commercial services, government administration, education	150 to 200
Between 100 and 400 metres of the construction site	Commercial, retail, commercial services, government administration, education	150 to 200

Employment

At the 2016 Census some 41,340 people were working in the destination zones relevant to the Parramatta local business study area, making it by far the largest business area along Stage 1 and reflecting the role of Parramatta as a metropolitan centre. As shown in Figure 16-5, most of these jobs were located in business services, which accounted for 15,080 jobs, the next largest sector was the 'other' sector which had some 13,600 jobs and mostly comprised jobs in public administration and safety. Jobs in the business services sector and 'other' category are primarily office jobs that provide services for businesses.

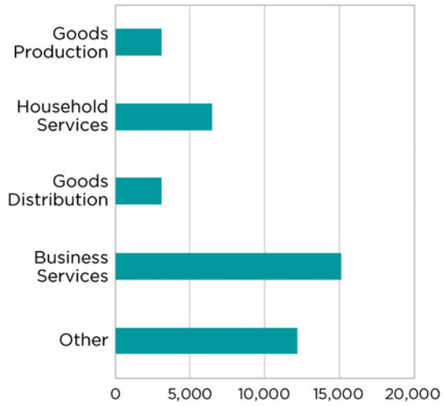

Figure 16-5: Employment by business categories – Parramatta destination zones

Source: Australian Bureau of Statistics, 2016; Ethos Urban

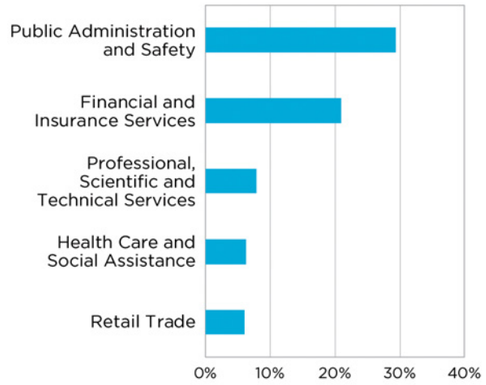

Figure 16-6: Top five industries – Parramatta destination zones

Source: Australian Bureau of Statistics, 2016; Ethos Urban

Figure 16-6 shows the top five industries of employment at the 2016 census including public administration and safety (29.4 per cent) and financial and insurance services (20.9 per cent), which together comprise 50 per cent of the top five industries.

Most jobs were located in the north-east of the local business study area, with retail being primarily located across a number of shopping malls, including the largest, Westfield Parramatta shopping centre, about 220 metres south of the construction site.

Travel patterns

The local business area has a strong connection to public transport, particularly via the existing Parramatta Station. As shown in Table 16-9, despite the strong connection to rail, travel via car (as a driver) is the preferred method of travel to work by local workers at 43.3 per cent with some 16,100 workers choosing this method of travel. Most workers using this method of travel worked in the north-east of the Parramatta destination zones.

Table 16-9: Top five methods of travel to work – Parramatta destination zones

Methods of travel to work	Number	Proportion
Car, as driver	16,107	43.3%
Train	13,026	35.0%
Bus	4,238	11.4%
Car, as passenger	1,664	4.5%
Walked only	1,563	4.2%

Source: Australian Bureau of Statistics, 2016; Ethos Urban

Train was the second largest method of travel to work with 35.0 per cent of workers using this method to get to work. Workers using this mode of travel would enter and leave the area via Parramatta Railway Station and disperse to jobs in and around the construction site. The next largest method of travel to work was via bus (11.4 per cent) and travel by car as a passenger and walking, both of which recorded just over four per cent.

16.7.2 Potential impacts

An assessment of the potential impacts relevant to the Parramatta local business study area is provided in Table 16-10. Overall, the Parramatta CBD local business study area is a diverse and dynamic area with a large number of businesses, and a high capacity to absorb and adapt to construction impacts that may change the localised trading environment around the construction site.

Potential impacts to local businesses would be minimised through the implementation of mitigation measures for amenity related issues (such as noise, traffic, visual and air quality) and those identified in Section 16.16. This would include a small business owner's support service to assist small business owners adversely impacted by construction.

Table 16-10: Parramatta – Local business impacts

Potential impact	Risk assessment	
	Likelihood	Significance
Potential indirect impacts		
Temporary traffic congestion and increased travel times Potential temporary impacts to businesses associated with construction traffic are generally unlikely due to the diversity of employment types and availability of multiple access routes into and out of the Parramatta CBD The extent to which workers and customers would be affected by temporary construction works would be largely dependent on their proximity to the construction site, and whether they travel on roads that are part of the construction haul route. Similarly, potential temporary traffic and travel time impacts for servicing deliveries would be greatest for businesses immediately adjacent to the construction site.	Unlikely	Slight negative
Loss of parking While impacts to on-street car parking would be minimal, the Parramatta metro station construction site would require the demolition of the City Centre car park and some off-street parking spaces – a loss of about 850 parking spaces. The demolition of the City Centre car park was previously identified in the Draft Parramatta CBD Public Car Parking Strategy (City of Parramatta, 2017), which identifies measures to offset potential loss of car parking. The removal of the City Centre car park is likely to reduce convenience for employees and customers visiting businesses within the local business area in the short-term.	Almost certain	Moderate negative
Loss of goods and services Noting that a number of businesses would be directly impacted by the construction site, there are unlikely to be flow on effects to businesses throughout the local business area that rely on goods and services from some of these directly impacted businesses. Some businesses may need to find alternative businesses to provide goods and services. However, given the overall scale of the Parramatta CBD, it is likely that substitution by other businesses capable of providing the same goods or performing the same services would be possible, minimising overall impacts.	Unlikely	Slight negative
Temporary reduced local amenity A range of businesses near the construction site may potentially be temporarily impacted by amenity, although this would be minimised through measures such as hoardings around the site. Businesses potentially affected would primarily be those located closest to the construction site and those more reliant on a pleasant urban amenity. Impacts on Church Street (Eat Street) would be mitigated by the relatively small direct frontage of the construction site to Church Street, and because the construction works would generally be set back from Church Street and be carried out behind hoardings.	Almost certain	Slight negative
Temporary power and utility interruptions Given the location of the construction site in the centre of the Parramatta CBD, unplanned power and utility interruptions could potentially result in temporary impacts to surrounding business during interruptions.	Unlikely	Slight negative
Safety and security Appropriate mitigation measures including lighting, signage and hoarding to divert pedestrians and traffic safely around construction sites would be implemented as necessary so that customer/visitor patronage to local business is maintained. Potential temporary impacts are likely to be limited to retail and cafes and restaurants located near the construction site that would normally continue trading into the evening.	Rare	Slight negative

Potential impact	Risk assessment	
	Likelihood	Significance
Potential opportunities		
Increase in passing trade Businesses located around the construction site may benefit from an increase in the number of customers as a result of construction workers buying goods and services from retail, cafes and restaurants.	Likely	Slight positive
Redistribution of trade Some local customers could redistribute their trade towards similar locally serving businesses within other parts of the local business area or the surrounding area which would be positive for those businesses that potentially experience an increase in trade.	Likely	Slight positive

16.8 Clyde stabling and maintenance facility

16.8.1 Existing environment

Local business profile

Clyde is an industrial area that straddles the M4 Western Motorway and the Great Western Highway, and is located adjacent to the Rosehill industrial area. Figure 16-7 shows the key business areas around the Clyde stabling and maintenance facility construction site, as well as the relevant destination zones for the local business profile.

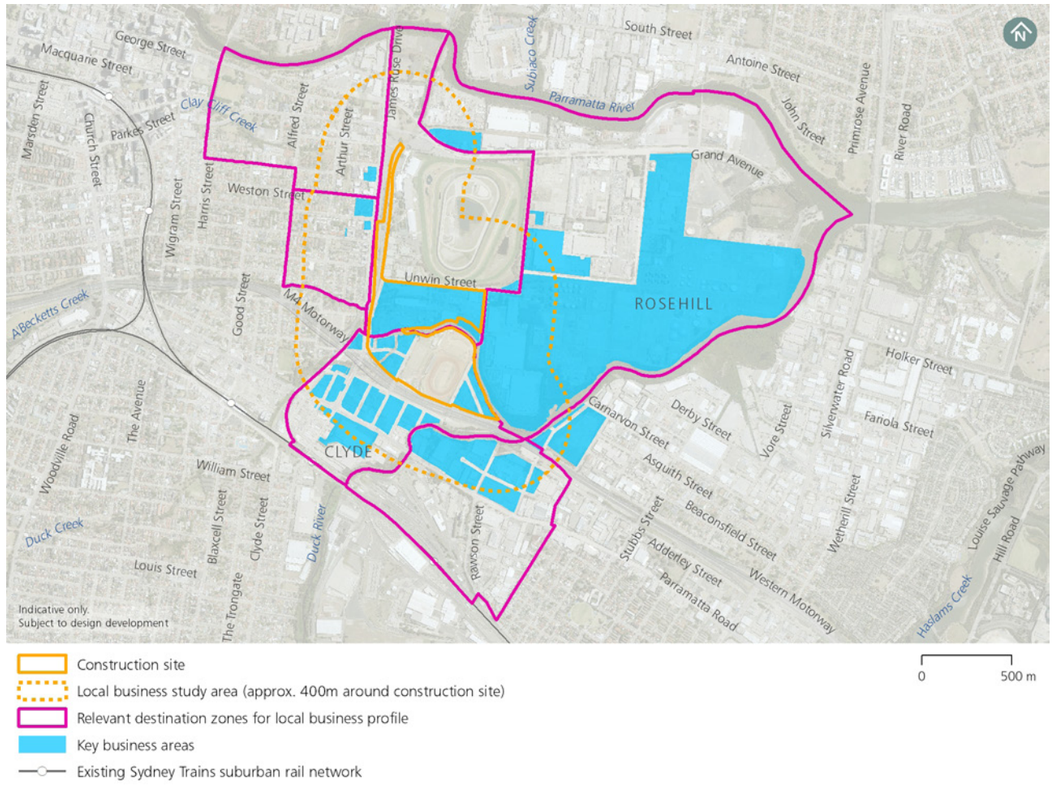

Figure 16-7: Clyde local business study area and relevant destination zones

The Clyde local business study area is primarily industrial with a large proportion of manufacturing, warehousing and industrial businesses, as identified in Table 16-11.

The northern part of the local business study area includes the Rosehill Gardens racecourse, and beyond to the future Camellia town centre, which currently contains a mix of retail outlets, light industries, urban services and warehouses. The future Camellia town centre is about 750 metres north of the construction site, and currently includes a supermarket, child care centre, and a café.

The eastern part of the local business study area is dominated by the Viva Energy Clyde and Parramatta Terminals that store and distribute fuels. North of the Viva Energy site are a number of heavier industries, including building material manufacturing and distribution facilities, and waste management facilities.

The western part of the local business study area is located to the west of James Ruse Drive, and includes several hotels and overnight accommodation that are reliant to some degree on the Rosehill Gardens racecourse, the shopping and restaurant district near the Hassall Street intersection which provide conference and event services to a broad customer base.

Businesses within the local business area are primarily destination businesses and while generally not likely to be reliant on passing trade, require access to the road network to access labour markets and customers, and to distribute goods and services.

The construction site is located across the Rosehill and Clyde industrial areas, and includes a range of businesses within the footprint, including warehouses, manufacturing facilities, urban services, and industrial or speciality retail outlets, as well as the Rosehill Heliport (Sydney Helicopters) and the Sydney Speedway (location on NSW Government owned land).

Table 16-11: Businesses within Clyde local business study area

Impact area	Types of businesses	Approximate number of businesses
Within construction site	Educational; Industrial; Arts and Recreation; Manufacturing; Retail; Warehousing; Urban Services	20 to 30
Within 100 metres of the construction site	Educational; Industrial; Arts and Recreation; Manufacturing; Retail; Warehousing	20 to 30
Between 100 and 400 metres of the construction site	Educational; Industrial; Arts and Recreation; Manufacturing; Retail; Warehousing; Childcare	10 to 20

Employment

At the 2016 census 8,530 people were employed within the destination zones relevant to the Clyde local business study area. As shown in Figure 16-8, employment within the local business study area tended to be in the goods production and goods distribution sectors, which accounted for 2,470 and 2,770 jobs respectively. Jobs in these sectors are traditionally located within industrial areas. Jobs in the household services sector were also well represented, which were primarily related to arts and recreation and other services. Recreational sector jobs are likely related to businesses providing entertainment services in association with the Rosehill Gardens racecourse.

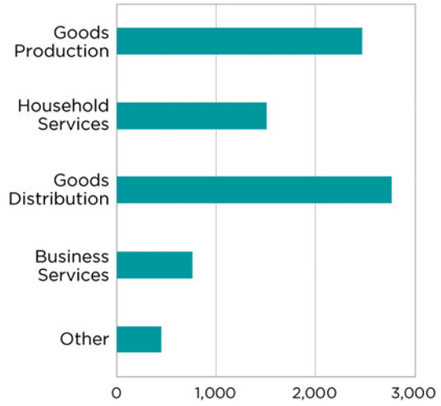

Figure 16-8: Employment by business categories – Clyde destinations zones

Source: Australian Bureau of Statistics, 2016; Ethos Urban

Figure 16-9: Top five industries – Clyde destination zones

Source: Australian Bureau of Statistics, 2016; Ethos Urban

Figure 16-9 above shows the top five industries for employment within the destination zones relevant to the study area at the 2016 census which accounted for more than 50 per cent. Jobs in the construction industry had the highest share, accounting for 13.1 per cent of jobs, followed by jobs in the manufacturing industry which accounted for 12.6 per cent of jobs, and the transport, postal and warehousing industry at 11.6 per cent of jobs. Compared to other local business study areas, Clyde had a very high concentration of jobs in these industries reflecting its nature as an industrial area.

Travel patterns

As highlighted in Table 16-12 below, the Clyde local business study area had one of the highest levels of car dependency across all the study areas, with 81.5 per cent of workers travelling to work using a car (as a driver), reinforcing that businesses are highly dependent on the road network to access the labour markets. Although there were train stations within the study area (Rosehill and Camellia which closed in January 2020), only 7.5 per cent of workers use this method of travel, with most of these likely to have their place of employment near the stations. The Clyde local business study area is particularly large, and includes many areas that are a significant distance away from the former train stations, explaining the low use of train as a method of travel to work.

Table 16-12: Top five methods of travel to work – Clyde destination zones

Methods of travel to work	Number	Proportion
Car, as driver	6,469	81.5%
Train	594	7.5%
Car, as passenger	345	4.3%
Truck	134	1.7%
Bus	132	1.7%

Source: Australian Bureau of Statistics, 2016; Ethos Urban

16.8.2 Potential impacts

An assessment of the potential impacts relevant to the Clyde local business study area is provided in Table 16-13. Businesses located in the future Camellia town centre area and west of James Ruse Drive are unlikely to be affected as they are well separated from the construction site.

Potential impacts to local businesses would be minimised through the implementation of mitigation measures for amenity related issues (such as noise, traffic, visual and air quality) and those identified in Section 16.16. This would include a small business owner's support service to assist small business owners adversely impacted by construction.

Table 16-13: Clyde – Local business impacts

Potential impact	Risk assessment	
	Likelihood	Significance
Potential indirect impacts		
Potential traffic congestion and increased travel times Potential temporary impacts to businesses associated with construction traffic would be minimised through measures such as reducing movements in network peak periods. Workers and businesses in this area already experience a congested road network during some periods of the day and the addition of construction traffic is expected to result in a relatively minor impact. Workers within the precinct are highly car dependent and temporary increases in traffic congestion and travel times around the local business area could potentially affect journey to work time. It is also expected that a high proportion of customers would access businesses within the area by car, meaning potential temporary increases in traffic congestion and travel times could also impact business accessibility. The Camellia peninsula is accessible by only two routes (Unwin Street and Grand Avenue), meaning businesses in the Camellia town centre, and throughout the Clyde and Rosehill industrial areas, are particularly susceptible to temporary increases in traffic congestion and travel times around the precinct, as there are no access alternatives available for workers, customers and servicing and deliveries.	Likely	Slight negative
Loss of goods and services Businesses within the construction site generally provide goods and services to a wider catchment and do not provide local business-to-business services. As such, there are unlikely to be flow on effects to other nearby businesses.	Rare	Neutral
Temporary reduced local amenity Temporary reduced amenity from noise, vibration, dust and visual impacts from construction works is unlikely to result in lower customer experience for surrounding businesses. Surrounding businesses are primarily industrial and would generally already experience comparatively lower amenity from surrounding industrial premises and existing infrastructure.	Unlikely	Slight negative
Temporary power and utility interruptions Given the large size of the construction site and the nature of surrounding businesses, unplanned power and utility interruptions could result in temporary impacts during interruptions.	Unlikely	Slight negative
Safety and security The industrial parts of the precinct already have relatively low levels of street activity and surveillance. Elsewhere, reduced business activity around the construction site is unlikely to result in any reduction in customer safety and security.	Rare	Slight negative
Potential opportunities		
Increase in passing trade Businesses may experience an increase in business trade and custom from construction workers. Local population servicing businesses such as retail and cafés and restaurants are the most likely to experience an increase in customers as a result of Stage 1 construction works.	Likely	Slight positive
Redistribution of trade Some local customers could redistribute their trade towards similar locally serving businesses within other parts of the local business study area which would be positive for those businesses that potentially experience an increase in trade.	Possible	Slight positive

16.9 Silverwater services facility

16.9.1 Existing environment

Local business profile

Silverwater is an extensive industrial area generally located around Silverwater Road. Figure 16-10 shows the key business areas around the Silverwater services facility construction site, as well as the relevant destination zones for the local business profile.

Figure 16-10: Silverwater local business study area and relevant destination zones

The Silverwater local business study area is primarily industrial with a large number of businesses specialising in manufacturing, urban services, and other industrial uses.

As highlighted in Table 16-14 below, there are no businesses currently located within the construction site footprint. However, there are a large number of businesses adjacent to the construction site and within 400 metres. Most of these businesses are industrial with a mix of manufacturing and urban services. There are also several child care services, cafes and restaurants, gyms and recreational facilities, and commercial premises within the local business area.

Table 16-14: Businesses within Silverwater local business study area

Impact area	Types of businesses	Approximate number of businesses
Within construction site	Nil	0
Within 100 metres of the construction site	Cafes and Restaurants; Child Care; Urban Services; Commercial; Manufacturing; Industrial	30 to 40
Between 100 and 400 metres from the construction site	Cafes and Restaurants; Urban Services; Commercial; Manufacturing; Industrial	20 to 30

Employment

At the 2016 census there were around 9,610 jobs within the destination zones relevant to the Silverwater local business study area. As shown in Figure 16-11, the majority of these were within the goods production sector which accounted for some 39.8 per cent (3,830) of jobs. The second largest sector was the goods distribution sector which contained 2,190 jobs. Businesses within both sectors rely on good access to the road network to access and distribute goods.

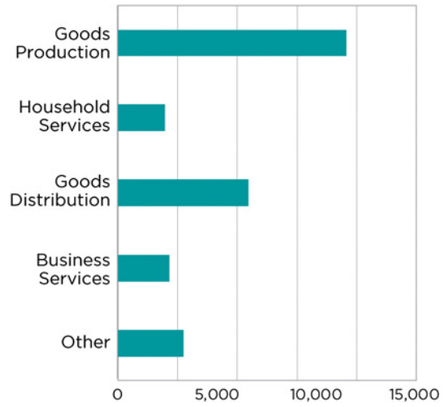

Figure 16-11: Employment by business categories – Silverwater destination zones

Source: Australian Bureau of Statistics, 2016, Ethos Urban

Figure 16-12: Top five industries – Silverwater destination zones

Source: Australian Bureau of Statistics, 2016, Ethos Urban

Figure 16-12 shows the top five industries of employment within the local business area, highlighting that there is a significant concentration of jobs within the manufacturing sector, which accounted for 22.3 per cent of all jobs in the local business area. Compared to other local business study areas, Silverwater had the highest overall share of jobs across the total from the manufacturing, construction and wholesale trade industries.

Travel patterns

As shown in Table 16-15, Silverwater is relatively well serviced by the road network, with good access to major arterial roads that lead north-south and east-west. In contrast, the local business study area is not accessible by train, and as a result, workers are highly dependent on cars to get to work, with 84.7 per cent of all journeys to work being by private motor vehicle. By comparison, only 5.4 per cent of workers used the train to get to work. Given the high levels of car use, businesses are reliant on the road network to access regional labour markets.

Table 16-15: Top five methods of travel to work – Silverwater destination zones

Methods of travel to work	Number	Proportion
Car, as driver	7,574	84.7%
Train	480	5.4%
Car, as passenger	379	4.2%
Truck	121	1.4%
Bus	135	1.5%

Source: Australian Bureau of Statistics, 2016; Ethos Urban

16.9.2 Potential impacts

An assessment of the potential impacts relevant to the Silverwater local business study area is provided in Table 16-16. Impacts to businesses within the Silverwater local business study area are expected to be minimal as the construction site is relatively small and it is set within an existing industrial area.

Potential impacts to local businesses would be minimised through the implementation of mitigation measures for amenity related issues (such as noise, traffic, visual and air quality) and those identified in Section 16.16. This would include a small business owner's support service to assist small business owners adversely impacted by construction.

Table 16-16: Silverwater – Local business impacts

Potential impact	Risk assessment	
	Likelihood	Significance
Potential indirect impacts		
Temporary traffic congestion and increased travel times Increased congestion is not predicted with the exception of the Derby Street approach to its intersection with Silverwater Road. As there are numerous alternative access routes into this part of the industrial area, temporary traffic congestion is unlikely to impact local businesses. These impacts are further mitigated by the relatively small scale of construction works at the construction site and the short duration of works. Workers within the local business area are highly car dependent and potential temporary increases in traffic congestion and travel times could affect workers journey times to work. It is also expected that a high proportion of customers would access local businesses by car, meaning potential temporary increases in traffic congestion and travel times could also impact businesses. Servicing and deliveries could also be affected by potential temporary increases in traffic congestion and travel times around the precinct.	Unlikely	Slight negative
Temporary reduced local amenity Temporary reduced amenity is not expected to impact surrounding businesses. Businesses currently experience amenity levels consistent with an industrial area which could include comparatively higher levels of noise, vibration, dust and visual impacts from surrounding premises.	Rare	Neutral
Temporary power and utility interruptions Unplanned power and utility interruptions could result in temporary impacts during interruptions.	Unlikely	Slight negative
Safety and security The business area already has a relatively low level of street activity and surveillance. Further, surrounding businesses are not expected to generate night-time pedestrian activity.	Rare	Slight negative
Potential opportunities		
Increase in passing trade Businesses may experience an increase in business trade and customers from construction workers. Local population servicing businesses such as retail, cafés and restaurants are the most likely to experience an increase in customers as a result of Stage 1 construction works.	Likely	Slight positive

16.10 Sydney Olympic Park metro station

16.10.1 Existing environment

Local business profile

The main business area is located south of the existing Sydney Olympic Park Station. Figure 16-13 shows the key business areas around the Sydney Olympic Park metro station construction site services facility, as well as the relevant destination zones for the local business profile.

Figure 16-13: Sydney Olympic Park local business study area and relevant destination zones

The Sydney Olympic Park local business study area has a diverse mix of commercial, education, tourism, hotel and retail uses, with some cafes and restaurants.

Businesses located within the local business study area also include a range of commercial businesses, education and technical engineering businesses. Reflecting the surrounding context of Sydney Olympic Park, many of the commercial offices are sports related organisations and businesses. Within the local business study area, Sydney Olympic Park has low-rise commercial office buildings and generally provides campus style commercial office space for a range of large businesses.

The northern part of the local business study area, near Dawn Fraser Avenue contains the main retail areas and includes a convenience store, retail, cafes and restaurants. The western part of the study area contains several large hotels. Hotels, cafes and restaurants are mostly aimed at serving the needs of patrons attending major sporting and entertainment events, at which time there is also a range of temporary or mobile business facilities (e.g. mobile food outlets) present in the local business area.

The Sydney Olympic Park metro station construction site is located south of the existing Olympic Park Station, and generally within the commercial part of the local business study area. The construction site contains three large warehouse style buildings used for commercial and educational purposes.

Table 16-17 below highlights the existing types of businesses within the local business study area.

Table 16-17: Businesses within the Sydney Olympic Park metro station local business study area

Impact area	Types of businesses	Approximate number of businesses
Within construction site	Commercial, education	10 to 20
Within 100 metres of the construction site	Commercial, education, retail, hotels, cafes and restaurants	20 to 30
Between 100 and 400 metres of the construction site	Commercial, education, retail, hotels, cafes and restaurants	50 to 80

Employment

Sydney Olympic Park is a known sports and events precinct with associated commercial/office facilities and food and retail services. There are also hotels to cater for the visitors to sporting and other events. Sydney Olympic Park is therefore characterised by a diverse mix of employment uses.

At the 2016 Census about 9,800 people were employed within the destination zones relevant to the Sydney Olympic Park local business study area, making it a relatively large business area. As shown in Figure 16-14, a high number of these workers (4,830 jobs) were employed in business services, accounting for almost 50 per cent of all jobs. Workers in these jobs are likely to be drawn to working in Sydney Olympic Park due to the convenience of getting to work and the campus style office building accommodation.

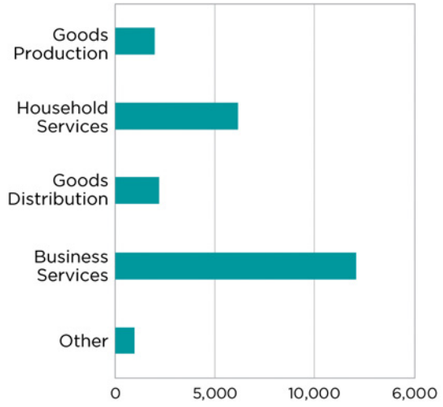

Figure 16-14: Employment by business categories – Sydney Olympic Park destination zones

Source: Australian Bureau of Statistics, 2016; Ethos Urban

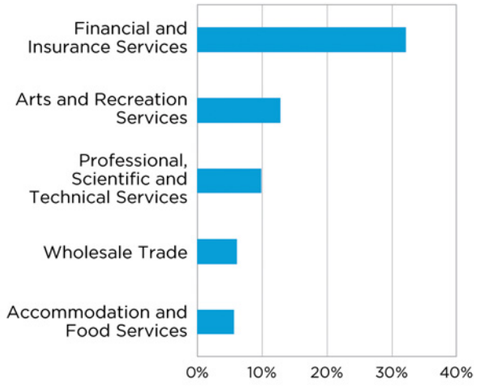

Figure 16-15: Top five industries – Sydney Olympic Park destination zones

Source: Australian Bureau of Statistics, 2016; Ethos Urban

The largest employers are financial and insurance services (3,170 jobs) and arts and recreation services (1,270 jobs), which are primarily associated with the sporting and event functions (see Figure 16-15). The contrast between the two largest industries is reflective of the mixed-use nature of the local business study area.

Travel patterns

As shown in Table 16-18, the highest proportion of commuters travel to work by car (as a driver) with about 57.9 per cent of the local workforce, (5,710 workers), preferring this method of travel. Public transport accounted for the second and third greatest mode of travel to work with 2,160 workers choosing to travel by train and 431 using the bus. Commuters are more likely to use public transport when their travel is related to attending major sporting and entertainment events.

As the local business study area is not well connected to surrounding residential areas, mainly due to barriers associated with sporting stadia and facilities, arterial roads (e.g. Homebush Bay Drive and the Western Freeway), and waterways, only a small proportion of the local workforce choose walking as the preferred mode of travel to work (139 people).

Table 16-18: Top five methods of travel to work – Sydney Olympic Park destination zones

Methods of travel to work	Number	Proportion
Car, as driver	5,709	63.7%
Train	2,160	24.1%
Bus	431	4.8%
Car, as passenger	324	3.6%
Walked only	139	1.6%

Source: Australian Bureau of Statistics, 2016; Ethos Urban

16.10.2 Potential impacts

An assessment of the potential impacts relevant to the Sydney Olympic Park local business study area is provided in Table 16-19. Overall, the highly specialised nature of Sydney Olympic Park indicates that most of the businesses should be more resilient to construction impacts, as customers are attracted by destination businesses serving a wider regional catchment, or for major events and sporting activities. Sydney Metro would work with the Department of Planning, Industry and Environment in relation to managing construction impacts during major events throughout the precinct. As such, temporary or mobile businesses associated with major events would generally not be impacted.

Potential impacts to local businesses would be minimised through the implementation of mitigation measures for amenity related issues (such as noise, traffic, visual and air quality) and those identified in Section 16.16. This would include a small business owner's support service to assist small business owners adversely impacted by construction.

Table 16-19: Sydney Olympic Park – Local business impact matrix

Potential impact	Risk assessment	
	Likelihood	Significance
Potential indirect impacts		
Temporary traffic congestion and increased travel times Businesses within the local business study area are familiar with operating in the context of major events and therefore may be capable of absorbing changes in vehicle movements associated with Stage 1 construction. Events would continue to be a major attraction for customers and it is anticipated that any temporary increase in traffic congestion and travel times would not affect the numbers of customers accessing local businesses during these events. Workers are highly car dependent and potential temporary increases in traffic congestion and travel times around the precinct could affect workers journey to work time. Servicing and deliveries could also be affected by temporary increases in traffic congestion and travel times around the construction site.	Rare	Slight negative
Loss of goods and services The types of businesses within the construction site footprint do not generally provide goods and services to other local businesses within the precinct. As such, businesses within the local business precinct are unlikely to need to find alternative goods and services providers.	Unlikely	Neutral
Temporary reduced local amenity A range of businesses near the construction site may be temporarily impacted by amenity although this would be minimised through measures such as hoardings around the site and acoustic sheds. Businesses potentially affected would primarily be those located closest to the construction site and those more reliant on a pleasant urban amenity.	Likely	Slight negative
Temporary power and utility interruptions Unplanned power and utility interruptions could result in temporary impacts during interruptions.	Unlikely	Slight negative
Safety and security Appropriate mitigation measures including lighting, signage and hoarding to divert pedestrians and traffic safely around construction sites would be implemented as necessary so that customer/visitor patronage to local business is maintained. Temporary impacts are likely to be limited to a small number of cafes and restaurants located near the intersection of Showground Road and Dawn Fraser Avenue that would normally continue trading into the evening. However, these businesses are all connected to the hotels and much of their trade would either be event based or linked to hotel patronage, reducing the likelihood of impacts.	Rare	Slight negative
Potential opportunities		
Increase in passing trade Shops, cafés and restaurants are most likely to experience an increase in customers as a result of Stage 1 construction works.	Likely	Slight positive
Redistribution of trade Directly impacted businesses are not local population serving in nature, meaning that surrounding businesses are unlikely to benefit by providing comparable goods and services.	Rare	Slight positive

16.11 North Strathfield metro station

16.11.1 Existing environment

Local business profile

North Strathfield has a number of business areas, generally located along the existing rail line and Concord Road. Figure 16-16 shows the key business areas around the North Strathfield metro station construction site, as well as the relevant destination zones for the local business profile.

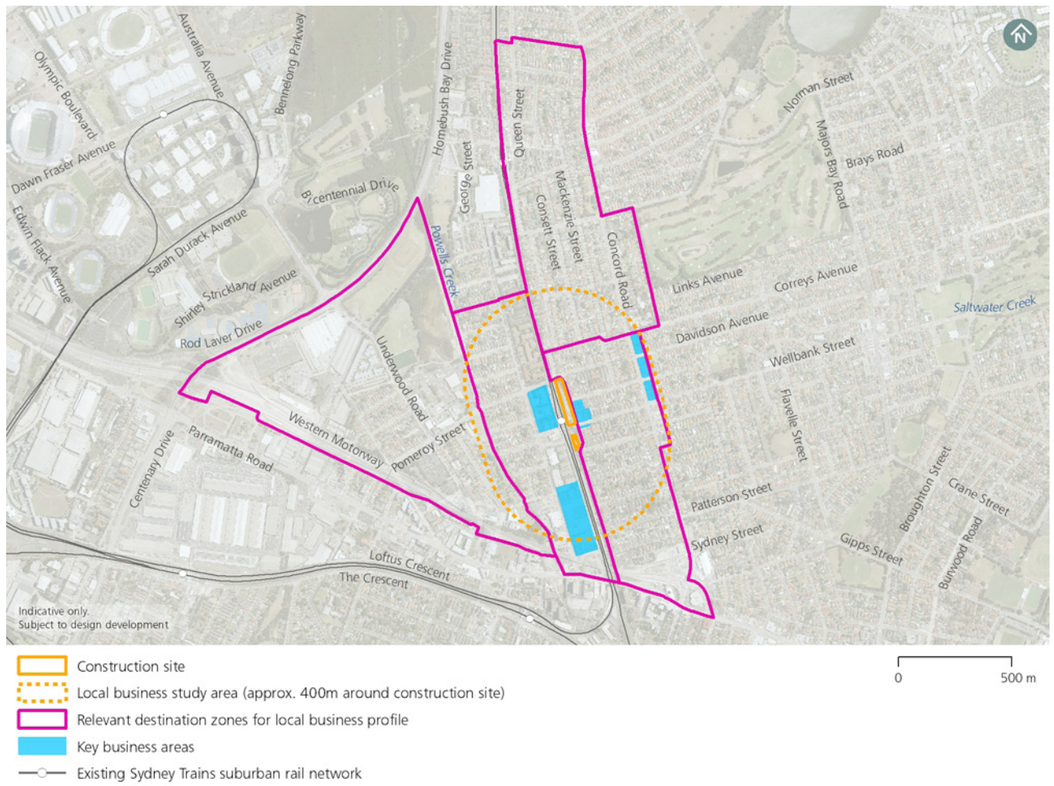

Figure 16-16: North Strathfield local business study area and relevant destination zones

The North Strathfield local business study area contains a mix of commercial, retail, education, health, cafes and restaurants across a number of business areas.

Several businesses are located along the eastern side of Queen Street, which comprises a local shopping area with a mix of local commercial services, health consulting rooms, shops and cafes.

A larger more varied neighbourhood shopping district is located along the eastern side of Concord Road, about 350 metres east of the North Strathfield metro station construction site. This retail strip provides a more diverse range of local population serving businesses, including a large number of restaurants, a petrol station, supermarket, and veterinary hospital.

About 150 metres to the south-west, located on George Street on the western side of the rail corridor, is a predominantly educational area also comprising a small local supermarket, a gym, and child care centres. Further south-west along George Street about 400 metres from the construction site is the Bakehouse Quarter, a mixed use area including offices, retail, cafes and restaurants, and entertainment venues.

There are no businesses within the construction footprint, although it is located directly opposite businesses along Queen Street.

Table 16-20 highlights the existing types of businesses within the North Strathfield local business study area.

Table 16-20: Businesses within North Strathfield local business study area

Impact classification	Types of businesses	Approximate number of businesses
Within construction site	Nil	0
Within 100 metres of the construction site	Commercial, retail, education, cafes and restaurants	20 to 30
Between 100 and 400 metres of the construction site	Commercial, retail, education, cafes and restaurants	60 to 90

Employment

The North Strathfield local business study area contains a diverse mix of employment uses in terms of both industry and building use.

The eastern side of the study area is characterised by small businesses associated with food and beverage, retail and local commercial services, while land to the west is occupied by the McDonald College and surrounding educational facilities, which is situated directly adjacent to the existing North Strathfield Station. The wider area is mainly residential, with the employment figures reflecting this mix of uses focused on local population serving businesses.

At the 2016 Census about 5,500 people were employed within the destination zones relevant to the North Strathfield local business study area, making it moderately sized. As highlighted in Figure 16-17, employment within the local business study area is fairly evenly distributed across sectors, with the two largest sectors being household services and goods distribution. Together these sectors make up over 60 per cent of all jobs with 1,660 and 1,650 jobs respectively at the 2016 census. A number of the jobs within the household sector were in other services, which includes a broad range of personal services; religious, civic, professional and other interest group services; selected repair and maintenance activities; and private households employing staff.

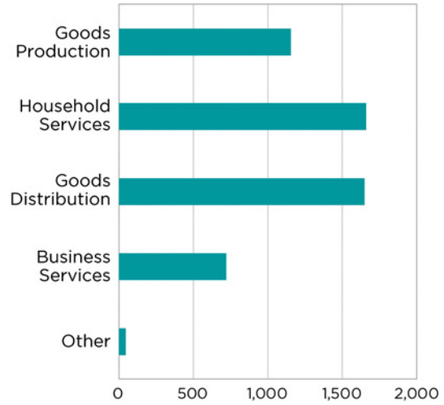

Figure 16-17: Employment by business categories – North Strathfield destination zones

Source: Australian Bureau of Statistics, 2016; Ethos Urban

Figure 16-18: Top five industries – North Strathfield destination zones

Source: Australian Bureau of Statistics, 2016; Ethos Urban

Retail trade employed a total of 920 workers while other services accounted for some 617 workers, representing the two largest employing industries in the study area. As shown in Figure 16-18, manufacturing, construction and transport, postal and warehouse services complete the top five employment industries within the local business study area.

These prominent industries reflect the role of North Strathfield as a predominantly residential area supported by a local centre and small businesses that serve the surrounding community.

Travel patterns

Table 16-21 hows the method of travel to work for people employed in the North Strathfield local business study area. The local business area is within walking distance to the existing North Strathfield and Concord West stations, both of which provide connections to the Sydney CBD, North Shore and Parramatta. Despite this, only 784 commuters choose to use the train as the preferred method of transport to work, accounting for 14.2 per cent of all commuters.

There are existing bus services throughout the local business study area, however only a small portion of workers choose these services as the preferred method of travel to work (2.1 per cent).

North Strathfield local business study area is also well connected by major arterial roads such as the M4 Western Motorway, allowing easy access by car. Accordingly, travelling to work by car as a driver and/or as a passenger represents the preferred method of travel for 68.5 per cent of work trips. This use of private transport indicates the existing public transport system (both bus and train) does not meet the needs of workers in local businesses.

Table 16-21: Top five methods of travel to work – North Strathfield destination zones

Methods of travel to work	Number	Proportion
Car, as driver	3,593	71.9%
Train	784	15.7%
Bus	201	4.0%
Car, as passenger	170	3.4%
Walked only	116	2.3%

Source: Australian Bureau of Statistics, 2016; Ethos Urban

16.11.2 Potential impacts

An assessment of the potential impacts relevant to the North Strathfield local business study area is provided in Table 16-22. The construction site is unlikely to result in reduced customers or passing trade for surrounding Queen Street businesses. Business on Concord Road and the Bakehouse Quarter are unlikely to be affected as they are well separated from the construction site.

Potential impacts to local businesses would be minimised through the implementation of mitigation measures for amenity related issues (such as noise, traffic, visual and air quality) and those identified in Section 16.16. This would include a small business owner's support service to assist small business owners adversely impacted by construction.

Table 16-22: North Strathfield – Local business impacts

Potential impact	Risk assessment	
	Likelihood	Significance
Potential indirect impacts		
Temporary traffic congestion and increased travel times Traffic and travel time impacts are not predicted around key business areas within the local business study area.	Rare	Slight negative
Temporary loss of parking Spare capacity on nearby streets would be used to accommodate as many as possible of the 20 on-street parking spaces (time-restricted to one or two hours) which would be temporarily lost during construction on the western side of Queen Street between Wellbank Street and Pomeroy Street. Some of these spaces are likely to be currently used by customers of businesses on Queen Street. This would temporarily affect convenience of and access to businesses on Queen Street.	Likely	Slight negative
Temporary reduced local amenity Potential noise, vibration, dust and visual impacts from construction works may temporarily result in reduced local amenity for some businesses along Queen Street although this would be minimised through measures such as hoardings around the site. Businesses closest to the construction site would be the most affected, particularly businesses such as cafes that are more reliant on a pleasant local urban amenity.	Likely	Slight negative
Temporary power and utility interruptions Unplanned power and utility interruptions could result in temporary impacts during interruptions.	Unlikely	Slight negative
Safety and security Safety and security associated with the construction site is unlikely to affect any businesses on Queen Street or further afield due to their separation from the construction site.	Rare	Slight negative
Potential opportunities		
Increase in passing trade Businesses along Queen Street may benefit from an increase in the number of customers from construction workers on site, including retail and cafes.	Possible	Slight positive

16.12 Burwood North Station

16.12.1 Existing environment

Local business profile

The main business areas around Burwood North are focussed around the Parramatta Road corridor. Figure 16-19 shows the key business areas around the Burwood North Station construction site, as well as the relevant destination zones for the local business profile.

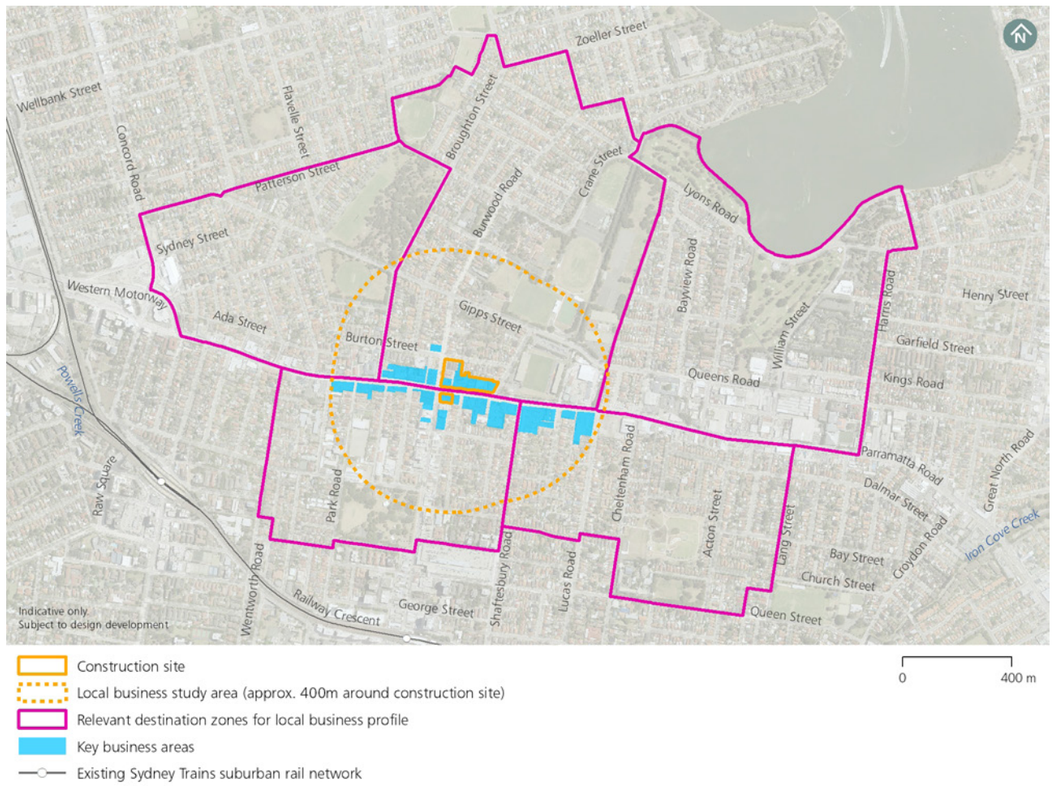

Figure 16-19: Burwood North local business study area and relevant destination zones

The Burwood North local business study area provides for a wide range of businesses including retail, motor repairs and showrooms, light industries, industrial retail outlets, commercial offices, cafes and restaurants. This diversity of businesses is generally continued along Parramatta Road and Burwood Road, which are attractive locations for business operators due to the high level of exposure to passing traffic.

The Burwood North Station construction site is reflective of this diversity with a number of businesses located within the footprint, comprising health and education related businesses, automotive, construction and business services, as well as a hotel, cafes and restaurants.

Table 16-23 highlights the existing types of businesses within the local business study area, identifying those that would be directly affected by the proposed construction works, and those near the construction site.

Table 16-23: Businesses within Burwood North local business study area

Impact area	Types of businesses	Approximate number of businesses
Within construction site	Commercial, automotive, retail, education, health, cafes and restaurants	20 to 30
Within 100 metres of the construction site	Commercial, retail, education, health, cafes and restaurants	30 to 50
Between 100 and 400 metres of the construction site	Health, commercial, retail, education, health, cafes and restaurants	20 to 40

Employment

At the 2016 census about 5,230 jobs were located within the destination zones relevant to the Burwood North local business study area. As shown in Figure 16-20, the majority of these jobs are in household services, which include jobs in the education and health care industries.

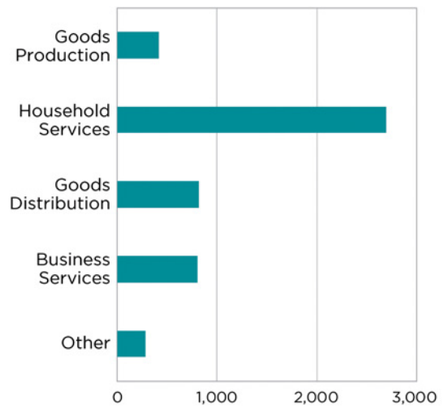

Figure 16-20: Employment by business categories – Burwood North destination zones

Source: Australian Bureau of Statistics, 2016; Ethos Urban

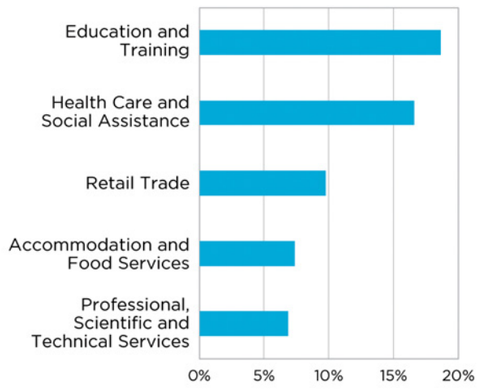

Figure 16-21: Top five industries – Burwood North destination zones

Source: Australian Bureau of Statistics, 2016; Ethos Urban

The top five industries of employment in the local business study area are shown in Figure 16-6. Education and training is the highest employing industry in the precinct, accounting for 18.6 per cent of total employment, followed by health care and social assistance (16.6 per cent). Retail trade, accommodation and food services and professional, scientific and technical services are also prominent employing industries in the local business area.

Travel patterns

As shown in Table 16-24, workers within the destination zones relevant to the Burwood North local business study area were highly dependent on cars to get to work. At the 2016 census, 69.5 per cent of workers used a car (as a driver) to get to work, this proportion was high compared to some of the other local business study areas. Major arterial roads including Parramatta Road and Liverpool Road provide good connections to labour markets and support the use of car as a method of travel. While the local business study area does not have a train station located within, travel by train was the second highest recorded method of travel to work (687 people or 14.9 per cent of all commutes). This percentage reflects the relatively close proximity of the study area to existing train stations at Strathfield and Burwood. Bus travel was the third most popular method of travel, however this only accounted for 230 or 5.0 per cent of commutes to work.

Table 16-24: Top five methods of travel to work – Burwood North destination zones

Methods of travel to work	Number	Proportion
Car, as driver	3,214	69.5%
Train	687	14.9%
Bus	230	5.0%
Car, as passenger	197	4.3%
Walked only	171	3.7%

Source: Australian Bureau of Statistics, 2016; Ethos Urban

16.12.2 Potential impacts

An assessment of the potential impacts relevant to the Burwood North local business study area is provided in Table 16-25. Overall, the nature of the businesses within the Burwood North local business study area and the existing environment suggests that most of the businesses would be more resilient to construction impacts.

Potential impacts to local businesses would be minimised through the implementation of mitigation measures for amenity related issues (such as noise, traffic, visual and air quality) and those identified in Section 16.16. This would include a small business owner's support service to assist small business owners adversely impacted by construction.

Table 16-25: Burwood North – Local business impacts

Potential impact	Risk assessment	
	Likelihood	Significance
Potential indirect impacts		
Temporary traffic congestion and increased travel times Businesses in this location are generally situated along major regional roads such as Parramatta Road and Burwood Road. Businesses along these corridors would be accustomed to large volumes of traffic and traffic congestion. As such, potential temporary increases in traffic congestion and travel times would not be expected to affect the numbers of customers accessing businesses within the local business study area.	Unlikely	Slight negative
Temporary loss of parking About six time-restricted on-street parking spaces would be temporarily removed on the western side of Loftus Street adjacent to the Burwood North Station northern construction site boundary. Impacts would be minimal given the location and low number of lost parking spaces, and the availability of parking on nearby streets.	Unlikely	Slight negative
Loss of goods and services Remaining businesses within the precinct are unlikely to need to find alternative providers of goods and services. The types of businesses within the construction site are destination businesses servicing a wider catchment or local household services and are unlikely to provide goods and services to local businesses within the study area.	Unlikely	Slight negative
Temporary reduced local amenity Impacts to businesses from temporary reduced amenity are unlikely. Nearby businesses are generally located on Burwood Road and Parramatta Road which are already subject to reduced amenity from being located on busy major roads, and would mostly be separated from the construction site by existing roads. Most of these businesses are also generally not of a type that are dependent on urban amenity.	Unlikely	Slight negative
Temporary power and utility interruptions Unplanned power and utility interruptions could result in temporary impacts during interruptions.	Unlikely	Slight negative
Safety and security The business area, particularly along Parramatta Road, already has a relatively low level of street activity. Further, surrounding businesses are not expected to generate night-time pedestrian activity.	Unlikely	Slight negative
Potential opportunities		
Increase in passing trade Local population servicing businesses such as retail and cafés and restaurants are the most likely to experience an increase in customers as a result of Stage 1 construction works.	Likely	Slight positive
Redistribution of trade Some local customers may redistribute their trade towards similar locally serving businesses within other parts of the business precinct or the surrounding area.	Possible	Slight positive

16.13 Five Dock Station

16.13.1 Existing environment

Local business profile

The main business areas around Five Dock are generally located within the Five Dock town centre, extends along Great North Road. Figure 16-22 shows the key business areas around the Five Dock Station construction site, as well as the relevant destination zones for the local business profile.

Figure 16-22: Five Dock local business study area and relevant destination zones

The Five Dock local business study area provides a wide range of local businesses offering goods and services to the local community, including retail, health, education, banks, commercial offices, cafes and restaurants.

The Five Dock Station construction site is located in the middle of the Five Dock town centre, and the footprint includes a cafe, a gym, a pharmacy, a bank, and retail, education and commercial office premises. Table 16-26 highlights the existing business types in the local business study area.

Table 16-26: Businesses within Five Dock local business study area

Impact area	Types of businesses impacted	Approximate Number of Businesses
Within construction site	Retail, commercial services, educational, health	10 to 20
Within 100 metres of the construction site	Retail, commercial services, educational, health	80 to 120
Between 100 and 400 metres of the construction site	Retail, commercial services, educational, health	100 to 150

Employment

At the 2016 census around 3,060 jobs were located within the destination zones relevant to the Five Dock local business study area, making it relatively small. As shown in Figure 16-23 about 44.1 per cent of these jobs were in the household services sector, with a large number of these jobs associated with the provision of health care services.

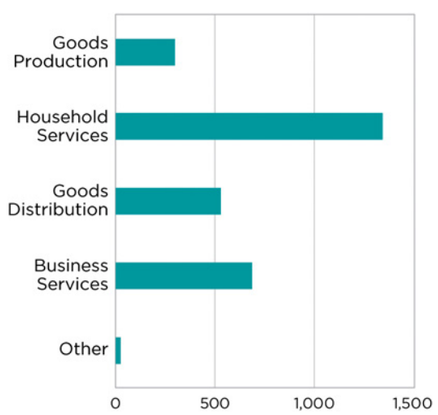

Figure 16-23: Employment by business categories – Five Dock destination zones

Source: Australian Bureau of Statistics, 2016; Ethos Urban

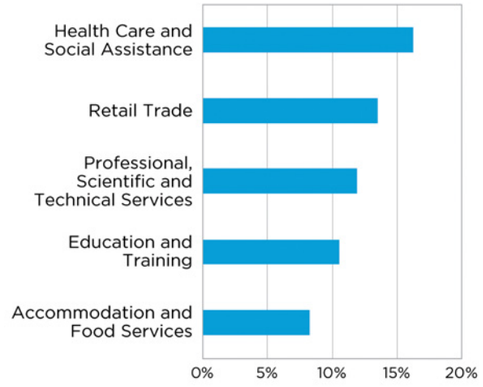

Figure 16-24: Top five industries – Five Dock destination zones

Source: Australian Bureau of Statistics, 2016; Ethos Urban

Jobs within the local business study area are evenly distributed across a range of industries, with no particular industry recording a dominant concentration of jobs as illustrated in Figure 16-24. Health care and social assistance accounted for the highest number of jobs in the local business study area with a total of 498 employing jobs, representing 16.3 per cent of the total jobs. This is followed by retail trade and professional, scientific and technical services which accounted for 364 and 322 jobs respectively.

Travel patterns

As shown in Table 16-27, travel patterns recorded in the 2016 census indicate that workers within the local business study area are highly dependent on car (as a driver) as the main method of travelling to work. Around 1,960 workers travelled to jobs within the local business area by private vehicle, accounting for 75.7 per cent of all travel to work. Other methods of travel to work were quite low, with train and bus only recording 6.4 and 6.3 per cent of all methods of travel to work (respectively), and walking only 4.4 per cent.

Table 16-27: Top five methods of travel to work – Five Dock destination zones

Methods of travel to work	Number	Proportion
Car, as driver	1,963	75.7%
Train	166	6.4%
Bus	164	6.3%
Car, as passenger	144	5.6%
Walked only	114	4.4%

Source: Australian Bureau of Statistics, 2016; Ethos Urban

16.13.2 Potential impacts

An assessment of the potential impacts relevant to the Five Dock local business study area is provided in Table 16-28. Potential impacts to local businesses would be minimised through the implementation of mitigation measures for amenity related issues (such as noise, traffic, visual and air quality) and those identified in Section 16.16. This would include a small business owner's support service to assist small business owners adversely impacted by construction.

Table 16-28: Five Dock – Local business impacts

Potential impact	Risk assessment	
	Likelihood	Significance
Potential indirect impacts		
Temporary traffic congestion and increased travel times Potential temporary impacts to businesses associated with construction traffic would be minimised through measures such as reducing movements in network peak periods. Temporary increases in traffic congestion and travel times could affect workers journey to work times. Servicing and deliveries for businesses within the local business area may also be affected by temporary increases in traffic congestion and travel times around the precinct.	Likely	Slight negative
Loss of parking Around 12 on-street parking spaces may be temporarily removed along Great North Road to the north of Fred Kelly Place, adjacent to the Five Dock Station western construction site. The Five Dock Station eastern construction site would involve permanent removal of an off-street parking area (about 12 parking spaces) accessed via Second Avenue and the temporary removal of about 10 on-street parking spaces near the site access and egress points along Waterview Street (unrestricted parking) and Second Avenue (time-restricted parking). The loss of parking could reduce convenience for some customers visiting businesses within the business precinct.	Almost certain	Slight negative
Loss of goods and services Some local businesses may need to find alternative providers of goods and services, which are likely to be available in the local area.	Likely	Slight negative
Temporary reduced local amenity Businesses located close to the construction site may temporarily experience reduced amenity although this would be minimised through measures such as hoardings around the site and acoustic sheds. As a local neighbourhood centre, amenity is an important attribute for some local businesses particularly the nearby childcare, library, church, and cafes and restaurants around Fred Kelly Place. Further assessment of these potential impacts is provided in Chapter 16 (Social impacts – Stage 1).	Almost certain	Moderate negative
Temporary power and utility interruptions Unplanned power and utility interruptions could result in temporary impacts during interruptions.	Unlikely	Slight negative

Potential impact	Risk assessment	
	Likelihood	Significance
Safety and security Appropriate mitigation measures including lighting, signage and hoarding to divert pedestrians and traffic safely around construction sites would be implemented as necessary so that customer/visitor patronage to local business is maintained.	Unlikely	Slight negative
Potential opportunities		
Increase in passing trade Local population servicing businesses such as retail and cafés and restaurants located close to the construction site are the most likely to experience an increase in customers as a result of Stage 1 construction works.	Possible	Slight positive
Redistribution of trade Some local customers may redistribute their trade towards similar locally serving businesses within other parts of the business precinct or the surrounding area.	Unlikely	Slight positive

16.14 The Bays Station

16.14.1 Existing environment

Local business profile

Business areas around The Bays are dominated by the Glebe Island and White Bay Port, but also include industrial areas adjoining the port, and retail areas along Victoria Road and Darling Street. Figure 16-25 shows the key business areas around The Bays Station construction site, as well as the relevant destination zones for the local business profile.

Figure 16-25: The Bays local business study area and relevant destination zones

The Bays local business study area contains a range of businesses that include retail, commercial, or industrial.

In the southern part of the local business study area is the Sydney Boathouse and Rozelle Bay marina supporting a range of businesses that provide boat and marine services.

In the northern part of the local business study area businesses generally comprise urban services and light industries within the existing warehouse buildings along Robert Street and Mullens Street, Rozelle. These existing warehouse buildings extend from immediately opposite the site at Robert Street to approximately 300 metres to the north-west. Businesses in this part of the study area include a pub, gyms, a church, specialised retail outlets and wholesale. More broadly, a large number of retail and commercial businesses are located along Victoria Road and Darling Street, to the site's north-west.

The eastern part of the local business study area contains the port related businesses associated with White Bay and Glebe Island Port, including the Cement Australia and Sugar Australia facilities operation from the Glebe Island Silos.

Table 16-29 below highlights the existing types of businesses within 400 metres of the construction site. The Bays Station construction site is located within the Glebe Island and White Bay Port, but would occupy land that is not currently leased for port related development.

Table 16-29: Businesses within The Bays local business study area

Impact area	Types of businesses	Approximate number of businesses
Within construction site	Nil	0
Within 100 metres of the construction site	Commercial; Retail; Wholesale; Industrial; Port	20 to 30
Between 100 and 400 metres of the construction site	Commercial; Retail; Wholesale; Industrial; Port	20 to 30

Employment

The local business study area comprises a mix of uses which includes the industrial and port facility areas, with a variety of service based industrial and commercial businesses. At the 2016 census some 3,280 jobs were located within the destination zones relevant to The Bays local business study area. As shown in Figure 16-26, jobs in business services have the largest representation, accounting for 32.5 per cent of all jobs (or 1,070 jobs) followed by household services at 25.9 per cent of all jobs. The location of these jobs reflects the diverse nature of the local business study area.

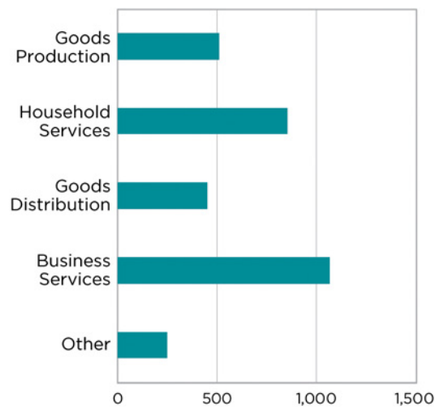

Figure 16-26: Employment by business categories – The Bays destination zones

Source: Australian Bureau of Statistics, 2016; Ethos Urban

Figure 16-27: Top five industries – The Bays destination zones

Source: Australian Bureau of Statistics, 2016; Ethos Urban

As shown in Figure 16-27, employment by industry tended to be diverse with no single industry being dominant. Professional, scientific and technical services was the most represented employment industry with 420 jobs, representing 12.8 per cent of all jobs. Construction made up the second highest portion of jobs with around 350 jobs and accounting for 10.7 per cent of all jobs.

Travel patterns

The Bays local business study area is highly accessible by road including via the major arterial roads of Anzac Bridge and Victoria Road. The most preferred method of travel to work was by car as a driver, which accounted for a total of 1,814 of commutes, representing 64.6 per cent of all journey to work trips to the local business area. Public transport via bus and train represented 9.9 per cent and 8.9 per cent of all journey to work commutes respectively.

There are little to no train networks connecting workers to The Bays local business study area or surrounding areas. There are however frequent and regular bus services. The top five methods of travelling to work are shown in Table 16-30 below.

Table 16-30: Top five methods of travel to work – The Bays destination zones

Methods of travel to work	Number	Proportion
Car, as driver	1,814	64.6%
Train	278	9.9%
Bus	251	8.9%
Walked only	229	8.2%
Care, as passenger	92	3.3%

Source: Australian Bureau of Statistics, 2016; Ethos Urban

16.14.2 Potential impacts

An assessment of the potential impacts relevant to The Bays local business study area is provided in Table 16-31. Potential impacts to local businesses would be minimised through the implementation of mitigation measures for amenity related issues (such as noise, traffic, visual and air quality) and those identified in Section 16.16. This would include a small business owner's support service to assist small business owners adversely impacted by construction.

Table 16-31: The Bays – Local business impacts

Potential impact	Risk assessment	
	Likelihood	Significance
Potential indirect impacts		
Temporary traffic congestion and increased travel times Potential temporary impacts to businesses associated with construction traffic would be minimised through measures such as reducing movements in network peak periods. Temporary increases in traffic congestion and travel times around the precinct could affect workers journey times to work. Road networks around the port are highly constrained, so temporary increases in traffic congestion and travel times could also impact the ability of businesses to efficiently receive deliveries and service vehicles. It is also expected that a high proportion of customers would access businesses within the precinct by car, meaning temporary increases in traffic congestion and travel times could also impact businesses trade.	Likely	Moderate negative
Temporary reduced local amenity Temporary reduced amenity from noise, vibration, dust and visual impacts from construction works is unlikely to result in lower customer experience for surrounding businesses Nearby businesses are primarily industrial in nature and already experience comparatively lower amenity levels from surrounding industrial premises and port related activities.	Unlikely	Slight negative
Temporary power and utility interruptions Unplanned power and utility interruptions could result in temporary impacts during interruptions.	Unlikely	Slight negative
Potential opportunities		
Increase in passing trade Businesses within The Bays local business area are unlikely to benefit from construction workers at the site, except potentially for nearby food and beverage outlets.	Unlikely	Slight positive

16.15 Cumulative impacts

Potential cumulative impacts were considered for assessment based on the likely interactions of Stage 1 with other projects and plans that met the adopted screening criteria. The approach to assessment and the other projects considered are described further in Appendix G (Cumulative impacts assessment methodology – Stage 1).

Measures to avoid, reduce, or mitigate the potential impacts of Stage 1 are collated in Chapter 27 (Synthesis of the Environmental Impact Statement). These measures would reduce the likelihood and magnitude of cumulative impacts should they occur. Construction planning and co-ordination would aim to ensure that Stage 1 is scheduled and managed to minimise the potential for cumulative impacts to occur.

Potential cumulative impacts to businesses around Parramatta metro station construction site as a result of other projects being undertaken concurrently in the surrounding area could include:

- Temporary changes and general disruption to traffic and transport services
- Potential temporary interruption of utilities
- Potential temporary increased travel times for workers
- Temporary reduction in amenity (as a result of construction noise, traffic congestion, changes to visibility, and dust).

The Westmead metro station construction site and The Bays station construction site would have some interactions with other projects, however the risk of cumulative impacts on respective local business precincts is considered to be minimal.

16.16 Management and mitigation measures

16.16.1 Approach

Business impacts would be managed in accordance with Sydney Metro's Construction Environmental Management Framework described in Chapter 27 (Synthesis of the Environmental Impact Statement) and the mitigation measures described below in Section 16.16.2. The Construction Environmental Management Framework includes a requirement for proactive consultation with business regarding the management of impacts.

The Construction Environmental Management Framework also specifies that a Community Communication Strategy would be prepared and implemented during construction. The Strategy would define the location specific measures and strategies to minimise impacts on individual businesses during construction, with particular consideration of the commercial character of the locality, its general trading profile (daily and annually), and information gained from the business profiling.

16.16.2 Mitigation measures

Mitigation measures that would be implemented to address potential business impacts are listed in Table 16-32.

Table 16-32: Mitigation measures – Business impacts Stage 1

ID	Impact / issue	Mitigation measures	Applicable location(s)[1]
BI1	General business impacts	Small business owner engagement would be undertaken to assist small business owners adversely impacted by construction.	All
BI2	Power and utility interruptions	Planned power and utility interruptions would be scheduled to before or after typical business hours where feasible and reasonable. Prior notice would be provided to all affected business owners of the interruptions.	All
BI3	Business visibility and accessibility	Hoarding and screening impacting the visibility of business would be minimised where feasible and reasonable, without compromising public safety or the effective management of construction airborne noise. Clear pathways and signage would be implemented around construction sites to maximise visibility of retained businesses, including sufficient lighting along pedestrian footpaths during night-time where relevant.	All

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (eg tunnel boring machine works); PSR: Power supply routes.

16.16.3 Interactions between mitigation measures

Mitigation measures in other chapters of this Environmental Impact Statement that are relevant to the management of potential business impacts include:

- Chapter 10 (Transport and traffic – Stage 1) – all measures
- Chapter 11 (Noise and vibration – Stage 1) – all measures
- Chapter 14 (Property and land use – Stage 1) – all measures
- Chapter 15 (Landscape character and visual amenity – Stage 1), specifically measures related to minimising landscape character and visual impacts
- Chapter 17 (Social impacts – Stage 1) – all measures
- Chapter 23 (Air quality – Stage 1) – all measures.

Together, these measures would minimise the potential business impacts of Stage 1.

There are no mitigation measures identified in the assessment of other environmental aspects that are likely to affect the assessment of business impacts.

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17 Social impacts – Stage 1

17 Social impacts – Stage 1

This chapter provides an assessment of the potential impacts on social infrastructure and communities during Stage 1 and identifies mitigation measures to minimise these impacts. This chapter is based on information in Technical Paper 6 (Social impact assessment).

17.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to social impacts of Stage 1 and where these requirements are addressed in this Environmental Impact Statement are outlined in Table 17-1.

Table 17-1: Secretary's Environmental Assessment Requirements – Social impacts Stage 1

Reference	Secretary's Environmental Assessment Requirements	Where addressed
3. Social and Economic (including property, land use and business impacts)		
3.2	Commitments made in Section 9.10.2 of the Scoping Report; and	This chapter
3.3	Address impacts to different aspects of people's lives set out in the Social Impact Assessment Guideline.	Section 17.5 to 17.16
3.6	Temporary loss of public open space	Sections 17.5 to 17.16

17.2 Legislative and policy context

The Social impact assessment guideline for state significant mining, petroleum production and extractive industry development (Department of Planning and Environment, 2017b) has been prepared by the Department of Planning, Industry and Environment to provide a consistent framework and approach to the assessment of social impacts associated with state significant resource projects. The approach set out in the social impact assessment guideline is being applied across a range of development types, including major infrastructure projects, and is referenced in the Secretary's Environmental Assessment Requirements to apply to the assessment of social impacts for Stage 1.

17.3 Assessment approach

17.3.1 Methodology

The assessment involved the following stages:

- Definition of the study area and the area of influence
- Review of evidence from other transport (metro) projects to gauge the potential magnitude and likelihood of impacts
- Undertaking a preliminary scoping assessment to identify potential impacts on various social factors, with consideration of the duration, extent, severity and sensitivity of potential social impacts. The preliminary scoping assessment highlighted what elements of the natural or human environment are expected to be impacted upon by Stage 1, how those impacts should be assessed and to what level of detail. It has been informed by the review of evidence and used to focus the social impact assessment on the most relevant and important issues for each locality and ensures the scale of assessment required is proportionate to the importance of the expected impacts. The preliminary scoping assessment is included in Technical Paper 6 (Social)
- Development of a social baseline for the study area, based on analysis of ABS Census data (2016). The social baseline includes:
  - Community profiles including the key demographic characteristics (e.g. age, income, employment, cultural and linguistic diversity, household structure, relative levels of advantage and disadvantage, and transport and access) for the whole Stage 1 corridor based on Statistical Area 2 (SA2) Census collection districts, as well as aggregated Statistical Area 1 (SA1) Census collection district information relevant to each construction site locality
  - Community profiles of SA2 for the residual sections of the corridor between construction sites, along which tunnelling works would occur
  - Community profiles for each construction site locality, based on SA1 Census collection districts that best align with these 400 metre catchments
  - Mapping community stakeholders
  - Identifying community assets, including both tangible (social infrastructure) and intangible (human and social capital, community cohesion, community values and connection to place) assets
- Identification of community values and concerns through a review of outcomes from community engagement (refer to Chapter 5 – Stakeholder and community engagement) and review of key local community strategic plans and other documents
- Assessment of potential impacts of Stage 1, on the specified social factors defined in Section 17.3.2 including:
  - A risk-based assessment of potential negative social impacts, taking into consideration the likelihood and consequence of the potential impact
  - An assessment of potential positive social impacts which considered the likelihood of the benefits and the scale of improvement or benefit (instead of a consequence level)
- Identification and assessment of potential cumulative social impacts
- Development of mitigation measures for identified negative impacts and means to enhance social benefits.

17.3.2 Social factors

The social impact assessment guideline defines social impact as changes that could occur as a result of a project on people's:

- **Way of life** including:
  - How people live, for example how they get around, access to adequate housing
  - How people work, for example access to adequate employment, working conditions and/or practices
  - How people play, for example access to recreational activities
  - How people interact with one another on a daily basis
- **Community**, including its composition, cohesion, character, how it functions and sense of place
- **Access to and use of infrastructure, services and facilities**, whether provided by local, state, or federal governments, or by for-profit or not-for-profit organisations or volunteer groups
- **Culture**, including shared beliefs, customs, values and stories, and connections to land, places, and buildings (including Aboriginal culture and connection to country)
- **Health and wellbeing**, including physical and mental health
- **Surroundings**, including access to and use of ecosystem services, public safety and security, access to and use of the natural and built environment, and its aesthetic value and/ or amenity
- **Personal and property rights**, including whether their economic livelihoods are affected, and whether they experience personal disadvantage or have their civil liberties affected
- **Decision-making systems**, particularly the extent to which they can have a say in decisions that affect their lives, and have access to complaint, remedy and grievance mechanisms
- **Fears and aspirations** related to one or a combination of the above, or about the future of their community.

Potential social impacts can often be successfully managed through appropriate consultation and clear communication with communities. Sydney Metro would develop a Community Communication Strategy to provide continued community engagement prior to and during construction works. Further information is provided in Chapter 5 (Stakeholder and community engagement).

In addition, many of the potential social impacts are associated with other environmental aspects addressed in the various chapters of this Environmental Impact Statement. Mitigation measures related to transport and traffic (Chapter 10), noise and vibration (Chapter 11), property and land use (Chapter 14), landscape character and visual amenity (Chapter 15), business impacts (Chapter 16) and air quality (Chapter 23) would also reduce potential social impacts.

17.3.3 Study area

The study area is defined by the area of social influence. The area of social influence has been determined for Stage 1 based on the consideration of:

- The activities that form part of Stage 1, including construction activities at the surface and tunnelling activities
- The likely scale and extent of potential direct and indirect impacts on the social factors. Indirect impacts are generally less tangible and more commonly relate to matters such as community values, identity and sense of connection to place
- Potentially affected built or natural features that have social value or importance
- The community and stakeholder groups that would most likely be affected by Stage 1
- The communities that may be affected by cumulative impacts from Stage 1 and other transport, construction and major urban renewal processes.

Based on the above considerations, the assessment of social impacts has considered the following 'areas of social influence of Stage 1':

- The 'locality' is defined as a 400 metre catchment around each Stage 1 construction site, and is a proxy for five minutes walking distance. This is the area in which communities are most likely to experience social impacts from Stage 1 construction works
- 'Suburb level' is where the extent of social impacts on communities is generally broader than the locality. It is a conceptual area not necessarily aligned to suburb boundaries
- Region: In some instances, the 'area of social influence' is extended to a 'region' to reflect potential social impacts on a broader community. This is applied where a construction site is in a locality frequented by regional populations, usually a key employment centre (such as Parramatta CBD), or a locality in which there is regional infrastructure or services such as Westmead or Sydney Olympic Park).

17.3.4 Risk assessment methodology

Each potential social impact that was carried forward from the preliminary scoping assessment has been assessed using a qualitative and objective based risk assessment framework which evaluates impacts based on the 'likelihood' of occurrence (defined in Table 17-2), and the 'consequence' of the potential social impact (defined in Table 17-3). A risk rating is then determined by combining the likelihood and consequence to identify the level of risk as shown in the matrix in Table 17-4.

Table 17-2: Likelihood definitions

Likelihood category	Description
Almost certain	Is expected to occur as a result of the project under most circumstances
Likely	Will probably occur as a result of the project in most circumstances
Possible	Could occur and has occurred in similar circumstances
Unlikely	Could occur as a result of the project but is not expected
Rare	Could occur only in exceptional circumstances
Almost unprecedented	Not expected to ever occur

Table 17-3: Consequence definitions

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

Table 17-4: Risk rating matrix

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

17.4 Avoidance and minimisation of impacts

The design development of Stage 1 aimed to avoid and minimise potential social and economic impacts by minimising the amount of privately owned land needed for construction sites to reduce impacts on the community (where possible). The design also aimed to avoid or minimise impacts as follows:

- **Project-wide** – Selection of tunnel boring machines to excavate the twin tunnels because they operate faster than other excavation machinery, resulting in a reduced construction timeframe and less disruption for the local community
- **Project-wide** – Design has minimised impacts to existing parking around existing train stations and in town centres, with the exception of Parramatta CBD, where closure of the City Centre (Horwood Place) car park is consistent with the City of Parramatta's approach of closing some council-owned parking facilities to allow redevelopment within Parramatta CBD, as stated in the Draft Parramatta CBD Public Car Parking Strategy (City of Parramatta, 2017b). This reduces impacts to the daily routine, including convenience and parking congestion
- **At Westmead** – Locating the station box to the south of the existing rail corridor and adopting an east-west orientation. This avoids or minimises direct and indirect impacts (such as noise) to the town centre immediately north of the existing Westmead Station, and minimises potential noise and vibration impacts on nearby noise sensitive receivers in the hospital precinct
- **At North Strathfield** – adopting a north-south orientation of the station box which is parallel to the existing rail corridor and avoids private property acquisition and direct impacts to pedestrian access to local services and facilities located along Queen Street.

17.5 Potential project-wide impacts

The social impact assessment identified a number of potential impacts that would broadly affect localities near Stage 1 construction sites or the Stage 1 corridor as a whole. The project-wide potential impacts are included in Table 17-5.

The potential impacts presented are unmitigated and would be appropriately managed through the implementation of a Community Communication Strategy and the mitigation measures through other relevant chapters of this Environmental Impact Statement. Sydney Metro would also develop a community benefit plan to guide the development of community benefit initiatives (by Principal Contractors).

Table 17-5: Social impact assessment – Potential project-wide impacts

Reference	Description of potential impacts
Way of life	• Temporary reduced amenity and potential impacts to people's enjoyment of everyday activities, including physical activities and social interactions, in the local area due to construction noise and vibration, increased traffic and air quality. Sensitive receivers closer to the construction sites would experience greater temporary impacts of construction noise and vibration. This includes receivers with higher sensitivity including residential communities and students. Refer to Chapter 11 (Noise and vibration – Stage 1) for further details on noise and vibration impacts.
Community	• Potential temporary changes to community character and people's sense of place and belonging associated with changes to streetscape, increased construction activity, and an influx of unfamiliar construction workers into the area. • Community sensitivities to these potential temporary impacts would likely be greater in localities that are characterised by low density residential dwellings and localised, low scale shopping precincts.
Access to and use of infrastructure, services and facilities	• Potential temporary changes to the accessibility of local services and social infrastructure – for people travelling by train, bus or on foot – due to temporary modifications of transport infrastructure in the immediate vicinity of the construction sites (including active transport). This would potentially be disproportionately felt by users who are experiencing disability or disadvantage. Access to social infrastructure would be maintained during construction, and any directly impacted bus infrastructure would be relocated within close proximity. • Potential temporary changes to the accessibility of local services and community facilities associated with the increased traffic, loss of car parking and reduced amenity.
Health and wellbeing	• Potential temporary impacts to health and wellbeing of nearby residents, workers and visitors that experience high levels of construction noise and vibration impacts. • Potential temporary impacts to wellbeing for residents or landowners affected by property acquisition, and associated uncertainty for business owners, employees and residents for their next steps once acquisition has been completed.
Surroundings	• Temporary changes to the local environment and streetscape and reduced local amenity resulting in potentially reduced community enjoyment of surroundings and homes if affected by construction noise or vibration from the construction site. • Perceived and potential actual temporary safety impacts associated with changed sightlines, changes to wayfinding, reduced activation of certain streets at night, and an influx of unfamiliar construction workers, which may affect residents' decisions to access specific places and facilities. • Perceived temporary safety impacts associated with the influx of unfamiliar construction workers in a local neighbourhood setting, which may cause anxiety and concern to residents. This impact would apply to all construction sites with the exception of The Bays Station.
Personal and property rights	• Potential impacts to personal and property rights may arise or be perceived through property acquisitions and construction processes. Property acquisition and compensation processes impacting directly affected landowners and tenants are being managed in accordance with processes under the Land Acquisition (Just Terms) Compensation Act 1991. Sydney Metro has appointed Personal Managers to offer residents and small businesses assistance and support throughout the acquisition process. Acquisition would occur at all sites with the exception of North Strathfield metro station and The Bays Station construction sites.
Fears and aspirations	• Potential impacts associated with concern about possible disruption to local community character, and perceptions about potential long term changes to the fabric of the community, particularly in combination with other construction activity. • Potential concerns - and aspirations - associated with longer term urban renewal impacts catalysed by construction and development of new public transport infrastructure: concern about significant changes to the local community. • Other residents may consider that the construction is a positive impact, as it signals better transport connections and more public and private investment in the local community is likely to be made in the future.

17.6 Stage 1 corridor (tunnelling)

17.6.1 Community profile and assets

The Stage 1 corridor is defined by the following characteristics which relate to human and social capital, community values and connection to place (based on ABS Census data (2016) and local community strategic plans):

- High human capital. The Stage 1 corridor has a high level of human capital relative to the rest of Greater Sydney. The level of education for the Stage 1 corridor is high compared to Greater Sydney, with residents from the western and eastern localities within the corridor obtaining the highest levels of education. In relation to labour market conditions and level of income of households, the corridor was comparable to the rest of Greater Sydney. Households with higher incomes tended to be concentrated in the eastern localities and decline further west along the Stage 1 corridor
- Cohesive communities. Many of the residential localities along Stage 1 corridor are tightly formed residential neighbourhoods with established, cohesive communities heavily reliant on local social infrastructure, community facilities and services for their day-to-day community health and wellbeing
- Strong social capital. There are a number of community groups along the Stage 1 corridor that contribute to fostering social connections and relationships including activist groups, chambers of commerce and cultural groups. Regularly held events such as markets, sporting events and major celebrations also connect the communities and contribute to a sense of place and identity amongst the diverse communities
- Highly engaged communities. Along the corridor there are a number of highly engaged communities, particularly those located within close-knit residential settings such as North Strathfield, Burwood North, Five Dock and The Bays. Many of these communities have active and engaged community groups
- Community perception of urban renewal and associated change and growth. The delivery of Stage 1 of Sydney Metro West would likely be received both with support from communities that endorse change and growth but also with resistance from communities due to the potential changes associated with urban renewal and the cumulative impact of other concurrent projects
- Transition away from car dependence. The need for improved parking, increased public and active transport options and reduced congestion have consistently been raised as issues during community consultation activities. The construction and complete delivery of Sydney Metro West would increase accessibility to new parts of metropolitan Sydney
- Community concerns associated with recent construction projects along the corridor. Some communities have expressed concern over the impact of construction and vibration on their homes, having experienced these issues recently during the construction of other projects.

Community assets

Community assets comprise both tangible assets, such as social infrastructure, and intangible assets, including human and social capital, community values and connection to place. With regards to the tangible assets, the Stage 1 corridor includes a wide range of regional social infrastructure serving a broad catchment including Westmead Hospital and Westmead Children's Hospital, Western Sydney University Parramatta campus, Parramatta Park, Sydney Olympic Park recreation and entertainment precinct, and the Iron Cove Bay Run. Extensive district and local infrastructure including open spaces, education facilities, recreational facilities, aged care facilities, community, childcare and medical centres, and creative and cultural facilities, are in close proximity of Stage 1 construction sites.

Across the Stage 1 corridor, surface construction sites are located in major and local centres, residential areas, industrial areas, and a recreation and entertainment precinct. The social context within each of these localities is distinct, ranging from the major centres in Westmead and Parramatta which have regional social infrastructure serving a broad regional population, to industrial and commercial settings like Silverwater and Clyde which have very limited social infrastructure. Further detail on this social infrastructure is discussed in the below sections.

Community values and aspirations

A review of Community Strategic Plans and social plans relevant to each local government area has been undertaken to identify community values and aspirations along the Stage 1 construction corridor. These Community Strategic Plans are overarching Council policy documents that are prepared on the basis of extensive community engagement and therefore provide further insights into issues important to the communities. The review of these plans are discussed in more detail in Technical Paper 6 (Social impact assessment) and summarised within each section below.

Key community issues identified across the corridor include community aspirations for unique, liveable neighbourhoods with a strong sense of place and character; need for improved public and active transport options, and concern over the impacts of increased population growth, particularly if not well supported by infrastructure.

17.6.2 Social impact assessment

An assessment of the potential social impacts associated with the tunnelling works occurring along the Stage 1 corridor is provided in Table 17-6. The tunnelling works are the underground works from Westmead to The Bays, with social risks from the surface construction sites (or surface works) discussed in the following sections.

The potential impacts presented are unmitigated and would be appropriately managed through the implementation of a Community Communication Strategy and the mitigation measures through other relevant chapters of this Environmental Impact Statement. Sydney Metro would also develop a community benefit plan to guide the development of community benefit initiatives (by Principal Contractors).

Table 17-6: Social impact assessment – Stage 1 corridor tunnelling works

Reference	Description of potential impacts	Social risk without mitigation[1]		
		Likelihood	Consequence	Risk rating
Way of life	• It is unlikely that there would be potential changes to living and working environments and daily routines of residents, business and services due to noise and vibration associated with tunnelling activities in close proximity. Potential temporary impacts in tunnelling sections between construction sites would be negligible, or if minor, only experienced for a very short period. This impact would be far less disruptive to how affected communities go about their daily activities compared to surface construction sites.	Unlikely	Minor	Low
Access to and use of infrastructure, services and facilities	• Potential temporary disruption to the use of existing social infrastructure, including services and civic spaces, due to noise and vibration from tunnelling works, albeit if this would occur, it would be minor and for a very short period of time.	Unlikely	Minor	Low
Health and wellbeing	• Potential temporary health and wellbeing impacts associated with construction noise and vibration from tunnelling activities would be negligible given predicted noise and vibration levels	Unlikely	Minor	Low
Surroundings	• Potential temporary reduced amenity due to construction ground borne noise and vibration associated with tunnelling activities, although these potential impacts would be minor and for a very short period of time.	Unlikely	Minor	Low
Personal and property rights	• Subsurface property acquisition associated with tunnelling works would be appropriately managed in accordance with processes under the *Land Acquisition (Just Terms) Compensation Act 1991*.	Unlikely	Minor	Low
Fears and aspirations	• Uncertainty regarding disruption and other potential temporary impacts to local communities' amenity, way of life and whether damage could occur to personal property due to tunnelling activities and associated noise and vibration • Potential concerns about subsurface acquisition.	Unlikely	Minor	Low

Note 1: "without mitigation" means without specific social mitigation measures that are above and beyond standard impact mitigation that will be in place.

17.7 Westmead metro station

17.7.1 Existing environment

Social context and community profile

The Westmead locality is defined by the following characteristics which relate to human and social capital, community values and connection to place (based on ABS Census data (2016) and local community strategic plans):

- A highly diverse migrant community. The locality has a large Indian and Sri Lankan population with over 70 per cent of residents born overseas. A high proportion of residents rent in medium and higher density housing therefore open space assets such as the nearby Parramatta Park are important to sustaining community health and wellbeing
- A high proportion of families and young people. The family-oriented, younger population are dependent on local social infrastructure and services such as childcare and school, several of which are located close to the construction site
- High social capital. High levels of social capital are evidenced by the number of organised and informal community groups in the locality including a number of places of worship
- A nationally significant health and education precinct. Westmead is home to one of the largest health, education, research and training precincts in Australia providing direct health services to almost 10 per cent of Australia's population and drawing in a large proportion of skilled workers from across metropolitan Sydney
- Growth supported by investment. Committed upgrades to health, education and medical facilities in Westmead over the next 10 years. Other city shaping infrastructure projects include the Parramatta Light Rail construction and redevelopment of Westmead Health precinct
- Challenging day-to-day accessibility throughout the Westmead locality. There are currently limited public transport or pedestrian options to travel across the suburb or to the town centre. Parking is highly valued amongst the community and the impact of construction works is a key community concern.

Community assets

The locality has a mix of social and community assets focused around health, education and research. Notable social infrastructure in proximity to the construction site includes the Westmead Health Precinct to the north, Parramatta Park to the east and Westmead Public School to the south-west. Figure 17-1 identifies the tangible community assets within the locality.

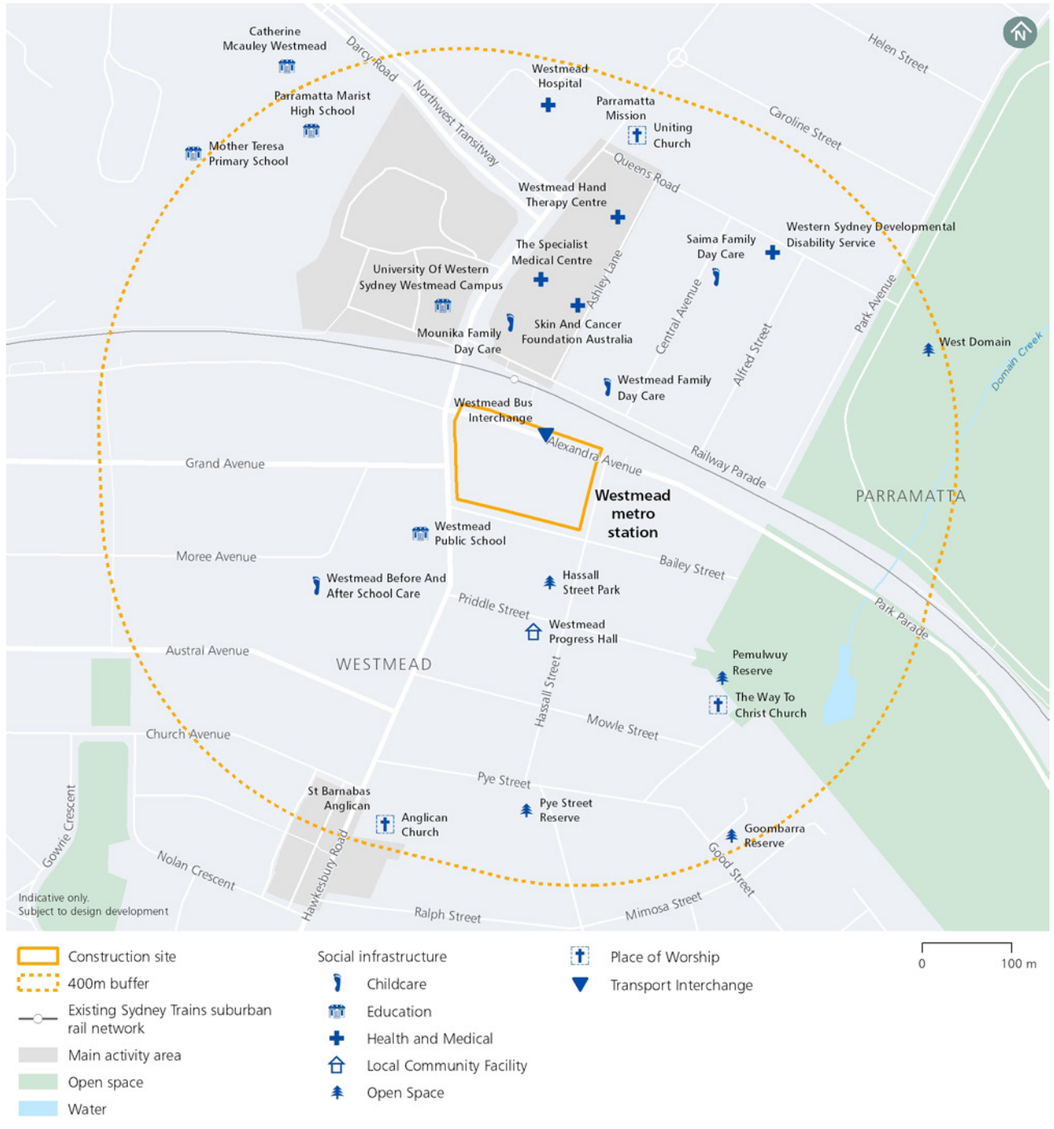

Figure 17-1: Westmead locality – Community assets (social infrastructure)

Community values and aspirations

The local community strategic plans for Cumberland (Cumberland City Council, 2017) and Parramatta (City of Parramatta, 2013) local government areas identify the key priorities for these communities, which include vibrant, safe and attractive local centres, including improved public transport. Other priorities include improved access to local and regional jobs, and a strong and diverse local economy supported by a network of local businesses.

A key issue relevant to Stage 1, as identified through the Community Strategic Plans, relates to community concern around ongoing growth and disruption associated with development, including infrastructure investment. Both communities recognise the opportunities offered by infrastructure investment and urban renewal, however some members of the community are concerned that growth is having an unacceptable impact on existing lifestyles and their neighbourhoods.

17.7.2 Social impact assessment

In addition to the project-wide potential impacts identified in Table 17-5, the potential impacts specific to Westmead metro station construction site locality are provided in Table 17-7. The social risk rating has been calculated taking into consideration the impacts described below as well as the project-wide impacts.

The potential impacts presented are unmitigated and would be appropriately managed through the implementation of a Community Communication Strategy and the mitigation measures through other relevant chapters of this Environmental Impact Statement. Sydney Metro would also develop a community benefit plan to guide the development of community benefit initiatives (by Principal Contractors).

Table 17-7: Social impact assessment – Westmead metro station construction site

Reference	Description of potential impacts	Social risk without mitigation[1,2]		
		Likelihood	Consequence	Risk rating
Way of life	Temporary changes to local access routes as a result of the construction site would include: • Temporary changed access arrangements to Westmead Station • Temporary relocation of bus stops at Westmead Station to alternative proximate sites • Temporary changed access routes to Westmead Public School for students arriving by train, or from the northern side of the station • As this precinct is an important regional employment hub with a high number of workers and visitors, any temporary changes to access of transport modes could affect large numbers of people on a daily basis, although these locations are located to the north of the existing station which would not be directly impacted • Temporary reduced amenity associated with: • Increased traffic noise due to the re-alignment of Alexandra Avenue and increased traffic along Grand Avenue • Temporary construction noise and vibration impacts would be experienced by residential communities in close proximity to the construction site and students and staff of Westmead Public School, which could affect their daily routines • Potential temporary impacts to students' learning environments. Consultation with Westmead Public School would be undertaken to understand their daily routines and consider feasible and reasonable mitigation measures to minimise potential disruptions which may include adjusting the timing of construction works to less sensitive periods • Permanent and temporary loss of some parking spaces on the streets on the southern side of the station which would be exacerbated by existing parking pressures in Westmead • Potential temporary disruption to the way of life for residents and visitors associated with trenching activities for power supply connection between the construction site and the West Parramatta Zone substation. Temporary impacts could result in an increased sense of frustration and inconvenience for a small number of residents along the power supply route on a temporary basis.	Almost certain	Moderate	High
Community	• Community impacts applicable to the project as a whole are discussed in Table 17-5.	Likely	Minor	Medium

Reference	Description of potential impacts	Social risk without mitigation[1,2]		
		Likelihood	Consequence	Risk rating
Access to and use of infrastructure, services and facilities	• Most visitors to the hospital and associated specialist health infrastructure and services would be minimally affected due to the location of the construction site on the southern side of Westmead Station. This is particularly important given that many visitors travel to Westmead to access regional health infrastructure and services and they may be vulnerable to any changes in public transport accessibility • Temporary minor changes to the accessibility of other social infrastructure in the locality due to adjustments to transport infrastructure in the immediate vicinity of the construction site.	Possible	Minor	Medium
Culture	• Potential temporary impacts on local social ties and community relationships to place due to loss of residential properties and several local businesses in this area (e.g. local mechanic, general practitioners and grocery shop). Westmead is currently undergoing transformation associated with the Parramatta Light Rail (Stage 1) construction activities and redevelopment of the hospital precinct, and therefore is in a state of transition.	Possible	Minor	Medium
Health and wellbeing	• Health and wellbeing impacts applicable to the project as a whole are discussed in Table 17-7. No additional health and wellbeing impacts have been identified for Westmead metro station.	Possible	Moderate	Medium
Surroundings	• Temporary construction impacts may be felt more acutely by visitors to Westmead accessing the health precinct as some visitors may be experiencing illness or disability, and/or stress and concerns, although these facilities are located to the north of the existing station, which would not be directly impacted • Temporary changes to surroundings and streetscape associated with trenching activities to establish a power connection between the construction site and West Parramatta Zone Substation. These impacts are likely to result in temporary impacts to amenity, limited to the proposed power supply route and would only occur for around one week in any one location at a time.	Likely	Moderate	High
Personal and property rights	• Personal and property rights impacts applicable to the project as a whole are discussed in Table 17-5. No additional personal and property rights impacts have been identified for Westmead metro station.	Almost certain	Moderate	High
Fears and aspirations	• Potential positive impacts on aspirations associated with perceived investment in Westmead as a major centre and potential for transformation of the area • Potential concern about urban renewal and loss of housing stock that is considered affordable in comparison to Greater Sydney.	Possible	Minor	Medium

Note 1: "without mitigation" means without specific social mitigation measures that are above and beyond standard impact mitigation that will be in place

Note 2: The social risk rating has taken into consideration the impacts described above as well as the project-wide impacts.

17.8 Parramatta metro station

17.8.1 Existing environment

Social context and community profile

Parramatta locality is defined by the following intangible community assets which relate to human and social capital, community values and connection to place (based on ABS Census data (2016) and local community strategic plans):

- Pace of change and population growth. The Parramatta CBD area is currently undergoing significant urban transformation with numerous major infrastructure projects. Associated with these developments will be a significant increase in the number of jobs and residents living and working in Parramatta over the next five to 10 years
- A changing local community. There would be a change in the types of jobs and local businesses within the area as the Parramatta CBD transforms over time. Local cultural institutions will be increasingly important to retaining community linkages and local heritage
- High social capital. Parramatta CBD is a vibrant urban area, comprising many diverse community and interest groups. Parramatta has a high level of social infrastructure comprised of education, health and cultural assets that attract a wide range of visitors. The community is united and social cohesion fostered through a wide range of regular and varied program of community of events and cultural gatherings
- New city-shaping infrastructure transforming a city. Parramatta is a key focus for public and private investment as it transforms into Sydney's Central City
- Community aspirations for balanced growth. The community supports the ongoing growth and development in Parramatta but would like to ensure adequate provision of infrastructure and preservation of community spaces.

Community assets

The Parramatta locality comprises the highest concentration of social infrastructure along the Stage 1 corridor. There is a range of regional and district level social infrastructure including government services, university campuses and other educational institutions. There are also a number of historic sites, cultural heritage sites and monuments distributed within proximity around the Parramatta construction site. Figure 17-2 identifies the tangible community assets within the locality.

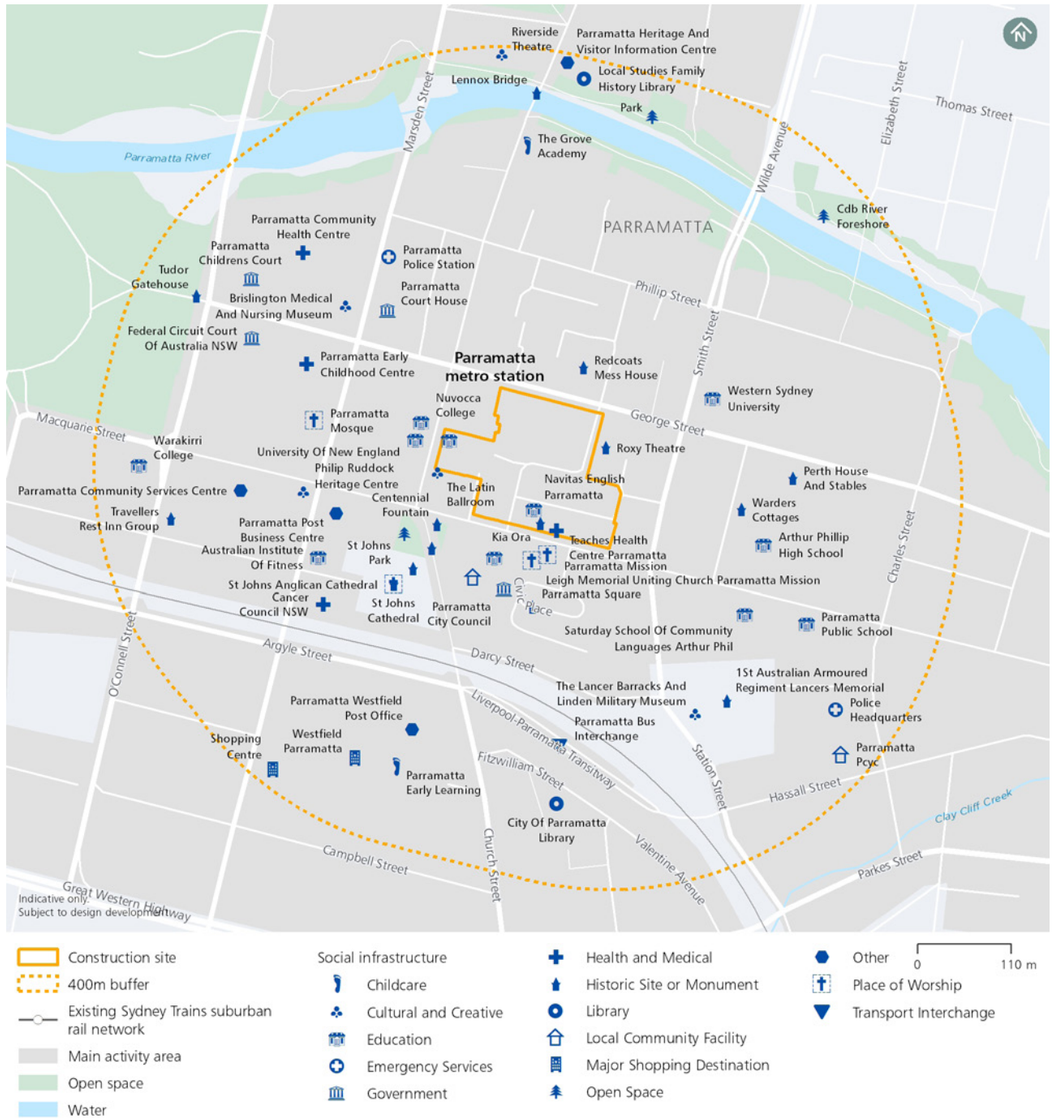

Figure 17-2: Parramatta locality – Community assets (tangible)

Community values and aspirations

Key issues of relevance identified through a review of the Parramatta 2038 Community Strategic Plan (City of Parramatta, 2013) and Socially Sustainable Parramatta Framework (City of Parramatta, 2017c), relates to concerns over the pace and scale of growth and development across Parramatta Local Government Area and the community aspiration that increased development leads to improved liveability. Community consultation activities carried out by the City of Parramatta Council throughout 2017 and 2018 highlighted that 'balanced growth' is a priority for Parramatta residents. While many residents are enthusiastic and supportive of growth and development in Parramatta, some residents are concerned about overdevelopment, and the increased population not being well supported by increased infrastructure provision. The key priorities for the Parramatta local government area community are a vibrant, safe and attractive Parramatta CBD, and ensuring local centres are supported through improved public transport infrastructure.

While the Parramatta local government area community recognises the benefits offered by infrastructure investment and urban renewal, some members are concerned over the pace and scale of growth and the impact this might have on the existing lifestyles.

17.8.2 Social impact assessment

In addition to the project-wide potential impacts identified in Table 17-5, the potential impacts specific to Parramatta metro station construction site locality are provided in Table 17-8. The social risk rating has been calculated taking into consideration the impacts described below as well as the project-wide impacts.

The potential impacts presented are unmitigated and would be appropriately managed through the implementation of a Community Communication Strategy and the mitigation measures outlined through other relevant chapters of this Environmental Impact Statement. Sydney Metro would also develop a community benefit plan to guide the development of community benefit initiatives (by Principal Contractors).

Table 17-8: Social impact assessment – Parramatta metro station construction site

Reference	Description of potential impacts	Social risk without mitigation[1,2]		
		Likelihood	Consequence	Risk rating
Way of life	• Potential changes to the community's daily activities to access goods and services due to: • Closure of retail premises within Parramall and Greenway Plaza Shopping Centres • The changes in this area would affect workers and visitors as well as residents, noting there is limited existing residential development within the locality • Reduced access to parking in the Parramatta CBD, as the works would result in the closure and demolition of the City Centre Car Park which provides car parking for businesses and visitors to the CBD. The closure was previously identified in the Draft Parramatta CBD Public Car Parking Strategy (City of Parramatta, 2017).	Almost certain	Moderate	High
Community	• Community impacts applicable to the project as a whole are discussed in Table 17-5 • Potential temporary localised changes to sense of place and community character in the area associated with changes to the business and retail character and structure of this part of Parramatta CBD due to increased construction activity • Parramatta CBD is a culturally and linguistically diverse area and there are a number of businesses and facilities that reflect this diverse local character located within the construction site • Potential temporary localised impacts on the social fabric associated with the loss of some community meeting spaces (i.e. local shops and cafes) and loss of affordable premises for businesses, or organisations providing social services or social enterprises.	Likely	Moderate	High
Access to and use of infrastructure, services and facilities	• Some pedestrian access routes through Parramatta CBD would be temporarily altered during construction which could affect the routes of customers from bus and suburban rail interchanges and impact the perceived convenience and amenity of the interchange. Some visitors visit the CBD to access community facilities and services who may be experiencing disadvantage or disability and would be more sensitive to temporary changed access arrangements. Alternative routes however would be available via Smith and Church Streets	Likely	Moderate	High

Reference	Description of potential impacts	Social risk without mitigation[1,2]		
		Likelihood	Consequence	Risk rating
Access to and use of infrastructure, services and facilities cont.	• Loss of premises for Parramatta Artist Studios (68 Macquarie Street), a Council-run artist studio space. There is currently limited access to creative and cultural facilities within Parramatta CBD and this facility is a local cultural hub within Parramatta CBD that provides affordable spaces for emerging artists to create work. The loss of this space would therefore have a degree of impact on the accessibility of creative and cultural facilities in the locality. Sydney Metro West would work with local council to identify alternative locations and opportunities for facilitating local creative and cultural activities. Sydney Metro would also provide support to local businesses and develop a community benefit plan to guide the development of community benefit initiatives which may include opportunities for local artists • Loss of premises for Darcy Street Project (a social enterprise), however the organisation is relocating to Parramatta Mission.	Likely	Moderate	High
Culture	• Potential impacts to Non-Aboriginal heritage items adjacent to the site (e.g. Roxy Theatre, colonial terraces, trees, and heritage facades along Macquarie and Church Streets), with associated impacts to sense of place and community character. There would be no direct impacts to any non-Aboriginal heritage items with built heritage items within the construction site retained, and controls implemented to minimise impacts of vibration intensive activity to built heritage items within and adjacent to the construction site – which would mitigate community concerns about any loss of culture • Potential impacts to Aboriginal heritage in this area. Parramatta is a significant place for Aboriginal people across Australia, including as the location of some of the earliest interactions between Aboriginal people and European settlers, and the displacement of Aboriginal communities. The construction site is partially located on the Parramatta Sand Body, which has significant Aboriginal heritage potential, which may be an issue of sensitivity to the community, including members of Aboriginal communities Potential temporary impacts to accessibility and connectivity of the Parramatta CBD during major events, for attendees. Parramatta CBD is a venue for major events in Western Sydney, including Sydney Festival, Parramatta Lanes, Parramasala and other events that contribute to community cohesion and sense of place. Construction works would likely be adjusted to accommodate major events and reduce the potential impacts.	Possible	Moderate	Medium
Health and wellbeing	• Potential temporary impacts to wellbeing associated with construction activity, relating to stress and disruption for residents, visitors and businesses.	Possible	Moderate	Medium
Surroundings	• Temporary changes to streetscape and establishment of construction site along a major retail spine and within a CBD context. This could be particularly experienced by workers and visitors accessing premises in close proximity to the construction site • Short-term changes to surroundings and streetscape associated with trenching activities to establish a power connection between the construction site and West Parramatta Zone Substation. Temporary impacts could result in an increased sense of frustration and inconvenience for a businesses, workers, visitors and residents along the power supply route on a temporary basis.	Likely	Moderate	High
Personal and property rights	• Personal and property rights impacts applicable to the project as a whole are discussed in Table 17-5. No additional personal and property rights impacts have been identified for Parramatta metro station.	Almost certain	Moderate	High
Fears and aspirations	• Potential impacts associated with concern about disruption to, and the ongoing transformation of, Parramatta CBD, which is currently undergoing significant changes. The scale and pace of change can impact people's sense of place and belonging • Potential positive impacts associated with excitement and anticipation of improved public transport to and from the Parramatta CBD, and ongoing investment in transforming the area into a major business and civic hub.	Possible	Minor	Medium

Note 1: "without mitigation" means without specific social mitigation measures that are above and beyond standard impact mitigation that will be in place

Note 2: The social risk rating has taken into consideration the impacts described above as well as the project-wide impacts.

17.9 Clyde stabling and maintenance facility

17.9.1 Existing environment

Social context and community profile

Clyde locality is defined by the following intangible community assets relating to human and social capital, community values and connection to place (based on ABS Census data (2016) and local community strategic plans):

- A sporting and recreation destination. The Rosehill Gardens racecourse and the Sydney Speedway (located on NSW Government owned land) are key sporting and recreation landmarks and are located within the catchment. The racecourse is one of Sydney's premier sporting and events destinations, and is located directly adjacent to the construction site. The racecourse attracts tens of thousands of visitors annually and contributes to the identity of the area
- Connections to place associated with recreation infrastructure. Both the racecourse and Sydney Speedway provide a strong community connection to place. As there is a limited range of local social infrastructure within the catchment, most residents are likely to travel to nearby Parramatta to access daily services and amenities
- Social capital connected with Parramatta CBD. As the Clyde locality is set within an industrial context, the residential community to the west of the construction site (within Rosehill) are more likely to feel community cohesion and a sense of belonging as part of the broader Parramatta CBD catchment rather than the Clyde industrial precinct.

Community assets

The catchment largely consists of a large industrial area with limited provision of social infrastructure including only two childcare centres, a preschool and one public school. Two key landmarks in the catchment include Rosehill Garden racecourse and Sydney Speedway (located on government owned land). Figure 17-3 identifies the tangible community assets within the locality.

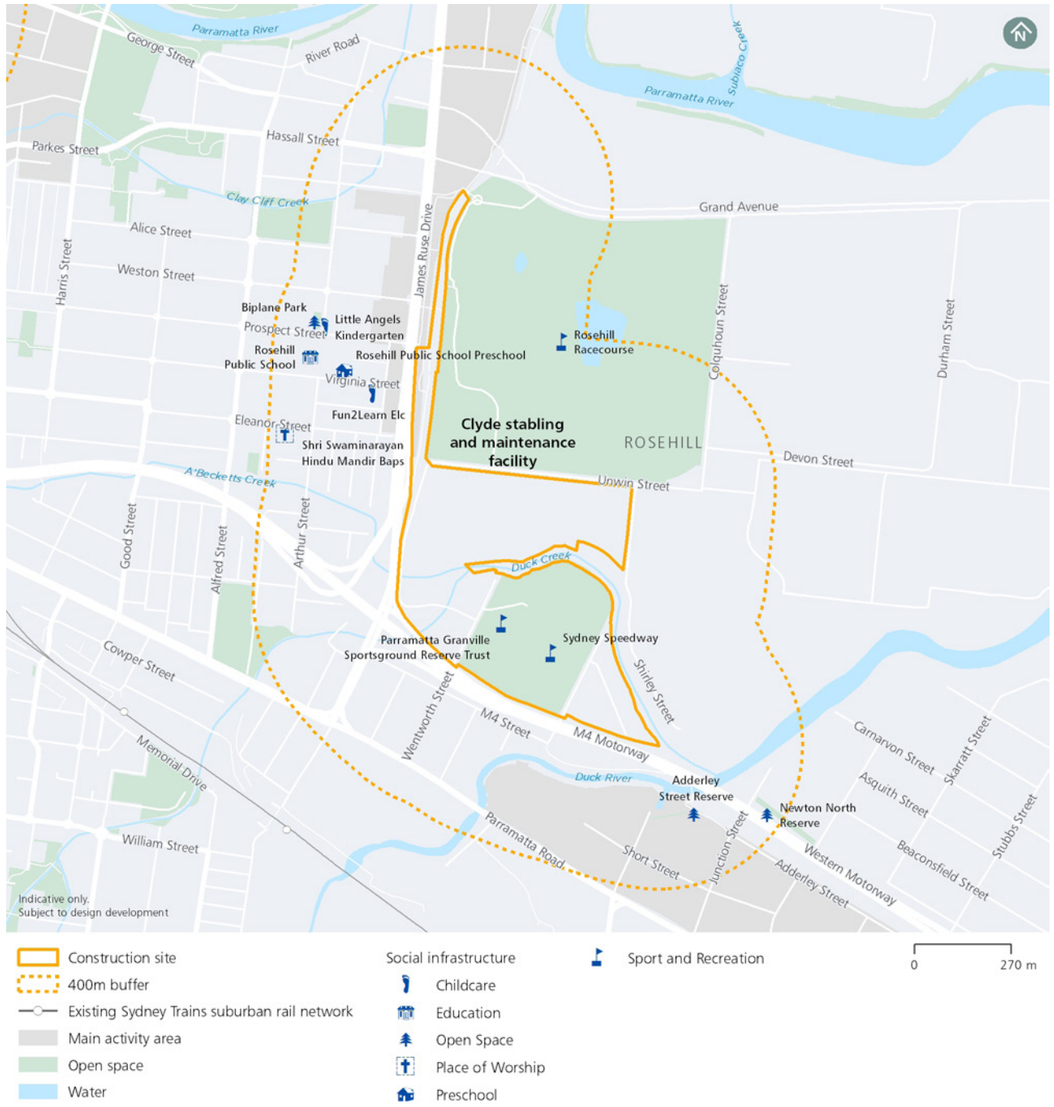

Figure 17-3: Clyde locality – Community assets (social infrastructure)

Community values and aspirations

The City of Parramatta Council's Community Strategic Plan (City of Parramatta, 2013) and Socially Sustainable Parramatta Framework (City of Parramatta, 2017c) identifies key priorities for the communities within the Parramatta local government area which include creating vibrant, safe and attractive local centres and improved public transport. Other priorities include improved access to local and regional jobs, and a strong and diverse local economy supported by a network of local businesses.

Key issues of relevance identified through a review of the City of Parramatta Council's Community Strategic Plan (City of Parramatta, 2013) and Socially Sustainable Parramatta Framework (City of Parramatta, 2017c) relate to community concern around ongoing growth and disruption associated with the development, including infrastructure investment. Communities recognise the opportunities offered by infrastructure investment and urban renewal however some members of the community are concerned that growth is having an unacceptable impact on existing lifestyles in their neighbourhoods.

17.9.2 Social impact assessment

In addition to the project-wide potential impacts identified in Table 17-5, the potential impacts specific to the Clyde stabling and maintenance facility construction site locality are provided in Table 17-9. The social risk rating has been calculated taking into consideration the impacts described below as well as the project-wide impacts.

The NSW Government has committed to relocating speedway racing to ensure speedway racing in Sydney continues.

The potential impacts presented are unmitigated and would be appropriately managed through the implementation of a Community Communication Strategy and the mitigation measures through other relevant chapters of this Environmental Impact Statement. Sydney Metro would also develop a community benefit plan to guide the development of community benefit initiatives (by Principal Contractors).

Table 17-9: Social impact assessment – Clyde stabling and maintenance facility construction site

Reference	Description of potential impacts	Social risk without mitigation[1,2]		
		Likelihood	Consequence	Risk rating
Way of life	• Potential changes to how the business community in the locality go about their daily activities due to the proposed realignment of Unwin and Kay Streets. Additionally, the vehicular travel route of some attendees of Rosehill Gardens racecourse (depending on their origin location) may also change due to the proposed road realignment.	Possible	Minor	Medium
Community	• Potential changes to community character and sense of place due to loss of established industrial businesses and major local and regional destinations • The natural environment at this locality is centred around Duck Creek and A' Becketts Creek which are highly degraded with no public access and therefore impacts to 'sense of place' are likely to be very limited.	Unlikely	Minor	Low
Access to and use of infrastructure, services and facilities	• Relocation of Sydney Speedway to a new site in Western Sydney • Proposed road realignment of Unwin and Kay Streets could potentially affect the travel routes of attendees to events or functions at Rosehill Gardens racecourse, however alternate travel routes would be available therefore impacts are anticipated to be limited.	Possible	Minor	Medium
Culture	• Potential changes to the cultural way of life for regular attendees that support and attend events at Sydney Speedway • Potential changes to community connection to place and shared histories associated with the relocation of Sydney Speedway to a new site.	Likely	Minor	Medium
Health and wellbeing	• The area is predominantly occupied by industrial uses therefore the potential temporary impacts of construction on health and wellbeing are likely to be minimal.	Unlikely	Minor	Low

Reference	Description of potential impacts	Social risk without mitigation[1,2]		
		Likelihood	Consequence	Risk rating
Surroundings	• This area is dominated by industrial uses and therefore the potential temporary impact of visual and noise amenity impacts of construction activities are likely to be minimal • Perceived temporary safety impacts associated with changed sightlines, changed vehicle routes and establishment of hoardings would be minimal due to the existing industrial nature of the area.	Unlikely	Minor	Low
Personal and property rights	• Personal and property rights impacts applicable to the project as a whole are discussed in Table 17-5. No additional personal and property rights impacts have been identified for the Clyde stabling and maintenance facility.	Almost certain	Moderate	High
Fears and aspirations	• Potential impacts associated with uncertainty about changes occurring in the Clyde and Rosehill industrial area, in association with major changes to the broader Parramatta community • Potential concerns regarding the management of existing contamination, as the site is in an industrial area, where there is known to be contamination due to the operation of heavy industrial uses in this area over a long period.	Possible	Minor	Medium

Note 1: "without mitigation" means without specific social mitigation measures that are above and beyond standard impact mitigation that will be in place

Note2: The social risk rating has taken into consideration the impacts described above as well as the project-wide impacts.

17.10 Silverwater services facility

17.10.1 Existing environment

Social context and community profile

The Silverwater locality is defined by the following intangible community assets relating to human and social capital, community values and connection to place (based on ABS Census data (2016) and local community strategic plans):

- An active commercial and enterprise precinct. Silverwater is characterised by its high concentration of small to medium enterprises and commercial centres
- A small residential population. The closest residential population is located about 200 metres to the south of the construction site. For daily local needs, residents would likely need to visit the Lidcombe Centre or the retail precinct around Auburn
- Strong social capital in nearby Newington. A strong social capital among communities of workers exists in Silverwater. In the nearby residential suburb of Newington, a strong social capital exists with a high level of participation demonstrated by the relatively high response rate to consultation on Sydney Metro West
- Advocacy for a metro station at Newington. There was a high volume of feedback from residents of Newington during early community engagement activities for a new metro station within their suburb. The residential precinct is relatively isolated within its broader industrial context and the community is reliant on the existing bus network for public transport needs.

Community assets

The catchment largely consists of a large industrial, retail and commercial area with limited provision of social infrastructure including only one childcare centre, a local performing arts space and two places of worship. Figure 17-4 identifies the tangible community assets within the locality.

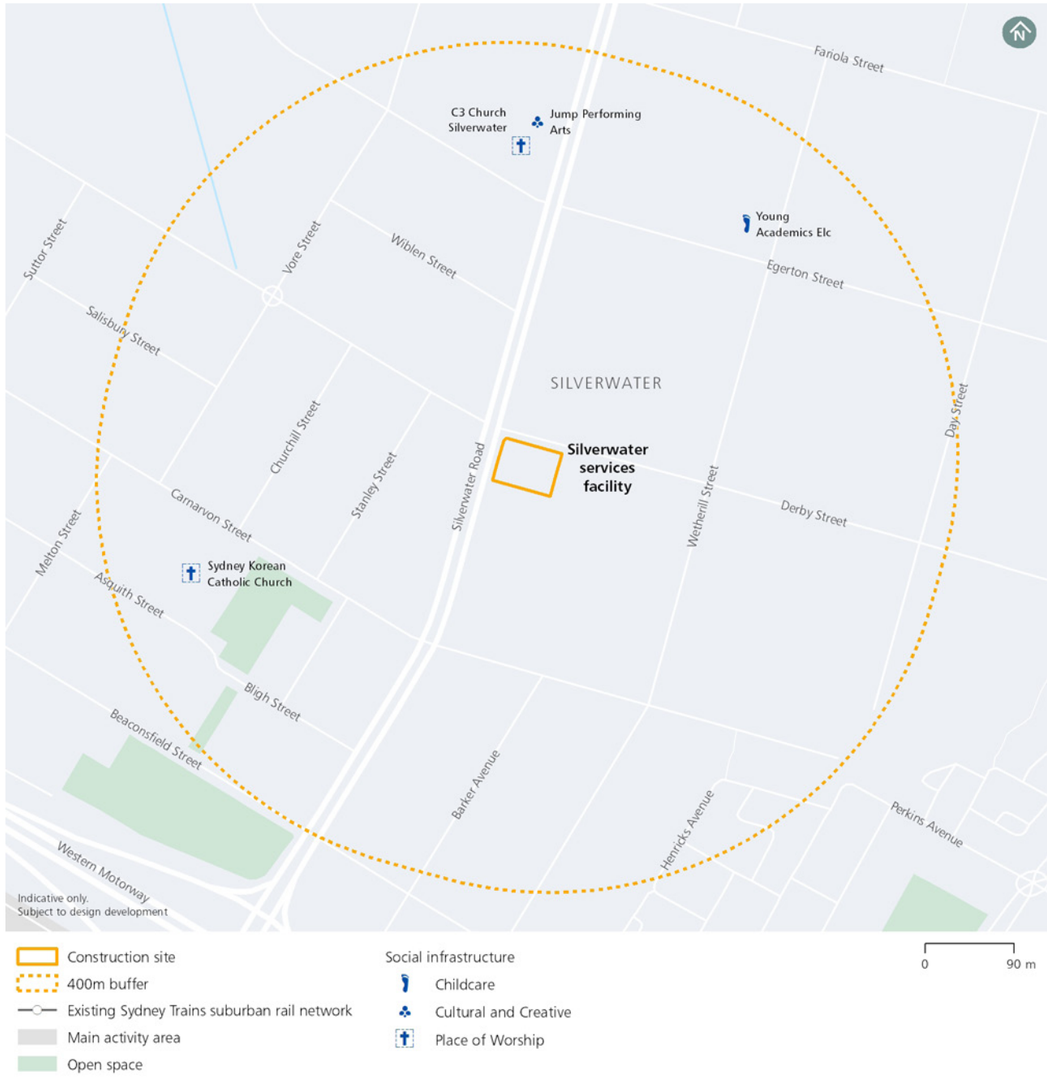

Figure 17-4: Silverwater locality – Community assets (social infrastructure)

Community values and aspirations

The City of Parramatta Council's Community Strategic Plan (City of Parramatta, 2013) and Socially Sustainable Parramatta Framework (City of Parramatta, 2017c) identifies key priorities for the communities within the Parramatta local government area which include creating vibrant, safe and attractive local centres and improved public transport. Other priorities include improved access to local and regional jobs, and a strong and diverse local economy supported by a network of local businesses.

Key issues of relevance identified through a review of the City of Parramatta Council's Community Strategic Plan (City of Parramatta, 2013) and Socially Sustainable Parramatta Framework (City of Parramatta, 2017c) relate to community concern around ongoing growth and disruption associated with the development, including infrastructure investment. Communities recognise the opportunities offered by infrastructure investment and urban renewal however some members of the community are concerned that growth is having an unacceptable impact on existing lifestyles in their neighbourhoods.

17.10.2 Social impact assessment

In addition to the project-wide potential impacts identified in Table 17-5, the potential impacts specific to the Silverwater services facility construction site locality are provided in Table 17-10. The social risk rating has been calculated taking into consideration the impacts described below, as well as the project-wide impacts.

The potential impacts presented are unmitigated and would be appropriately managed through the implementation of a Community Communication Strategy and the mitigation measures through other relevant chapters of this Environmental Impact Statement. Sydney Metro would also develop a community benefit plan to guide the development of community benefit initiatives (by Principal Contractors).

Table 17-10: Social impact assessment – Silverwater services facility construction site

Reference	Description of potential impacts	Social risk without mitigation[1,2]		
		Likelihood	Consequence	Risk rating
Way of life	• Potential temporary disruption of daily activities primarily for local workers travelling to the commercial precinct due to increased construction traffic. Construction traffic is not anticipated to have a major impact on the network and the area can be accessed from multiple directions. As such, these potential impacts are likely to be minimal.	Possible	Minor	Medium
Access to and use of infrastructure, services and facilities	• The social infrastructure within walking distance of the site, including Sydney Korean Catholic Church, Hume Park, C3 Church Silverwater, Young Academics ELC and Jump Performing Arts, are approximately 300 metres from the construction site and it is not anticipated that the construction site would affect travel to these sites. Any temporary increase in traffic volumes related to haulage routes associated with this site may occasionally result in increased travel times and reduced parking. However, these impacts are likely to be very minor.	Unlikely	Insignificant	Low
Surroundings	• Potential temporary amenity impacts on homes and businesses in the area associated and noise and vibration related to truck movements, however this area is currently an industrial and commercial area and the closest residential community to the site is about 250 metres away. As such, potential impacts would be negligible.	Possible	Insignificant	Low

Note 1: "without mitigation" means without specific social mitigation measures that are above and beyond standard impact mitigation that will be in place

Note 2: The social risk rating has taken into consideration the impacts described above as well as the project-wide impacts.

17.11 Sydney Olympic Park metro station

17.11.1 Existing environment

Social context and community profile

The Sydney Olympic Park locality is defined by the following intangible community assets relating to human and social capital, community values and connection to place (based on ABS Census data (2016) and local community strategic plans):

- A high-density residential community. The local housing profile suggests that all dwellings within the immediate vicinity of the site are high density apartments. The rental rate in the locality is quite high (65 per cent)
- A state significant destination for major sport and entertainment events. Sydney Olympic Park is home to more than 10 sporting, events and convention facilities that attract about 10 million visitors each year
- Social capital impacted by visitor population. Sydney Olympic Park's role as a major events destination means social capital is largely transient, with a high volume of visitors and relatively small community of residents living entirely in high density apartments
- A culturally diverse population. The residents within the locality comprise the highest proportion of Aboriginal residents than any other locality along the corridor
- A vision for growth. The Sydney Olympic Park Master Plan is a long term strategic plan with a vision to transform the locality by creating a vibrant town centre that will accommodate increased commercial, residential, sports and entertainment ventures.

Community assets

Sydney Olympic Park is a regionally significant destination centred around sports, recreation, events and entertainment. The majority of social infrastructure within proximity to the Sydney Olympic Park metro station construction site comprises large-scale sporting facilities or associated infrastructure. Figure 17-5 identifies the tangible community assets within the locality.

Figure 17-5: Sydney Olympic Park precinct (primary study area) – Community assets (social infrastructure)

Community values and aspirations

The Sydney Olympic Park community is in an establishing phase with ABS Census data (2011) showing there were zero occupied private dwellings and a residential population of 65 persons, with the residential community increasing since 2011 to its current size of 4,460 (ABS Census data (2016). One of the key priorities for the communities within the Parramatta local government area (as identified by City of Parramatta Council (2017c, 2018b) are vibrant, safe and attractive local centres including improved public transport. Other priorities include improved access to local and regional jobs, and a strong and diverse local economy supported by a network of local businesses.

17.11.2 Social impact assessment

In addition to the project-wide potential impacts identified in Table 17-5, the potential impacts specific to the Sydney Olympic Park metro station construction site locality are provided in Table 17-11. The social risk rating has been calculated taking into consideration the impacts described below as well as the project-wide impacts.

The potential impacts presented are unmitigated and would be appropriately managed through the implementation of a Community Communication Strategy and the mitigation measures through other relevant chapters of this Environmental Impact Statement. Sydney Metro would also develop a community benefit plan to guide the development of community benefit initiatives (by Principal Contractors).

Table 17-11: Social impact assessment – Sydney Olympic Park metro station construction site

Reference	Description of potential impacts	Social risk without mitigation[1,2]		
		Likelihood	Consequence	Risk rating
Way of life	• Potential temporary way of life impacts could occur in relation to the movement of transport facilities such as the taxi rank on Herb Elliott Avenue, which would need to be temporarily relocated, although measures would be in place to retain pedestrian amenity and access to the temporary rank.	Possible	Minor	Medium
Community	• Potential temporary changes to community character and sense of place would be limited due to the generally non-residential nature of the locality, although this is already independently changing • Some localised impacts associated with the loss of premises for a social enterprise organisation that provides services and employment opportunities for people with mental health issues.	Possible	Minor	Medium
Access to and use of infrastructure, services and facilities	• Positive impacts to pedestrian access routes through the broader Sydney Olympic Park precinct through the pedestrianisation of Showground Road • Some loss of conference centre space for organisations associated with the loss of the premises of the Figtree Conference Centre. The loss of these premises could also affect some employees, as this is a social enterprise which provides training and employment opportunities for mental health patients from Flourish Australia Potential minor temporary disruption to access to education services in the locality due to loss of premises for SP Jain School of Global Management.	Possible	Minor	Medium
Culture	• Temporary restriction of access to a portion of the Abattoir Heritage Precinct, although Sydney Metro are investigating feasible design options which would potentially avoid temporary impacts to the abattoir.	Possible	Minor	Medium
Health and wellbeing	• Potential temporary impacts to health and wellbeing associated with construction noise and vibration, particularly given this would be a 24-hour construction site with sensitive receivers in the immediate locality, including the hotels to the north-west. Apart from overnight hotel guests, temporary impacts are likely to be particularly experienced by workers in the locality and visitors to surrounding recreation, education and other facilities. While this site is a 24-hour construction site, noise impacts would be significantly mitigated by an acoustic shed (or other acoustic measures) • One affected premises (Figtree Conference Centre) is a social enterprise providing employment opportunities for people with mental health. Some of the employees of this organisation may be less resilient to change and be at greater risk of mental health and wellbeing impacts associated with any upcoming relocation changes associated with the future lease cessation of their workplace. Sydney Metro West would work closely with local businesses to provide ongoing support. In addition a community benefit plan would be developed to identify opportunities to create positive social outcomes and respond to the needs of the local community.	Possible	Minor	Medium
Surroundings	• Temporary reduced amenity for noise and vibration sensitive receivers, including hotels located to the north-west of the construction site, and the NSW Institute of Sport to the south-east of the site. While this site is a 24-hour construction site, noise impacts would be significantly mitigated by an acoustic shed.	Possible	Minor	Medium
Personal and property rights	• Personal and property rights impacts applicable to the project as a whole are discussed in Table 17-5. No additional personal and property rights impacts have been identified for Sydney Olympic Park metro station.	Almost certain	Moderate	High
Fears and aspirations	• Positive impacts associated with perceived investment in and upgrading of the locality associated with infrastructure investment – an issue particularly relevant to local business owners.	Possible	Minor	Medium

Note 1: "without mitigation" means without specific social mitigation measures that are above and beyond standard impact mitigation that will be in place

Note 2: The social risk rating has taken into consideration the impacts described above as well as the project-wide impacts.

17.12 North Strathfield metro station

17.12.1 Existing environment

Social context and community profile

The North Strathfield locality is defined by the following intangible community assets relating to human and social capital, community values and connection to place (based on ABS Census data (2016) and local community strategic plans):

- Strong social capital and connection to place. The numerous community and resident groups active in the area are evidence of the high level of social capital and connection to place in North Strathfield. Furthering the sense of place, there are a number of school and childcare services within the immediate precinct which form central nodes within the community
- An active and engaged community. There are several highly active and engaged residents' groups including the North Strathfield Residents Group and the Save North Strathfield Residents Action Group. Both groups have differing views on urbanisation, development and growth
- Impact on community related to the delivery of the WestConnex project. The community has expressed concern over the impact of construction and vibration on their homes, having experienced issues during the construction of WestConnex M4 East (now complete). Other frustrations and concerns relate to construction fatigue associated with WestConnex M4 East
- Transformative urban renewal – the Bakehouse Quarter. The Bakehouse, a key local destination offering a collection of food and beverage, entertainment and recreational opportunities, has recently been acquired by a private developer with plans for additional residential development in the future.

Community assets

The locality comprises social infrastructure oriented towards local and community-based assets that are reflective of the residential character of the area including several childcare centres, education, and health and medical facilities and services. Figure 17-6 identifies the tangible community assets within the locality.

Figure 17-6: North Strathfield locality – Community assets (social infrastructure)

Community values and aspirations

Key community values identified in the YOUR future 2030 Community Strategic Plan (City of Canada Bay, 2018) include the community's aspiration to respect and promote the local sense of place within local village neighbourhoods, and to strengthen character and heritage.

The community strongly values the vibrant local centres, green spaces, and opportunities to be near the water. Maintaining the feeling of safety in the area is important to the community.

Key community priorities include improving public and active transport, while reducing traffic congestion and parking issues. The community does not feel the provision of infrastructure and services has kept pace with the population growth across the local government area, and that enhanced infrastructure is required.

17.12.2 Social impact assessment

In addition to the project-wide potential impacts identified in Table 17-5, the potential impacts specific to the North Strathfield metro station construction site locality are provided in Table 17-12. The social risk rating has been calculated taking into consideration the impacts described below as well as the project-wide impacts.

The potential impacts presented are unmitigated and would be appropriately managed through the implementation of a Community Communication Strategy and the mitigation measures outlined through other relevant chapters of this Environmental Impact Statement. Sydney Metro would also develop a community benefit plan to guide the development of community benefit initiatives (by Principal Contractors).

Table 17-12: Social impact assessment – North Strathfield metro station construction site

Reference	Description of potential impacts	Social risk without mitigation[1,2]		
		Likelihood	Consequence	Risk rating
Way of life	• Potential temporary changes to daily routines and people's ability to conveniently access key local services and facilities, including changes to the western side of Queen Street, opposite the local shops and medical centre. Potential temporary changes to daily routines for pedestrian access to the eastern entry to the existing North Strathfield Station from Queen Street and for attendees of schools and preschools (and their families), adjacent to the western side of the existing North Strathfield Station • Potential temporary impacts to students' learning environments. Consultation with schools in proximity to the construction sites would be undertaken to understand their daily routines and then consider more suitable times to schedule noisy activities to minimise potential disruptions to student's learning environments • Temporary changes to local bus stops for schools. Consultation would take place with schools, if affected • Temporary loss of about 20 on-street car parking spaces along the western side of Queen Street. Spare capacity on nearby streets would be used to accommodate as many of these parking spaces as possible • Potential temporary changes to daily routines for local residents and workers associated with changes to local traffic conditions.	Likely	Moderate	High
Community	• Potential temporary changes to local community character and sense of place due to changed access to the eastern entry of the existing North Strathfield Station, the local shops on Queen Street, and changes to the streetscape along Queen Street due to hoardings.	Possible	Minor	Medium
Access to and use of infrastructure, services and facilities	• Potential temporary changes to the convenience and accessibility to some extent of local services along Queen Street associated with the loss of customer car parking on Queen Street, as parking availability on nearby east-west streets (Wellbank, Waratah, Beronga) is often congested.	Possible	Minor	Medium
Culture	• Potential temporary changes to local communities' shared connections to place associated with disruptions to local character, the eastern entrance to North Strathfield Station and daily activities affecting the local retail and services precinct on Queen Street • A portion of the landscaped park/ornamental garden and pathways fronting Queen Street at the eastern entry to the station precinct have local heritage significance and would be removed for site establishment and the northern construction site.	Possible	Minor	Medium
Health and wellbeing	• Potential temporary health and wellbeing impacts applicable to the project as a whole are discussed in Table 17-5. No additional health and wellbeing impacts have been identified for the North Strathfield metro station.	Possible	Moderate	Medium
Surroundings	• Temporary changes to the streetscape (e.g. hoardings) and loss of mature trees and vegetation along the western side of Queen Street, which currently contribute to the suburban local streetscape character • Loss of some gardens at the station entrance on Queen Street.	Likely	Moderate	High
Personal and property rights	• There would be no acquisition of private property at the North Strathfield metro station construction site.	Possible	Minor	Medium
Fears and aspirations	• No additional impacts have been identified for the North Strathfield metro station.	Possible	Moderate	Medium

Note 1: "without mitigation" means without specific social mitigation measures that are above and beyond standard impact mitigation that will be in place

Note 2: The social risk rating has taken into consideration the impacts described above as well as the project-wide impacts.

17.13 Burwood North Station

17.13.1 Existing environment

Social context and community profile

The Burwood North locality is defined by the following intangible community assets relating to human and social capital, community values and connection to place (based on ABS Census data (2016) and local community strategic plans):

- A well-established residential community. A large proportion of residents have lived and worked in the area for decades. As such, the locality has an older and more established demographic who have a strong connection to the area
- Strong sports-related social capital. The locality has a proud sporting history, especially with Concord Oval and Cintra Park. The large areas of open space for recreation regularly attract a range of communities from across the region for both organised and informal sporting and recreational activities. A range of sporting organisations and clubs provide a high degree of social capital within the locality
- Incremental gentrification of the neighbourhood. The recent influx of new cafes and restaurants reflects a changing demographic within the area. These new attractions are establishing Burwood North as a destination hotspot amongst the wider Inner-West community. The gentrification of the area is being met by a range of mixed sentiments from residents
- Valued open space and recreation infrastructure. The number of sports and recreation facilities within the locality form a significant cluster of facilities. Residents especially have deep historical connections with Concord Oval, which is the training ground for several major rugby, rugby league and soccer clubs.

Community assets

The area is characterised by its large expanses of sport and recreation areas including Concord Oval. There is a variety of social infrastructure within the locality including a number of schools and places of worship. Figure 17-7 identifies the tangible community assets within the locality.

Figure 17-7: Burwood North locality – Community assets (social infrastructure)

Community values and aspirations

Key community values identified in YOUR future 2030 Community Strategic Plan (City of Canada Bay, 2018) include the community's aspiration to respect and promote the local sense of place within local village neighbourhoods, and to strengthen character and heritage. The community strongly values the vibrant local centres, green spaces, and opportunities to be near the water. Maintaining the feeling of safety in the area is important to the community.

Key community priorities also include improving public and active transport, while reducing traffic congestion and parking issues. The community does not feel the provision of infrastructure and services has kept pace with the population growth across the local government area, and that enhanced infrastructure is required.

Burwood 2030 Community Strategic Plan (Burwood Council, 2010) identifies many similar themes including the importance of convenient and accessible public transport and its key role in the liveability and sustainability of the area.

17.13.2 Social impact assessment

In addition to the project-wide potential impacts identified in Table 17-5, the potential impacts specific to the Burwood North station construction site locality are provided in Table 17-13. The social risk rating has been calculated taking into consideration the impacts described below as well as the project-wide impacts.

The potential impacts presented are unmitigated and would be appropriately managed through the implementation of a Community Communication Strategy and the mitigation measures outlined through other relevant chapters of this Environmental Impact Statement. Sydney Metro would also develop a community benefit plan to guide the development of community benefit initiatives (by Principal Contractors).

Table 17-13: Social impact assessment – Burwood North Station construction site

Reference	Description of potential impacts	Social risk without mitigation[1,2]		
		Likelihood	Consequence	Risk rating
Way of life	• There would be no direct impacts to nearby recreational facilities or open space. However, there may be potential temporary changes to community members' routines relating to accessing open spaces at Concord Oval and Cintra Park and visiting the Pine Inn, a local gathering place that would be removed for the northern construction site • Temporary reduced amenity due to construction noise and vibration and visual impacts, particularly experienced by nearby residential communities and users of local social infrastructure. This site is located on a high-volume traffic corridor (Parramatta Road), and nearby receivers experience existing noise amenity impacts in the locality • Some temporary disruption to local pedestrian and vehicle routes however Parramatta Road is dominated by large format retail and high traffic volumes, and does not have a high degree of pedestrian amenity. Pedestrian routes in the construction site locality would generally be maintained through the location of construction sites largely within existing blocks. Also, construction traffic planning has been undertaken to reduce impacts on the local road network as much as practicable	Likely	Moderate	High
Way of life cont.	• Temporary removal of around six on-street parking spaces on Loftus Street for the duration of Stage 1 construction. Also temporary changes to access to bus services along Parramatta Road due to the relocation of local bus stops likely to be used by local residents, residents of the nearby nursing home, nearby schools and users of recreation facilities.	Likely	Moderate	High

Reference	Description of potential impacts	Social risk without mitigation[1,2]		
		Likelihood	Consequence	Risk rating
Community	• Potential temporary changes to local community character arising from changes to the streetscape character around Burwood Road, Burton Street and Loftus Street • Potential temporary changes to the access to and the number and type of local businesses, including the large format retail on Parramatta Road, which may affect local residents' sense of community character and convenience • Closure of the premises of the Pine Inn premises could affect those community members that may visit this local place to gather and enjoy social connections.	Possible	Moderate	Medium
Access to and use of infrastructure, services and facilities	• There would be no direct impacts to nearby recreational facilities or open space. However there may be potential for temporary reduced amenity of local recreation facilities and open parks and spaces used for community gathering spaces (e.g. Cintra Park, Concord Oval), due to the construction site, and associated construction noise and vibration • Potential temporary changes to the access, useability and amenity of some nearby community facilities, including Concord Community Centre, MLC Primary School, St Marys Primary School and other facilities.	Possible	Moderate	Medium
Culture	• There would be no direct impacts to nearby recreational facilities or open space. However, there may be potential temporary changes to community connections to place, due to the establishment of the construction site and changed pedestrian and vehicle access to local community facilities, open space and recreation. Community consultation indicates there is a strong connection to facilities in this area, particularly Concord Oval.	Possible	Minor	Medium
Health and wellbeing	• Potential temporary impacts to wellbeing associated with construction activity, relating to stress and disruption for residents, visitors and businesses.	Possible	Moderate	Medium
Surroundings	• Temporary reduced visual amenity due to changes to the local streetscape along the eastern side of Burwood Road and a section of the southern side of Burton Street, with the establishment of the construction site, hoarding and acoustic shed (or other acoustic measures).	Likely	Minor	Medium
Personal and property rights	• Personal and property rights impacts applicable to the project as a whole are discussed in Table 17-5. No additional personal and property rights impacts have been identified for the Burwood North station.	Almost certain	Moderate	High
Fears and aspirations	• Fears and aspirations impacts applicable to the project as a whole are discussed in Table 17-5. No additional impacts have been identified for the Burwood North station.	Likely	Minor	Medium

Note 1: "without mitigation" means without specific social mitigation measures that are above and beyond standard impact mitigation that will be in place

Note 2: The social risk rating has taken into consideration the impacts described above as well as the project-wide impacts.

17.14 Five Dock Station

17.14.1 Existing environment

Social context and community profile

The Five Dock locality is defined by the following intangible community assets relating to human and social capital, community values and connection to place (based on ABS Census data (2016) and local community strategic plans):

- Strong social capital. There are large numbers of family-owned local businesses that have been passed down through generations. There is a strong connection to place at Fred Kelly Place where many of the older residents meet daily
- A culturally rich community. The culturally rich community is largely defined by a strong Italian and migrant heritage. The residents highly value the 'small village' atmosphere and rely on the bus network for transport needs
- A proud Italian heritage. There are several festivals and events throughout the year that celebrate the strong Italian heritage of the area including the Ferragosto festival, which takes place along Great North Road
- A strong local character. The Five Dock community has historically been vocal in opposition of higher density housing proposals. A strong sense of local character and place are important values to the community which are reflected throughout the village with murals representing the community
- Connection to Fred Kelly Place – the heart of the community. The Fred Kelly Place is a highly valued and key community asset where local residents congregate regularly to connect, socialise and interact. The Place is centred around the local library and retail institutions and includes a small children's playground.

Community assets

The construction site would be located along the Great North Road within the commercial core of the locality and surrounded by a range of local social infrastructure and community facilities. In close proximity to the construction site are the Five Dock Library, Fred Kelly Place and a number of childcare centres. Figure 17-8 identifies the tangible community assets within the locality.

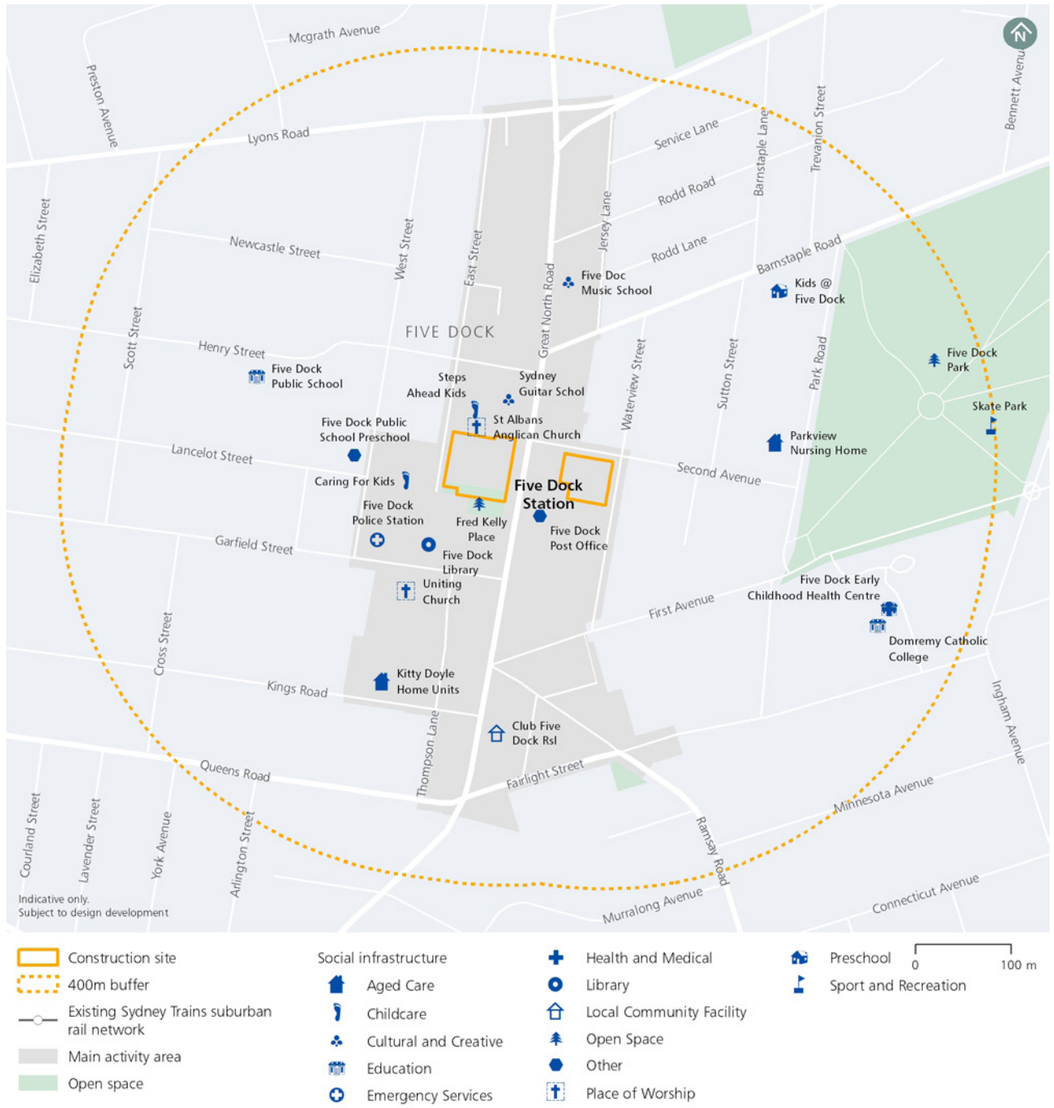

Figure 17-8: Five Dock locality – Community assets (social infrastructure)

Community values and aspirations

Key community values identified in YOUR future 2030 Community Strategic Plan (City of Canada Bay, 2018) include the community's aspiration to respect and promote the local sense of place within local village neighbourhoods, and to strengthen character and heritage. The community strongly values the vibrant local centres, green spaces, and opportunities to be near the water. Maintaining the feeling of safety in the area is important to the community.

Key community priorities include improving public and active transport, while reducing traffic congestion and parking issues. The community does not feel the provision of infrastructure and services has kept pace with the population growth across the local government area, and that enhanced infrastructure is required.

17.14.2 Social impact assessment

In addition to the project-wide potential impacts identified in Table 17-5, the potential impacts specific to the Five Dock station construction site locality are provided in Table 17-14. The social risk rating has been calculated taking into consideration the impacts described below as well as the project-wide impacts.

The potential impacts presented are unmitigated and would be appropriately managed through the implementation of a Community Communication Strategy and the mitigation measures outlined through other relevant chapters of this Environmental Impact Statement. Sydney Metro would also develop a community benefit plan to guide the development of community benefit initiatives (by Principal Contractors).

Table 17-14: Social impact assessment – Five Dock Station construction site

Reference	Description of potential impacts	Social risk without mitigation[1,2]		
		Likelihood	Consequence	Risk rating
Way of life	• Potential temporary changes to the daily routines of community members and meeting daily living needs (e.g. access to Westpac Bank, local pharmacy, local cafes) due to the loss of premises that are leased to these businesses. The western construction site is located next to Fred Kelly Place, which community consultation has identified is a key location for local people to gather, connect socially and share stories • Potential reduction of walkability of areas close to the construction sites due to reduced amenity, concerns about safety, presence of haulage trucks • Potential impacts on accessibility due to temporary loss of car parking spaces (around 12 on-street car parking spaces along Great North Road and around 10 on-street car parking spaces on Waterview Street and Second Avenue). Permanent removal of around 12 restricted off-street parking spaces accessible from Second Avenue. Greater impacts may be experienced by the high proportion of older people living in Five Dock that may drive regularly to the centre to access services and for social connections.	Almost certain	Moderate	High
Community	• Potential temporary impact to communities' sense of place and how it functions resulting from the loss of established businesses, changes to streetscape and urban fabric, and impacts to key community gathering spaces (e.g. Fred Kelly Place and children's playground, local cafes, St Albans Anglican Church and Five Dock Library) • Potential temporary impact on amenity of local cafes and restaurants along Great North Road near the construction sites. The disrupted amenity due to noise, vibration, increased traffic may reduce the ability for the local community to enjoy social connections.	Likely	Moderate	High
Access to and use of infrastructure, services and facilities	• Potential temporary changes to the walkability of infrastructure, services and facilities in Five Dock and impacts to amenity of adjacent spaces (e.g. Fred Kelly Place) would impact local communities. Greater impacts may be experienced by the high proportion of older people living in Five Dock, as well as people living with a disability, due to limited mobility.	Likely	Moderate	High

Reference	Description of potential impacts	Social risk without mitigation[1,2]		
		Likelihood	Consequence	Risk rating
Culture	• Potential temporary impacts on local community connections to place and shared values and histories associated with the loss of premises containing long-established local businesses • Potential impacts to events such as Ferragosto, which is a large annual event which attracts many visitors to Five Dock and celebrates the local heritage, contributes to community cohesion and sense of place. This festival takes place along Great North Road adjacent to the construction site.	Possible	Moderate	Medium
Health and wellbeing	• Potential temporary wellbeing impacts associated with reduced amenity of local civic spaces that are important and well-utilised by the local community (e.g. Fred Kelly Place), impacting people's use and enjoyment of them.	Possible	Moderate	Medium
Surroundings	• Potential temporary safety impacts which would be managed, with the western construction site inbound and outbound truck routes directly off Great North Road (a high pedestrian activity area) with the inbound route crossing near Fred Kelly Place • Perceived temporary safety impacts associated with changed sight lines and unfamiliar construction workers may be disproportionately felt by the higher proportion of older people in Five Dock and at the two surrounding childcare centres.	Likely	Moderate	High
Personal and property rights	• Personal and property rights impacts applicable to the project as a whole are discussed in Table 17-5. No additional personal and property rights impacts have been identified for the Five Dock station construction site.	Almost certain	Moderate	High
Fears and aspirations	• Fears and aspirations impacts applicable to the project as a whole are discussed in Table 17-5. No additional impacts have been identified for the Five Dock station.	Possible	Moderate	Medium

Note 1: "without mitigation" means without specific social mitigation measures that are above and beyond standard impact mitigation that will be in place

Note 2: The social risk rating has taken into consideration the impacts described above as well as the project-wide impacts.

17.15 The Bays Station

17.15.1 Existing environment

Social context and community profile

The Bays Station locality is defined by the following intangible community assets relating to human and social capital, community values and connection to place (based on ABS Census data (2016) and local community strategic plans):

- Strong historic identity. The locality has strong historic links to industrialisation, namely through the former White Bay Power Station. There are currently a range of light industrial and urban services throughout the locality including car repairs, metal works and port operations
- Strong capital and connection to place. The former White Bay Power Station is an iconic landmark that embodies a range of values associated with its heritage and form. The landmark contributes to the local character and is highly valued by a range of community groups
- The Bays West transformation. The industrial waterfront parts of the locality, including White Bay Power Station, are within The Bays West site, which is subject to future major urban transformation. This is intended to include major employment areas and public spaces.

Community assets

The social infrastructure that would be in proximity to the construction site is currently limited to several local-serving community facilities. However, a range of social infrastructure is expected to be provided through the delivery of the planned urban renewal of the area as a mixed-use precinct. Figure 17-9 identifies the tangible community assets within the locality.

Figure 17-9: The Bays locality – Community assets (social infrastructure)

Community values and aspirations

Key community priorities identified in the Our Inner West 2036 Community Strategic Plan (Inner West Council, 2018) include a harmonious and cohesive city, with affordable and diverse housing options, good access to facilities, and a thriving economy and cultural life. It is also a community priority to deliver safe and attractive public spaces for diverse communities to meet and interact. The community acknowledges that integrated public and active transport options are needed to support population growth, economic growth and improve the amenity of local centres.

17.15.2 Social impact assessment

In addition to the project-wide potential impacts identified in Table 17-5, the potential impacts specific to The Bays station construction site locality are provided in Table 17-15. The social risk rating has been calculated taking into consideration the impacts described below as well as the project-wide impacts.

The potential impacts presented are unmitigated and would be appropriately managed through the implementation of a Community Communication Strategy and the mitigation measures outlined through other relevant chapters of this Environmental Impact Statement. Sydney Metro would also develop a community benefit plan to guide the development of community benefit initiatives (by Principal Contractors).

Table 17-15: Social impact assessment – The Bays station construction site

Reference	Description of potential impacts	Social risk without mitigation[1,2]		
		Likelihood	Consequence	Risk rating
Way of life	• Potential temporary disruption to daily activities, primarily for local workers and nearby residents occurring from the traffic impacts associated with 24-hour construction activities at this construction site and truck movements in the area • Potential temporary disruption to the way of life for residents and visitors associated with trenching activities for power supply connection between the construction site and nearby substation. Potential impacts are likely to result in an increased sense of frustration and inconvenience for residents on a temporary basis, but would be limited to communities for the short-term along the power supply routes.	Unlikely	Minor	Low
Community	• Community concerns regarding potential impacts on community character, heritage values and sense of place may arise in relation to the location of the construction site in close proximity to the iconic, heritage-listed White Bay Power Station. This large structure has high visibility, heritage value and an iconic status within the community, both locally and more broadly; it is an important symbol of the area's industrial past • Potential temporary changes to community character affecting local community values and sense of place for Rozelle residents to the north of the construction site, as the area is already heavily affected by various construction works in this construction site locality.	Unlikely	Minor	Low
Access to and use of infrastructure, services and facilities	• Construction activities would be sited within the primarily self-contained industrial locality– a locality which currently has low permeability for local pedestrians and vehicles • The community's use and enjoyment of some social infrastructure in close proximity to the construction site (e.g., C3 Church Rozelle) may be temporarily affected by construction noise and vibration, particularly given this construction site is a high-activity 24-hour site, albeit one which is already subject to construction activities associated with other infrastructure projects.	Possible	Minor	Medium
Culture	• The proximity of the construction site to White Bay Power Station, which is a historic site with connections to the industrial and 'working class' heritage of Rozelle and Balmain, may cause community concerns about construction works and potential impact to local character and narratives associated with the area.	Possible	Minor	Medium
Health and wellbeing	• As the area is predominantly occupied by industrial uses, potential temporary impacts of construction activity on health and wellbeing are unlikely.	Unlikely	Minor	Low
Surroundings	• As the area is predominantly occupied by industrial uses, potential temporary impacts of construction activity on the surroundings are likely to be minimal • Temporary changes to surroundings and streetscape associated with short-term trenching activities to establish a power connection between the construction site and Rozelle sub-transmission substation.	Likely	Minor	Medium
Personal and property rights	• There would be no acquisition of private property at The Bays construction site.	Unlikely	Minor	Low
Fears and aspirations	• Potential concerns associated with any adverse impacts of construction on White Bay Power Station, which is a highly valued piece of historic infrastructure with connections to the industrial and 'working class' heritage of Rozelle and Balmain.	Likely	Minor	Medium

Note 1: "without mitigation" means without specific social mitigation measures that are above and beyond standard impact mitigation that will be in place

Note 2: The social risk rating has taken into consideration the impacts described above as well as the project-wide impacts.

17.16 Cumulative impacts

Potential cumulative social impacts may occur as a result of other projects being undertaken concurrently in the surrounding area. Potential cumulative impacts were considered for assessment based on the likely interactions of Stage 1 with other projects and plans that met the adopted screening criteria. The approach to assessment and the other projects considered are described further in Appendix G (Cumulative impacts assessment methodology – Stage 1).

The construction sites likely to experience cumulative social impacts are:

- Westmead metro station construction site. Potential temporary changes to amenity and character of the area, feelings of safety, lifestyle changes and potential wellbeing impacts due to long term disruption caused by the construction of large infrastructure and development projects in areas affected by Parramatta Light Rail (Stage 1) and the developments within the Westmead Health precinct and the Westmead town centre, potentially resulting in community frustration and fatigue
- Parramatta metro station construction site. A potential sense of disruption and inconvenience, and both positive and negative temporary changes to sense of place and community character due to concurrent construction works of the Parramatta Light Rail (Stage 1), Parramatta Square urban renewal project, Westfield Shopping Centre redevelopment, Arthur Phillip High School redevelopment and the Western Sydney University Innovation Hub
- Sydney Olympic Park metro station construction site. Both positive and negative temporary changes to sense of place and community character due to construction of various projects consistent with the Sydney Olympic Park Masterplan 2030
- The Bays station. Potential temporary reduced amenity, increased traffic congestion contributing towards feelings of 'construction fatigue' due to concurrent construction activities associated with WestConnex, Sydney Metro City and Southwest (Chatswood to Sydenham) truck marshalling facility, Bays Precinct Urban Transformation Plan, Western Harbour Tunnel.

Other construction sites have either minimal interactions with other projects, and so minimal potential for cumulative impacts, or only relatively minor potential social impacts as a result of Stage 1.

17.17 Management and mitigation measures

17.17.1 Approach to management and mitigation

Social impacts would be partially managed by the plans and measures in the Sydney Metro Construction Environmental Management Framework, Construction Noise and Vibration Standard and the Construction Traffic Management Framework described in Chapter 27 (Synthesis of the Environmental Impact Statement). The mitigation measures in Section 17.17.2 would also be implemented.

17.17.2 Mitigation measures

Mitigation measures that would be implemented to address potential social impacts are listed in Table 17-16.

Table 17-16: Mitigation measures – Social impacts Stage 1

Reference	Impact/issue	Mitigation measure	Application location(s)[1]
Social impacts			
S1	Impacts on social infrastructure	Consultation would be carried out with managers of social infrastructure located near construction sites about the timing and duration of construction works and management of potential impacts, with the aim of minimising potential disruption to the use of the social infrastructure from construction activity.	WMS, PMS, CSMF, SSF, SOPMS, NSMS, BNS, FDS, TBS
S2	Loss of social infrastructure	Engagement would be carried out with Parramatta City Council to identify alternative locations for the Parramatta Artist Studios to provide opportunities for facilitating local creative and cultural activities.	PMS
S3	Social impacts	A Community Benefit Plan would be developed to guide the development of community benefit initiatives (by Principal Contractors) during construction of Stage 1 to make a positive contribution to the potentially affected community. The key objectives of the plan would include: • Identify opportunities to create environmental and community benefits and provide positive social outcomes • Respond to community priorities and needs in the locality of each relevant construction site.	WMS, PMS, SOPMS, NSMS, BNS, FDS, TBS
S4	Impacts on events or festivals	In addition to mitigation measure TT17, consultation would be carried out with festival and event organisers in proximity to construction sites to mitigate potential impacts on the operation of the festival or event.	PMS, FDS
S5	Promote local culture and identity	In addition to mitigation measure LV16, consultation would be carried out with stakeholders to identify opportunities for public art to reflect community values, culture and identity of the local community.	WMS, PMS, SOPMS, NSMS, BNS, FDS
S6	Activation of streetscapes	In addition to mitigation measure LV10, potential temporary activation in the vicinity of the Five Dock Station western construction site would include opportunities to provide spaces and places for the community to gather and meet each other, culture and identity.	FDS

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (e.g. tunnel boring machine works); PSR: Power supply routes.

17.17.3 Interactions between mitigation measures

Mitigation measures in other chapters of this Environmental Impact Statement that are relevant to the management of potential social impacts include:

- Chapter 10 (Transport and traffic – Stage 1) – all measures
- Chapter 11 (Noise and vibration – Stage 1) – all measures
- Chapter 14 (Property and land use – Stage 1) – all measures
- Chapter 15 (Landscape character and visual impacts – Stage 1) – all measures
- Chapter 16 (Business impacts – Stage 1) – all measures.

Together, these measures would minimise the potential social impacts of Stage 1.

18 Groundwater and ground movement – Stage 1

18 Groundwater and ground movement – Stage 1

This chapter provides an assessment of the potential impact of Stage 1 on groundwater and ground movement and identifies mitigation measures to address these impacts. This chapter draws on information in Technical Paper 7 (Hydrogeology).

18.1 Secretary's environmental assessment requirements

The Secretary's Environmental Assessment requirements relating to groundwater and ground movement, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 18-1.

Table 18-1: Secretary's Environmental Assessment Requirements – Groundwater and ground movement Stage 1

Reference	Requirement	Where addressed
9. Water – Hydrology and flooding		
9.1	The existing hydrological regime for any surface and groundwater resource (including mapping, the reliance by users, and for ecological purposes) likely to be impacted, including stream orders.	Section 18.4.2
9.2	A water balance for ground and surface water including the proposed intake and discharge locations, volume, frequency and duration.	Chapter 19 (Soils and surface water quality – Stage 1)
9.3	Requirements for baseline monitoring of hydrological attributes	Section 18.8.2
9.4	The impact on surface and groundwater hydrology in accordance with the current guidelines, including: a. natural processes within rivers, wetlands, estuaries, marine waters and floodplains;	Section 18.6 Chapter 21 (Hydrology and flooding – Stage 1)
	b. impacts from any permanent and temporary interruption of groundwater flow;	
	c. stormwater and wastewater management on natural hydrological attributes and the conveyance capacity of existing stormwater systems where discharges are proposed through such systems; and	
	d. water take (direct or passive) from all surface and groundwater sources with estimates of annual volumes during construction.	
9.5	Flood behaviour for a range of flood events up to the probable maximum flood (taking into account sea level rise and storm intensity due to climate change) including: a. potential flood affectation of other properties, assets and infrastructure;	Chapter 21 (Hydrology and flooding – Stage 1)
	b. consistency (or inconsistency) with applicable Council floodplain risk management plans;	
	c. compatibility with the flood hazard of the land; and	
	d. compatibility with the hydraulic functions of flow conveyance in flood ways and storage areas of the land.	
10. Water – Quality		
10.1	Surface and groundwater quality impacts including: a. identifying and estimating the discharge water quality and degree of impact that any discharge(s) may have on the receiving environment, including consideration of all pollutants that pose a risk of non-trivial harm to human health and the environment;	Section 18.4.2, Section 18.6.5 Chapter 19 (Soils and surface water quality – Stage 1)
	b. identifying the rainfall event that the water quality protection measures will be designed to cope with; and	Chapter 19 (Soils and surface water quality – Stage 1)
	c. assessing the significance of any identified impacts including consideration of the relevant ambient water quality outcomes.	
10.2	Demonstrating how Stage 1 will, to the extent that the project can influence, ensure that: a. where the NSW WQOs for receiving waters are currently being met they will continue to be protected; and	Chapter 19 (Soils and surface water quality – Stage 1)
	b. where the NSW WQOs are not currently being met, activities will work toward their achievement over time; and	
	c. justify, if required, why the WQOs cannot be maintained or achieved over time.	

18.2 Legislative and policy context

18.2.1 National Water Quality Management Strategy

The National Water Quality Management Strategy is the adopted national approach to protecting and improving water quality in Australia. It includes specific documents relating to the protection of groundwater resources.

The primary document relevant to the assessment of groundwater risks or Stage 1 is the Guidelines for Groundwater Quality Protection in Australia (Australian Government, 2013). This document sets out a high-level risk-based approach to protecting or improving groundwater quality for a range of groundwater beneficial uses (called 'environmental values'), including aquatic ecosystems, primary industries (including irrigation and general water users, stock drinking water, aquaculture and human consumption of aquatic foods), recreational and aesthetic values (e.g. swimming, boating and aesthetic appeal of water bodies), drinking water, industrial water and cultural values.

18.2.2 NSW Legislation

Under the *Water Management Act 2000*, water sharing plans provide the basis for equitable sharing of surface water and groundwater between water users, including the environment.

For groundwater, Stage 1 lies within the area covered by the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011. The Water Sharing Plan contains provisions for allocation of water to construction projects through a volume of 'unassigned water' or through the ability to purchase an entitlement where groundwater is available under the long-term average annual extraction limit (LTAAEL).

The LTAAEL for the Sydney Basin Central Groundwater Source is 45,915 megalitres per year, which is 25 per cent of the estimated annual recharge for the area. Under the Water Sharing Plan, there are currently 120 groundwater access licences, with a total licensed volume of 2,592 megalitres per year. As such there is up to 43,323 megalitres per year of water available under the LTAAEL.

18.2.3 NSW Policy

NSW Aquifer Interference Policy

The NSW Aquifer Interference Policy (NSW Office of Water, 2012) defines the regime for protecting and managing impacts of aquifer interference activities on NSW water resources.

The NSW Aquifer Interference Policy requires that for an aquifer interference activity (such as excavation which intercepts the aquifer) to meet the minimal impact considerations, any change in groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity. Groundwater along the alignment may potentially be used by aquatic ecosystems and primary industries to account for small-scale domestic use of groundwater, although this varies locally depending on local groundwater conditions such as quality and salinity.

The NSW Aquifer Interference Policy also provides a framework for assessing the impacts of aquifer interference activities on water resources. To assess potential impacts, groundwater sources are categorised as either highly productive or less productive, with sub-categories for different aquifers, such as alluvial, coastal sands, porous rock, and fractured rock. For each category, there are a number of prescribed minimal impact considerations relating to water table and groundwater pressure drawdown, and changes to groundwater and surface water quality.

The Sydney Basin Central Groundwater Source is declared a Less Productive Groundwater Source. Therefore, the Less Productive Minimal Impact Considerations of the NSW Aquifer Interference Policy apply with respect to Porous and Fractured Rock Water Sources. An assessment of Stage 1 against the Less Productive Minimal Impact Considerations is provided in Section 18.6.9.

NSW Groundwater Dependent Ecosystems Policy

The NSW State Groundwater Dependent Ecosystems Policy (Department of Land and Water Conservation, 2002) provides guidance on the protection and management of Groundwater Dependent Ecosystems. It sets out management objectives and principles to:

- Ensure that the most vulnerable and valuable ecosystems are protected
- Manage groundwater extraction within defined limits thereby providing groundwater flow sufficient to sustain ecological processes and maintain biodiversity
- Ensure that sufficient groundwater of suitable quality is available to ecosystems when needed
- Ensure that the precautionary principle is applied to protect groundwater dependent ecosystems, particularly the dynamics of flow and availability and the species reliant on these attributes
- Ensure that land use activities aim to minimise adverse impacts on groundwater dependent ecosystems.

18.3 Assessment approach

The assessment approach for groundwater and ground movement involved:

- A review of publicly available data and web-based information searches, including:
  - WaterNSW Groundwater Bore Database (WaterNSW, 2019)
  - NSW Water Register (WaterNSW, 2019)
  - Groundwater Dependent Ecosystems Atlas (Bureau of Meteorology, 2019)
  - Geological maps, topography and drainage maps, and soil maps.
- A review of groundwater investigations previously carried out within and around the construction footprint, where available, and review of similar assessments for previous tunnelling projects in the Sydney region, including Sydney Metro Northwest and WestConnex M4 East
- Site investigations for Sydney Metro West including installation of 55 monitoring piezometers, with Vibrating Wire Piezometers installed in 12 boreholes
- Development of a conceptual model of the existing Stage 1 hydrogeological environment to assess potential groundwater changes as a result of Stage 1 construction activities
- Identification and assessment of potential groundwater and ground movement impacts from the construction of Stage 1 using the conceptual model, including:
  - Expected changes to groundwater level, flow and quality on surrounding land uses, other groundwater users, surface water/groundwater interaction and potential impacts to groundwater dependent ecosystems
  - Effects of ground movement on nearby structures, either due to excavation or ground consolidation following groundwater drawdown
- Development of monitoring and mitigation measures to address potential groundwater impacts and ground movement.

18.3.1 Groundwater modelling

Groundwater models were developed for each Stage 1 construction site in the software package SEEP/W. The model was based on regional hydrogeological data, and local geotechnical and hydrogeological data recorded as part of Sydney Metro West site investigations.

Groundwater level drawdown contours were developed based on the results of multiple model cross sections (i.e. cross sections and long sections through station box, cavern and shaft excavations). The two-metre drawdown contour represents the minimal impact consideration (for groundwater level drawdown) of the NSW Aquifer Interference Policy (NSW Office of Water, 2012).

The models were used to estimate:

- Groundwater inflows to excavations and station/services facility excavations
- Groundwater level drawdown associated with construction.

Potential impacts are assessed by reviewing the predicted groundwater level drawdown due to Stage 1 against the locations and conditions of existing supply bores; groundwater dependent ecosystems; acid sulfate soils; and interpreted existing groundwater recharge, flow and surface water-groundwater behaviour.

Key assumptions in the model include:

- All cross caverns would be untanked during construction
- Excavations would be open for up to two years during construction
- The excavations are 'wished-in-place' (i.e. progressive excavation over time is not considered). This assumption results in potentially higher inflows to the excavations than would be experienced with progressive excavation, and therefore provides a conservative estimate of groundwater inflow
- The modelling is based on limited geotechnical and hydrogeological data. Where data are not available at sites, assumptions regarding ground conditions have been made.

A full list of modelling assumptions is provided in Technical Paper 7 (Hydrogeology).

18.3.2 Ground movement

The following framework was applied to assess and mitigate potential impacts of ground movement on existing buildings, tunnels, road pavements and utilities:

- Identification of the ground movement zone of influence as triggered by construction and classification of all existing buildings and infrastructure within that zone
- Risk assessment of the structures within the zone of influence against acceptance criteria and where necessary development of solutions to minimise the impact of construction on potentially critical buildings and infrastructure
- Implementation of minimisation measures (for buildings and structures classified as critical), re-assessment and review of performance.

18.4 Existing environment

18.4.1 Geological context

Topography

Stage 1 falls within the catchment of the Parramatta River and Sydney Harbour. The catchment lies to the west of the Sydney CBD within the relatively flat region of the Cumberland Plain. Elevations range from 140 metres Australian Height Datum (AHD) in the north-west of the catchment to sea level in the east. Most of the waterways are within urbanised coastal areas.

Geology

The Sydney 1:100,000 Geological Series Sheet 9130 (NSW Department of Mineral Resources, 1983) and the Parramatta 1:100,000 Geological Sheet 9030 (NSW Department of Mineral Resources, 1991) indicate that most of the Stage 1 construction footprint is underlain by geological units associated with the Wianamatta Group. Ashfield Shale underlies most of the Stage 1 construction footprint and tunnel alignment, with occurrences of Hawkesbury Sandstone and Mittagong Formation. In addition, significant areas of disturbed ground (imported fill) are known to be present within the Stage 1 footprint at Rosehill, Silverwater, Sydney Olympic Park and The Bays.

A description of the geological formations is presented in Table 18-2 and shown in Figure 18-1. The geological long section is provided in Technical Paper 7 (Hydrogeology).

Table 18-2: Geological units – Stage 1 construction footprint

Geological unit	Description	Relevant Stage 1 construction sites
Fill	Material comprising waste, emplaced material and engineered fill.	• Silverwater services facility • Clyde stabling and maintenance facility • The Bays Station
Quaternary deposits (residual and alluvial soils)	Alluvial and marine sediments associated with gullies, valleys, and former drainage channels.	• Westmead metro station • Parramatta metro station • Silverwater services facility • Clyde stabling and maintenance facility • Sydney Olympic Park metro station • North Strathfield metro station • Burwood North Station • Five Dock Station • The Bays Station
Mittagong Formation	Interbedded dark siltstone and fine-grained sandstone beds and laminae of varying thickness.	• Westmead metro station • Parramatta metro station • Clyde stabling and maintenance facility • Silverwater services facility • Sydney Olympic Park metro station • North Strathfield metro station • Burwood North Station • Five Dock Station
Ashfield Shale	Black to dark grey shale and laminate.	• Westmead metro station • Parramatta metro station • Silverwater services facility • Clyde stabling and maintenance facility • Sydney Olympic Park metro station • North Strathfield metro station • Burwood North Station • Five Dock Station
Hawkesbury Sandstone	Medium to coarse-grained quartz sandstone.	• All Stage 1 construction sites

Note: Geological units presented in order of depth from surface.

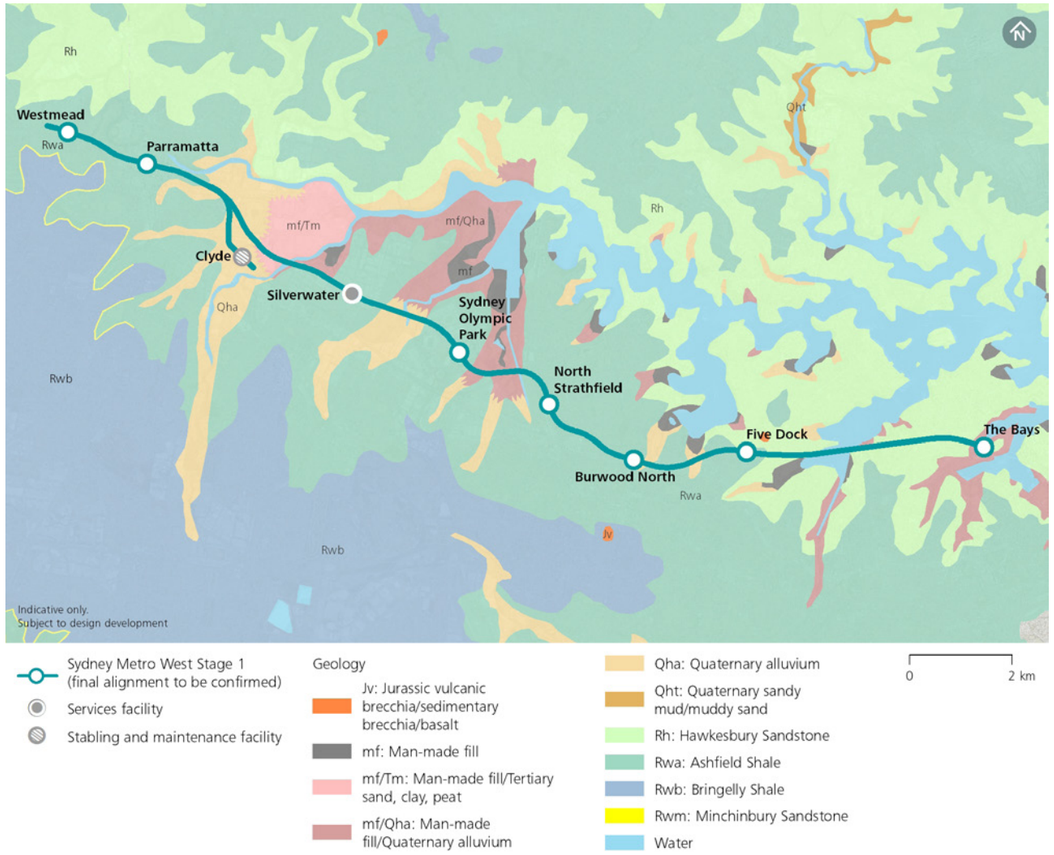

Figure 18-1: Regional geological context

Geological structural features

The geology within the Stage 1 construction footprint is crossed by several volcanic structural features such as dykes and faults that may impact groundwater flow. Dykes are bodies of rock that cut across other geological units. Faults are a fracture within rock where displacement may have occurred. Dykes and faults may provide a conduit or hydraulic barrier for groundwater inflows.

Structural features near Stage 1 include:

- Dykes within Ashfield Shale and Hawkesbury Sandstone. Dykes may be present near the construction sites for North Strathfield metro station and The Bays Station. A dyke may also be present near the tunnel alignment to the east of Five Dock Station
- Geological faults within Ashfield Shale, Mittagong Formation and Hawkesbury Sandstone. An observed fault is present near the Sydney Olympic Park metro station. Faults may also be present near the North Strathfield metro station, Burwood North Station and The Bays Station construction sites. Faults may also cross the tunnel alignment to the south and east of Sydney Olympic Park metro station construction site, to the south of North Strathfield metro station construction site and to the south of Burwood North Station construction site.

18.4.2 Groundwater

Aquifers

Aquifers are permeable rocks or soil that transmit groundwater and are related to the geological units. Aquifers near Stage 1 include porous and fractured rock aquifers. Porous aquifers in alluvial soils are continuous (unconfined) over an area. Porous aquifers in residual soils are often ephemeral, localised and discontinuous. They are reflective of water moving down the soil profile and building up on the underlying bedrock.

Fractured rock aquifers occur where groundwater is transmitted through fractures or joints and bedding planes, such as in the shales and Hawkesbury Sandstone.

Groundwater levels

The groundwater level across most of the Stage 1 construction footprint is generally shallow and typically between one metre and five metres below ground surface at most locations. Table 18-3 shows the groundwater level near the Stage 1 construction sites.

Table 18-3: Groundwater levels near construction sites

Construction site	Typical groundwater level near construction site (metres below ground surface)
Westmead metro station	3
Parramatta metro station	6
Clyde stabling and maintenance facility	3 (assumed at the shaft) 5 (assumed at the dive portal)
Silverwater services facility	1
Sydney Olympic Park metro station	12
North Strathfield metro station	5
Burwood North Station	12
Five Dock Station	2
The Bays Station	2

Surface water and groundwater interaction

Interaction between groundwater and surface water is expected to be limited to:

- Likely surface water infiltration that filters through soils and contributes to groundwater
- Discharge from groundwater to surface watercourses and waterbodies, especially in low lying areas or deeply incised channels
- Leakage from surface watercourses which recharge the groundwater.

Table 18-4 identifies watercourses and waterbodies near Stage 1 construction sites which have the potential for groundwater to contribute to baseflow. However, where the portions of these watercourses are lined they would be unlikely to have a connection with the groundwater system.

Table 18-4: Watercourses near Stage 1 construction sites

Construction site	Watercourse or waterbody	Approximate distance from Stage 1 (m)
Westmead metro station	Parramatta River	250
	Toongabbie Creek	1,250
	Domain Creek	250
	Finlaysons Creek	1,000
Parramatta metro station	Parramatta River Clay Cliff Creek	250 1,500
Clyde stabling and maintenance facility	Duck River	Less than 100
Silverwater services facility	Duck River	1,000
Sydney Olympic Park metro station	Haslams Creek	900
	Powells Creek	1,000
	Saleyards Creek	350
	Associated water bodies (Lake Belvedere, Bennelong Pond)	350
	Bicentennial Park Wetlands	500
	Newington Wetlands	1,500
North Strathfield metro station	Powells Creek Saltwater Creek	400 600
Burwood North Station	St Lukes Park Canal Saltwater Creek	500 1,400
Five Dock Station	Iron Cove Creek Parramatta River / neighbouring bays	600 600
The Bays Station	Whites Creek Parramatta River / White Bay	550 50

Groundwater quality

Groundwater quality is influenced by the underlying geological units. The expected groundwater quality associated with the key geological units for Stage 1 (refer to Table 18-2) is provided in Table 18-5.

Table 18-5: Expected groundwater quality in key geological units

Geological unit	Expected salinity (as total dissolved solids)	Expected pH	Other expected characteristics
Quaternary deposits (residual and alluvial soils)	Fresh to saline	Neutral to slightly acidic	• Nil
Ashfield Shale	Brackish to saline 2,000 milligrams per litre to 20,000 milligrams per litre	Neutral to slightly acidic (4-8)	• Nil
Hawkesbury Sandstone	Fresh to brackish 300 milligrams per litre to 1,400 milligrams per litre	Neutral to slightly acidic (4.5 to 8)	• Elevated iron • Elevated manganese
Mittagong Formation	Fresh to brackish 250 milligrams per litre to 350 milligrams per litre	Neutral to slightly acidic (4.5 to 8)	• Elevated iron • Elevated manganese

Groundwater samples collected along the alignment were consistent with the typical ranges listed in Table 18-5. Details are provided in Technical paper 7 (Hydrogeology). Data collected from the groundwater monitoring bores exceeded ANZECC (2019) trigger levels for 95 per cent protection of freshwater aquatic ecosystems for the following substances:

- Ammonia
- Heavy metals (including cobalt, manganese, arsenic, copper, lead, nickel and zinc).

ANZECC (2019) does not provide a 95 per cent trigger level for iron, however iron concentrations in measured groundwater near the Stage 1 construction footprint is relatively high.

Human activities may have also influenced groundwater quality and groundwater contamination from current or historical land uses in some areas along the alignment. Construction sites with the potential for contaminated groundwater include Westmead metro station, Parramatta metro station, Clyde stabling and maintenance facility, Silverwater services facility, Sydney Olympic Park metro station, Burwood North Station and The Bays Station. Further information is provided in Chapter 20 (Contamination – Stage 1).

Groundwater users and extraction

A review of the WaterNSW Groundwater Bore Database (WaterNSW, 2019) and the Register of Water Approvals (WaterNSW, 2019) identified 31 registered groundwater bores located within the predicted groundwater level drawdown zone of influence during construction. These are shown in Figure 18-2 and include:

- Twenty-eight bores which are installed for monitoring purposes
- One bore which is installed for industrial purposes
- One bore which is installed for dewatering purposes
- One bore which is installed for water supply.

In addition, there are 39 Water Access Licence users within one kilometre of Stage 1.

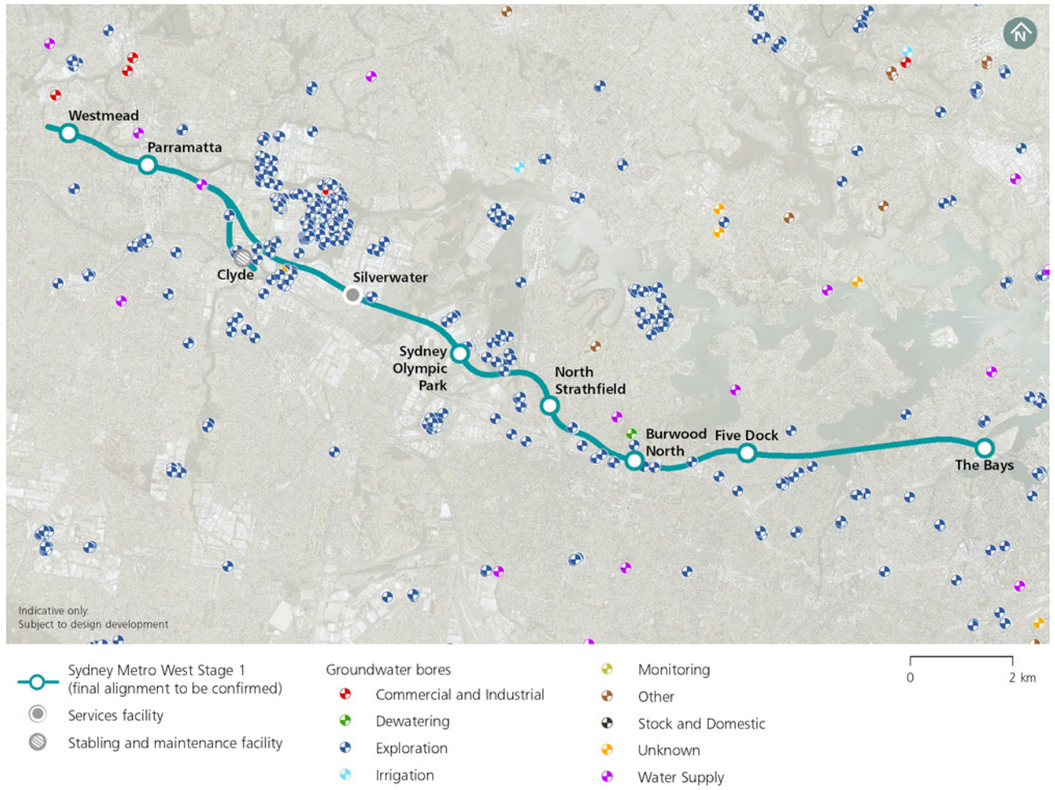

Figure 18-2: Existing groundwater bores within one kilometre of Stage 1

Groundwater dependent ecosystems

Technical Paper 10 (Biodiversity development assessment report) identifies potential groundwater dependent ecosystems located in proximity to (about one kilometre of) the Stage 1 construction sites and tunnel. These are shown in Figure 18-3.

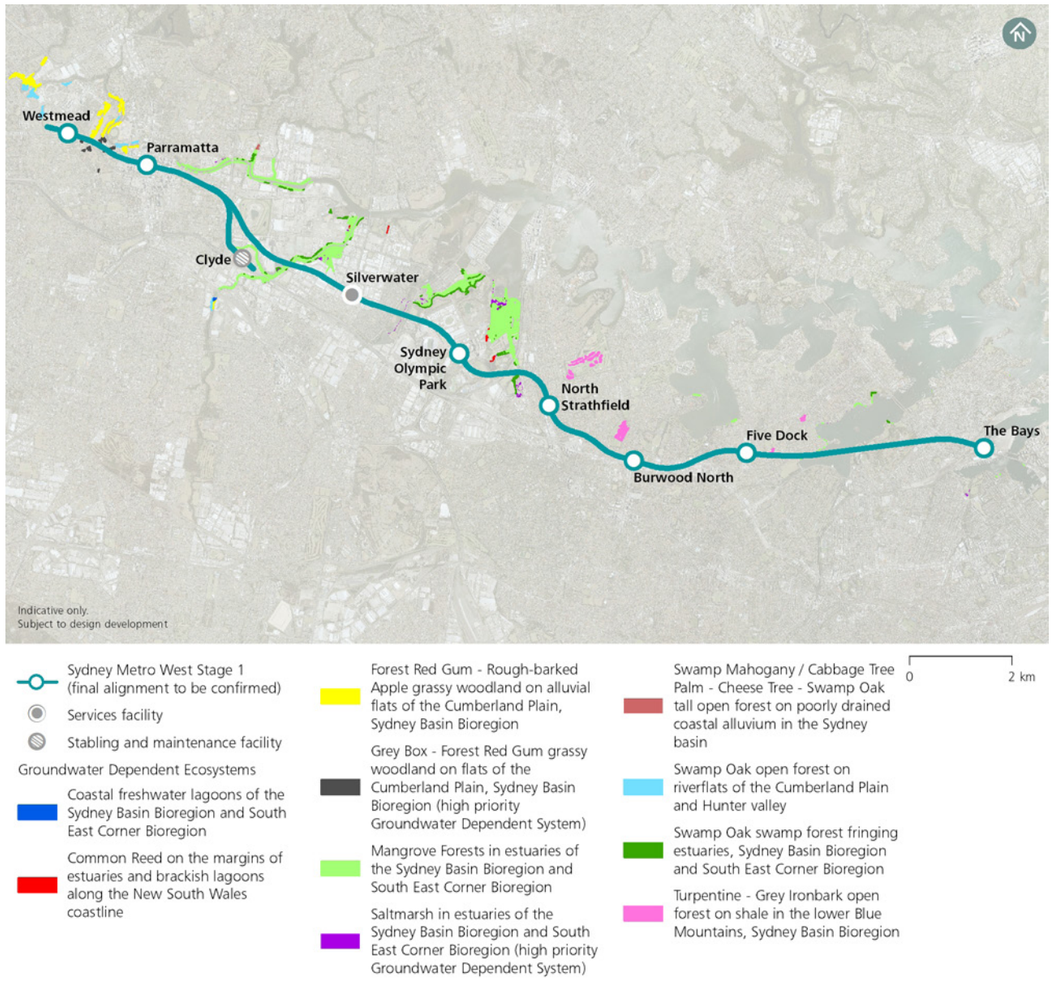

Figure 18-3: Groundwater dependent ecosystems

There are no mapped aquatic groundwater dependent ecosystems within the Stage 1 study area, however Chapter 22 (Biodiversity – Stage 1) identifies areas of high potential groundwater dependent terrestrial vegetation including:

- Saltmarsh in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion
- Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion Plant Community Type (849) (a vegetation community classified as Cumberland Plain Woodland in the Sydney Basin Bioregion)
- Forest Red Gum – Rough-barked Apple grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion Plant Community Type (835) (a vegetation community classified as Cumberland Plain Woodland in the Sydney Basin Bioregion).

High priority groundwater dependent ecosystems are listed in Schedule 4 of the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources (Department of Industry, 2011). The plan lists Cumberland Plain Woodland and Coastal Saltmarsh in the Sydney Basin Bioregion as high priority groundwater dependent ecosystems. Therefore, Grey Box - Forest Red Gum woodland on the flats of the Cumberland Plain in the vicinity of Westmead metro station and Parramatta metro station construction sites, and the Saltmarsh in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion in the vicinity of Sydney Olympic Park metro station and North Strathfield metro station construction sites are classified as high priority groundwater dependent ecosystems.

18.4.3 Conceptual hydrogeological model

A conceptual hydrogeological model of the existing environment has been developed for Stage 1. A conceptual hydrogeological model is a mostly qualitative description of the groundwater system, including groundwater levels, quality, inputs/outputs and a description of geology and its properties. A conceptual model allows the effect of newly introduced changes to the hydrogeological system to be understood and assessed, such as those proposed for Stage 1 construction activities. It also allows consideration of whether more detailed numerical modelling is necessary.

The conceptual hydrogeological model for Stage 1 incorporates the groundwater and geology elements described in Sections 18.4.1 and 18.4.2 and is shown graphically in Technical Paper 7 (Hydrogeology).

18.5 Avoidance and minimisation of impacts

The design development of Stage 1 has included a focus on avoiding or minimising potential groundwater impacts and ground movement. This has included:

- Tanking at Parramatta, Five Dock and The Bays stations to avoid ongoing groundwater inflow
- Tanking of tunnels to avoid ongoing groundwater inflow.

18.6 Potential impacts

18.6.1 Ground movement

The specific risk to most buildings and structures due to ground movement is considered negligible, with superficial damage to buildings unlikely. Construction of some underground sections of Stage 1 may potentially induce ground movement at the surface and below ground which could include ground settlement and lateral movement. If not adequately managed, ground movement has the potential to cause damage to infrastructure, nearby buildings and other structures.

Ground movement may occur from either the release or redistribution of stress in rock formations or from ground consolidation following the drawdown of groundwater. Typically ground movement caused by stress redistribution in rock generally occurs shortly after excavation, while consolidation settlement from groundwater drawdown can occur over a longer period.

The tunnels and many other project elements are designed as tanked structures and, therefore, long-term settlement effects associated with groundwater drawdown are not anticipated at most locations. For Stage 1, it is expected that any potential settlement associated with groundwater drawdown would be minimal as most underground excavation would be within rock that has low permeability. Some settlement could potentially occur as a result of groundwater drawdown associated with open excavations and this potential would be greatest in soft superficial surface deposits, if the perched water table is lowered.

Ground movement risk levels have been determined with reference to geotechnical conditions, distance from construction activities and building characteristics including condition and type of masonry. For the purposes of a screening assessment, the risk-based criteria outlined by the Construction Industry Research and Information Association (1996) have been used and are detailed in Table 18-6. These criteria specify the maximum settlement of the building and the maximum slope of the ground below building foundations for each risk level. A small number of buildings and structures assessed as having a risk level of two or greater would be subject to more detailed building strain assessment and would potentially require a structural assessment later in the design process.

Table 18-6: Ground movement risk levels

Risk	Description	Maximum slope of building	Maximum settlement of building (mm)
1	Negligible: Superficial damage unlikely	<1:500	<10
2	Slight: Possible superficial damage which is unlikely to have structural significance	1:500 to 1:200	10 to 50
3	Moderate: Expected superficial damage and possible structural damage to buildings, possible damage to relatively rigid pipelines	1:200 to 1:50	50 to 75
4	High: Expected structural damage to buildings. Expected damage to rigid pipelines, possible damage to other pipelines	>1:50	>75

Preliminary settlement contours were developed for the Stage 1 corridor to identify the expected zone of influence and magnitude of induced settlement. The development of the contours considered the following construction activities:

- Tunnelling
- Mining (station caverns and adits, ventilation caverns and cross passages)
- Open-cut and trough excavation from the surface using conventional excavation techniques (station excavations, ventilation shafts and dive sites).

Settlement contour intervals (namely 1mm, 3mm, 5mm, 10mm, 15mm, 20mm and 25mm) were selected to cover the expected typical range of potential ground movement. The three millimetre contour defines what is considered to be the extent of the Stage 1 influence, while the ten millimetre contour defines the point at which more detailed future assessment is required as per Table 18-6. Most of the alignment falls within the risk category one and is therefore considered to have a negligible ground movement risk, with superficial damage to buildings unlikely. Small areas at station sites and dive sites are within risk category two. These would be subject to further assessment at later design stages, which may include building strain and structural assessment to address settlement related risks.

18.6.2 Groundwater levels

During tunnel construction, tunnel boring machines would progress through Ashfield Shale, Mittagong Formation and Hawkesbury Sandstone and would place a pre-cast segmental tunnel lining as tunnelling progresses. Groundwater level drawdown due to the tunnels is not likely to be significant as the tunnels would be tanked almost immediately following tunnelling and given the relatively low hydraulic conductivity and storativity (i.e. a measure of the capacity of the aquifer to release groundwater) of the rock and the short timeframe over which an unlined excavation would be open in the tunnels.

The impacts of cross passage construction on groundwater are not likely to be significant as the tunnel cross passages have a relatively small footprint and may be open for a short period of time prior to being waterproofed.

Estimates of groundwater level drawdown from the current water level as a result of Stage 1 excavation at each construction site have been developed and are provided in Technical Paper 7 (Hydrogeology). Further discussion of predicted groundwater inflows and potential impacts are provided in the sections below.

18.6.3 Groundwater inflows and local flow regime

Excavations at Stage 1 construction sites would act as groundwater sinks, causing the surrounding groundwater to flow towards the excavations. Some excavations would be tanked (i.e. sealed) during construction, which would prevent groundwater from flowing into the excavation. Other excavations would be untanked (i.e. the excavation would not be sealed and groundwater would flow to the excavation across both soil and rock horizons). Whether an excavation is untanked or tanked would influence the actual groundwater inflow rates at each of the construction sites where excavations would occur.

Rock in the vicinity of water-bearing geological features such as faults, dykes and joint swarms has the potential to have relatively high hydraulic conductivity (i.e. ability of groundwater to pass through the pores and fractures in the rock). Identification of such features would be carried out, and significant water-bearing features would be grouted prior to excavation, to reduce the potential for relatively high groundwater inflows to the excavations.

The inflow rates in Table 18-7 provide indicative maximum inflows at both one and two years after excavation to address the requirements of the NSW Aquifer Interference Policy and the Water Sharing Plan.

Excavations would change the direction of existing groundwater flow regime, causing groundwater to flow towards the excavation. There is a potential for contaminants within the groundwater to be mobilised towards the excavation sites, at some locations, particularly near Clyde, Silverwater, Sydney Olympic Park, North Strathfield and The Bays. It is expected that all potential groundwater contamination identified can be managed to acceptable levels with the implementation of appropriate management measures and/or remediation (refer to Chapter 20 (Contamination - Stage 1)).

Table 18-7: Predicted maximum groundwater inflows at Stage 1 construction sites

Construction site	Construction design	Predicted inflow rate (litres/second)		Predicted inflows (megalitres)	
		One year after excavation	Two years after excavation	One year after excavation	Two years after excavation
Westmead metro station	Untanked excavation Tanked crossover cavern[1]	1.5	1.5	54	46
Parramatta metro station	Tanked (soil) Untanked (rock)	2.7	2.7	89	85
Clyde stabling and maintenance facility	Tanked (soil) Untanked (rock)	0.5	0.8	38	40
Silverwater services facility	Untanked	0.3	0.3	11	10
Sydney Olympic Park metro station	Untanked	0.4	0.4	13	12
North Strathfield metro station	Untanked	0.4	0.4	22	12
Burwood North Station	Untanked excavation and shaft Tanked crossover cavern[1]	3.1	2.8	117	91
Five Dock Station	Untanked	1.7	1.7	64	53
The Bays Station	Tanked (soil) Untanked (rock)	10.1	10.1	319	320

Note 1: For the purpose of modelling, these are assumed to be untanked, however would later be tanked

18.6.4 Groundwater recharge

Groundwater recharge is the downward movement of water to the water table (i.e. the saturated part of the geological layer).

Soils are recharged by rainfall and localised irrigation, as well as incidental runoff from impervious surfaces. When rock layers are exposed at surface, there can be direct recharge of the rock aquifers, with transmission primarily through rock joints. Recharge to the rock aquifers elsewhere is by downward percolation through soils.

Table 18-8 discusses the potential impacts on groundwater recharge at each Stage 1 construction site. At most sites, there would potentially be very little change from pervious to impervious surfaces and therefore potential impacts to groundwater recharge would be low.

Table 18-8: Potential impacts on groundwater recharge

Construction site	Potential impacts on groundwater recharge
Westmead metro station	Stage 1 would increase the proportion of impervious areas through the site establishment and excavation which could potentially reduce recharge rates within the footprint of the construction site. The proposed construction site is small relative to the local catchment, and the net impact on regional recharge is not likely to be significant.
Parramatta metro station	Almost all the proposed construction site is currently impervious. Stage 1 would therefore not reduce recharge rates near the site.
Clyde stabling and maintenance facility	About 30 per cent of the construction site is currently pervious. Stage 1 is likely to reduce the groundwater recharge rate in the vicinity of the construction site. This would potentially reduce the groundwater baseflow to Duck Creek and A'Becketts Creek.
Silverwater services facility	Most of the proposed construction site area appears to be pervious and Stage 1 may therefore potentially reduce recharge rates. The proposed construction site is small relative to the local catchment area, and the net impact on regional recharge is not likely to be significant.
Sydney Olympic Park metro station	Most of the proposed construction site is currently impervious. Therefore, Stage 1 would not reduce recharge rates near the construction site.
North Strathfield metro station	Most of the proposed construction site area appears to be pervious and Stage 1 may therefore potentially reduce recharge rates. At a regional scale, the contribution of potential recharge from the site is likely to be minor, and changes to groundwater recharge from the conversion of the site to an impervious area are likely to be minor to negligible.
Burwood North Station	Almost all the proposed construction site is currently impervious. Stage 1 would not reduce recharge rates near the site.
Five Dock Station	Almost all the proposed construction site is currently impervious. Stage 1 would not reduce recharge rates near the site.
The Bays Station	Almost all the proposed construction site is currently impervious. Stage 1 would not reduce recharge rates near the site.

18.6.5 Groundwater quality

Groundwater inflow would be collected and treated during construction via temporary water treatment plants so that discharged water quality is compliant with the ANZECC/ARMCANZ (2000) and ANZG (2018) guideline values and/or meets the requirements of the relevant environment protection licence for Stage 1 prior to entering the local stormwater system.

Existing contaminated groundwater could be mobilised by groundwater drawdown resulting from Stage 1 construction activities. Potential migration of existing contaminants could impact the beneficial uses of groundwater in nearby areas. This may cause volatile contaminants to come into contact with underground structures, creating a risk of vapour intrusion to underground structures. Both risks could impact groundwater users, the health and safety of construction workers, groundwater disposal options and, potentially other drained structures in the areas.

It is possible that saline water could be drawn into the fresh groundwater at Parramatta, Clyde, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock and The Bays. Groundwater supply for primary industries/ industrial/drinking water and sites with groundwater-dependent cultural or spiritual values have not been identified in areas where this potential impact could occur. Based on this, potential saline water intrusion in this area is not likely to impact on the environmental values of the aquifers. Further discussion is provided in Technical Paper 7 (Hydrogeology).

Further information relating to soils and surface water, and contamination are provided in Chapter 19 and Chapter 20 respectively.

18.6.6 Groundwater users

Potential impacts to groundwater users due to groundwater level drawdown during construction were identified at two locations. These are summarised in Table 18-9. No impacts were identified at other locations.

Table 18-9: Potential impacts to groundwater users due to groundwater level drawdown

Construction site	Bore ID/use	Potential impact
Westmead metro station	GW108378 – Commercial/ industrial	At two years after Stage 1 excavation, it is estimated that groundwater level drawdown at this bore would be four metres. This does not satisfy the minimal impact considerations of the NSW Aquifer Interference Policy. Given the depth of the bore, and an assumed groundwater table of about 20 metres below ground surface, the available water column in the bore would be reduced by about two per cent. Based on this, groundwater supply is not likely to be affected at this bore due to Stage 1.
Burwood North Station	GW305646 – Water Supply	It is estimated that groundwater level drawdown at this bore would be two metres at two years after Stage 1 excavation. Two metres is at the limit of minimal impact considerations as per the NSW Aquifer Interference Policy (NSW Office of Water, 2012), and considering that the modelling is conservative, it is unlikely that this bore would be impacted. The bore is not listed as active however a site inspection could confirm the viability of this bore. If it is viable, the bore would be monitored throughout construction and make good measures implemented if a loss of yield were to occur.

18.6.7 Groundwater dependent ecosystems

The tunnel alignment would pass within 500 metres of groundwater dependent ecosystems in the suburbs of Westmead, Parramatta, Clyde, Silverwater and Sydney Olympic Park. Given the tunnel would be tanked (sealed), the groundwater level drawdown is likely to be insignificant and potential impacts to groundwater dependent ecosystems due to tunnel excavation are not expected.

For high priority groundwater dependent ecosystems (associated with Cumberland Plain Woodland) near Westmead and Parramatta, the likelihood of these ecosystems being impacted by the groundwater level drawdown associated with Stage 1 is low. The groundwater level drawdown in the sandstone induced by station excavation is not likely to cause direct groundwater level drawdown within these geological units.

Negligible impacts are expected at the saltmarsh estuaries near Sydney Olympic Park metro station and North Strathfield metro station construction sites as these sites are located outside of the impacted groundwater zone.

Potential saline water intrusion into groundwater is not likely to impact groundwater dependent ecosystems. Groundwater dependent ecosystems that have been identified in the vicinity of potential saline water intrusion (see Section 18.6.5) are tolerant of saline groundwater.

Further discussion on potential impacts to groundwater dependent ecosystems is provided in Chapter 22 (Biodiversity – Stage 1).

18.6.8 Interactions of groundwater with surface water

Interactions between surface water and groundwater due to tunnelling activities are not expected due to the depth of tunnels. However, it is not known whether groundwater at surface construction sites may potentially contribute to baseflow of nearby surface water bodies, based on the current level of site investigations. Notwithstanding, several locations have been identified where there is potential for interaction between groundwater and surface water to be affected due to groundwater drawdown. These potential interactions of groundwater with surface water are summarised in Table 18-10.

Additional site investigation at the locations of the creeks would be required to confirm the existing baseflow contribution to these creeks. This would include investigation of ground conditions, groundwater levels, and stream flows. Further assessment of the potential change in baseflow due to Stage 1 would be undertaken based on the findings of the investigation.

Table 18-10: Potential interactions of groundwater with surface water

Construction site	Surface water bodies near the construction site	Potential impact
Westmead metro station	Domain Creek and Toongabbie Creek	It is possible that groundwater level drawdown could result in reduced groundwater flow towards the creeks, and ultimately reduced baseflow to the creeks. However, as baseflows are likely to be a minor component of streamflow, the significance of this potential change is likely to be low. Therefore it is considered unlikely that a reduction in stream flow would occur that could impact the groundwater dependent ecosystem; Forest Red Gum - Rough-barked Apple grassy woodland.
Parramatta metro station	Clay Cliff Creek Parramatta River	Clay Cliff Creek is a concrete lined channel and is not likely to receive groundwater baseflow. Stage 1 excavation at Parramatta metro station construction site is not likely to reduce baseflow contributions to streams.
Clyde stabling and maintenance facility	A'Becketts Creek and Duck Creek	It is possible that groundwater level drawdown due to excavation of the shaft and dive could potentially reduce baseflow contribution and reduce stream flows to A'Becketts Creek and Duck Creek. However, as baseflows are likely to be a minor component of streamflow, the significance of this change in flows is likely to be low. If there is existing groundwater baseflow contribution to A'Becketts Creek and Duck Creek, then Stage 1 has the potential to reduce that baseflow contribution and reduce stream flows. Stage 1 could potentially cause reduced baseflow to A'Becketts Creek and Duck Creek due to groundwater level drawdown, and the reduced groundwater recharge caused by converting pervious ground to impervious ground at the Sydney Speedway. A potential reduction in stream flow could impact the groundwater dependent ecosystem; Mangrove Forests located along Duck Creek. Other aquatic ecosystems could also potentially be impacted if baseflows are reduced (which is considered unlikely). Potential groundwater level drawdown at Duck Creek is likely to be negligible. However, a proportion of the inflows to the shaft may be indirectly sourced from the waters of Duck Creek which may leak into the underlying and adjacent ground, and potentially migrate towards the shaft excavation. However, the significance of this impact is likely to be low, due to negligible groundwater drawdown.

Construction site	Surface water bodies near the construction site	Potential impact
Sydney Olympic Park metro station	Haslams Creek, the Mason Park wetlands, Bicentennial Park wetlands and the Brickpit	It is possible that groundwater level drawdown at distance from these surface water bodies could result in reduced groundwater flow towards the surface water bodies, which could potentially mean receiving reduced baseflow. Reduction in stream flow may impact groundwater dependent ecosystem; Common Reed, Swamp Oak swamp forest, Mangrove Forests and Saltmarsh located along Haslams Creek and in the Bicentennial Park wetlands and the Mason Park wetlands. The potential impact on Haslams Creek is likely to be low as baseflows are likely to be a minor component of creek stream flow, and the groundwater modelling undertaken is conservative. For the Bicentennial and Mason Park wetlands, groundwater baseflows are likely to be a minor component of water contributing to the wetland systems, therefore the potential impact is likely to be low. Rainfall and tidal flows from the Parramatta River are likely to be the dominant source of water for the wetland systems.
North Strathfield metro station	Powells Creek, the Mason Park wetlands, Powells Creek Reserve and Bicentennial Park	It is possible that groundwater level drawdown could result in reduced groundwater flow towards the creek, and ultimately reduced baseflow to the creek. However, as baseflows are likely to be a minor component of streamflow, the significance of this potential impact is likely to be low. If a reduction in stream flow occurred it could impact groundwater dependent ecosystem; Common Reed, Swamp Oak swamp forest, Mangrove Forests and Saltmarsh. Other aquatic ecosystems could also likely be impacted if baseflows are reduced.
Burwood North Station	St Lukes Park Canal and Barnwell Park Canal	Surface water-groundwater interaction is not likely to be affected by groundwater level drawdown. Groundwater is not likely to contribute to these waters as they are concrete-lined channels. The potential naturalisation of these channels by Sydney Water would modify the banks of the channels but would retain the concrete-lining at the base and centre-line of the channels.
Five Dock Station	Barnwell Park Canal and Iron Cove Creek	Groundwater is not likely to contribute to these waterways as they are concrete-lined channels. The naturalisation of these channels by Sydney Water would modify the banks of the channels but would retain the concrete-lining at the base and centre-line of the channels. Connection between surrounding groundwater and the concrete-lined channel is not likely, and groundwater level drawdown is not likely to affect groundwater interaction with these surface waterways. Water from Kings Bay may also be indirectly drawn into the groundwater to the south of the bay causing intrusion of saline water into groundwater (see Section 18.6.5).
The Bays Station	White Bay	A proportion of inflow to the station excavation is likely to be indirectly sourced from White Bay, as bay waters could be drawn into the groundwater system. Therefore, it is possible that the excavation could cause intrusion of saline water into groundwater (see section 18.6.5).

18.6.9 Policy compliance

Consistency with minimum harm criteria

The *Water Management Act 2000* includes the concept of ensuring 'no more than minimal harm' for both the granting of water access licences and the granting of approvals. While Stage 1 does not require a licence/approval under the *Water Management Act 2000*, the minimal harm criteria in the NSW Aquifer Interference Policy (NSW Office of Water, 2012) have been used for the purposes of assessment (refer to Table 18-11).

Table 18-11: Minimal harm assessment

Minimal harm considerations	Assessment
Water table	
1. **Less than or equal to ten per cent cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any:** a. **High priority groundwater dependent ecosystem; or** b. **High priority culturally significant site;** **listed in the schedule of the relevant water sharing plan.** **A maximum of a two-metre cumulative decline at any water supply work.**	High priority groundwater dependent ecosystems (terrestrial vegetation) include the Grey Box - Forest Red Gum woodland on the flats of the Cumberland Plain near Westmead metro station and Parramatta metro station construction sites, and the Saltmarsh in estuaries of the Sydney Basin Bioregion and South east Corner Bioregion near Sydney Olympic Park metro station and North Strathfield metro station construction sites. Groundwater level drawdown is not predicted at the location of these ecosystems, except for the Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain to the east of Westmead metro station construction site. However, this ecosystem grows in clay alluvium and this geological unit is likely to be of relatively low permeability, with a potential perched water table present (which may be temporary) upon which these groundwater dependent ecosystems may intermittently rely. The groundwater level drawdown in the sandstone induced by station excavation is not likely to cause direct groundwater level drawdown within a potential perched aquifer in the clay alluvium. The likelihood of this ecosystem being impacted by the groundwater level drawdown associated with Stage 1 is therefore low. The Greater Metropolitan Regional Groundwater Sources Water Sharing Plan does not list any high priority culturally significant in the vicinity of Stage 1. Groundwater modelling has estimated a groundwater level drawdown of two metres at two years after excavation at water supply bore GW305646, and four metres at two years after excavation at water supply bore GW108378. This does not satisfy the minimal impact considerations of the NSW Aquifer Interference Policy. However, the available water column in bore GW108378 would be reduced by Stage 1 by about two per cent. Based on this, groundwater supply is not likely to be affected at this bore due to Stage 1. At bore GW305646, site inspection would be carried out to confirm the current viability of this bore. If viable, the bore would be monitored throughout construction. Make good measures would be implemented if a loss of yield were to occur.

Minimal harm considerations	Assessment
2. If more than ten percent cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: a. **High priority groundwater dependent ecosystem; or** b. **High priority culturally significant site;** **listed in the schedule of the relevant water sharing plan if appropriate studies demonstrate to the Minister's satisfaction that the variation would not prevent the long-term viability of the dependent ecosystem or significant site.** **If more than a two-metre decline cumulatively at any water supply work, then make good provisions should apply.**	Item (1) responses apply. Mitigation measures to address impacts have been identified (see Section 18.8).
Water pressure	
1. **A cumulative pressure head decline of not more than a two-metre decline, at any water supply work.**	Mitigation measures to address potential impacts at bore GW305646 have been identified (see Section 18.8).
2. **If the predicted pressure head decline is greater than consideration (1) above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline would not prevent the long-term viability of the affected water supply works unless make good provisions apply.**	Mitigation measures to address potential impacts at bore GW305646 have been identified (see Section 18.8).
Water quality	
1. **Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.**	Where contaminated groundwater, saline groundwater, or acid sulfate soils are present within the groundwater level drawdown zone of influence, Stage 1 has the potential to alter the groundwater quality from the contaminant/saline water sources to the excavations. If there is a beneficial use in this zone, then this beneficial use could be lowered. If this process occurs, this requirement of the Aquifer Interference Policy would not be satisfied and mitigation measures have been identified (see Section 18.8).
2. **If consideration (1) is not met then appropriate studies would need to demonstrate to the Minister's satisfaction that the change in groundwater quality would not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.**	Water supply works (WaterNSW-registered groundwater bores) are not expected to be impacted by groundwater quality changes induced by Stage 1. Changes to groundwater quality near the groundwater dependent ecosystems due to Stage 1 are not expected.
Additional considerations	
Any advice provided to a gateway panel, the Planning and Assessment Commission or the Minister for Planning on a State significant development or State significant infrastructure would also consider the potential for: • **Acidity issues to arise, for example exposure of acid sulfate soils** • **Water logging or water table rise to occur, which could potentially affect land use, groundwater dependent ecosystems and other aquifer interference activities.** **Specific limits would be determined on a case-by-case basis, depending on the sensitivity of the surrounding land and groundwater dependent ecosystems to waterlogging and other aquifer interference activities to water intrusion.**	Where the presence of acid sulfate soils and potential groundwater level drawdown within those soils is confirmed, an acid sulfate soils management plan would be developed for Stage 1 to reduce the risks associated with oxidation/activation of acid sulfate soils (refer to Chapter 19 (Soils and surface water quality – Stage 1)). The risk of water logging or water table rise is assessed to be negligible due to Stage 1 excavation works.

Consistency with Water Sharing Plan rules

All groundwater and surface water in the Stage 1 construction footprint is managed through the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011. The Water Sharing Plan provides rules to manage and allocate the groundwater resource, including specific rules on taking groundwater near high priority groundwater dependant ecosystems, groundwater dependent culturally significant sites, sensitive environmental areas, and near licenced bores. The groundwater source relevant to Stage 1 is the 'Sydney Basin Central'. While Stage 1 does not require a licence and/or approval under the *Water Management Act 2000*, these rules have been used for the purposes of assessment (refer to Table 18-12).

Table 18-12: Compliance with Water Sharing Plan rules

Rule	Assessment
Part 7 – Rules for granting access licences	A water access licence is not required for Stage 1.
Part 8 – Rules for managing access licences	A water access licence is not required for Stage 1.
Part 9 – Rules for water supply work approvals	The *Water Management Act 2000* requires that a water supply work approval is obtained for groundwater ingress to tunnels, stations and services facilities. The approval process would determine distance restrictions to minimise interference between water supply works. In the case of Stage 1, the water supply works include the excavations and permanently drained structures, including the station boxes, shafts, dives and services facilities.
Part 9 – 39 Distance restrictions to minimise interference between water supply works	While some of the distance restrictions identified in Part 9 – 39 are not satisfied, water supply bores (approved water supply works that are reported to supply water) would not be adversely impacted.
Distance restriction from an approved water supply work nominated by another access licence is 400 metres	Stage 1 sites lie within 400 metres of approved water supply works under other access licences.
Distance restriction from an approved water supply work for basic landholder rights only is 100 metres	Stage 1 sites lie within 100 metres of approved water supply works for basic landholder rights.

Rule	Assessment
Distance restriction from the property boundary is 50 metres	Stage 1 sites lie within 50 metres of property boundaries.
Distance restriction from an approved water supply work nominated by a local water utility or major utility access licence is 1000 metres	Water supply works nominated by a local water utility or major utility access licence were not identified within 1000 metres of the Stage 1 sites.
Distance restriction from a Department observation bore is 200 metres	Observation bores/monitoring piezometers operated and maintained by WaterNSW were not identified within 200 metres of the Stage 1 sites. While some of the distance restrictions identified in Part 9 – 39 are not satisfied, water supply bores (approved water supply works that are reported to supply water) would not be adversely impacted.
Part 9 – 40 Rules for water supply works located near contamination sources	Construction sites with the potential for contaminated groundwater include Westmead metro station, Parramatta metro station, Clyde stabling and maintenance facility, Silverwater services facility, Sydney Olympic Park metro station, Burwood North Station and The Bays Station. Restrictions on water supply works approvals would apply to Stage 1 where construction dewatering and permanent drainage infrastructure for Stage 1 are near ground contamination. Refer to Chapter 20 (Contamination - Stage 1) for information on contamination.
Part 9 – 41 Rules for water supply works located near sensitive environmental areas	Stage 1 sites with the potential to induce groundwater level drawdown are not located within 100 metres of a high priority groundwater dependent ecosystem listed in Schedule 4 of the relevant Water Sharing Plan, or within 40 metres of the top of the high bank of a lagoon or any third order or higher order stream, or within 100 metres of the top of an escarpment. The Stage 1 excavations lie greater than 40 metres from first or second order streams.
Part 9 – 42 Rules for water supply works located near groundwater dependent culturally significant sites	Groundwater-dependent culturally sensitive sites have not been identified within 100 metres of the Stage 1 sites.
Part 9 – 44 Rules for water supply works located within distance restrictions	Stage 1 sites that do not comply with the above distance restrictions could have limitations on groundwater take under the Water Sharing Plan. However, with implementation of the mitigation measures, it is expected that such limitations would not be required.
Part 10 – Access licence dealing rules	As per response to Part 7.

18.7 Cumulative impacts

Potential cumulative impacts were considered for assessment based on the likely interactions of Stage 1 with other projects and plans that met the adopted screening criteria. The approach to assessment and the other projects considered are described further in Appendix G (Cumulative impacts assessment methodology – Stage 1).

Potential cumulative groundwater impacts include:

- Overlapping of groundwater drawdown associated with the excavation of individual Stage 1 stations and shafts. This could potentially occur in areas where the drawdown extends to the adjacent excavation impact; for example at North Strathfield, Burwood North and Five Dock
- Existing and proposed infrastructure with drained excavations/structures near to the Stage 1 excavations, including building basements and excavations associated with the WestConnex M4 East and the Western Harbour Tunnel and Beaches Link.

Based on the groundwater assessment provided in the Environmental Impact Statement for the WestConnex (M4 East) project (WestConnex Delivery Authority, 2015), the WestConnex (M4 East) tunnels are predicted to induce groundwater level drawdown in the vicinity of North Strathfield metro station, Burwood North Station and Five Dock Station construction sites. The Environmental Impact Statement for the WestConnex (M4 East) project predicted long term (steady state) drawdown only and does not present predicted drawdowns during WestConnex (M4 East) construction or in the early years of operation. The predicted drawdown for Stage 1 of Sydney Metro West indicates that there may be cumulative drawdown in some areas in the vicinity of North Strathfield metro station and Five Dock Station construction sites due to WestConnex (M4 East) and Stage 1, and that this cumulative drawdown could be several metres greater than that predicted for Stage 1 alone. The drawdown predicted in the vicinity of Burwood North Station construction site due to WestConnex (M4 East) is significantly greater than the drawdown predicted due to Stage 1.

Based on the predicted groundwater level drawdown due to the WestConnex (M4 East) tunnels, the potential impacts to potential acid sulfate soils, groundwater dependent ecosystems, groundwater users (domestic supply bores) and contaminant migration that have been identified due to the Stage 1 excavations for North Strathfield metro station, Burwood North Station and Five Dock Station construction sites may have already occurred (at least partially) due to the existing excavation of the WestConnex (M4 East) tunnels.

The groundwater assessment provided in the Environmental Impact Statement for the WestConnex M4-M5 Link project (WestConnex Delivery Authority, 2017), which includes the Rozelle Interchange, does not predict long term (steady state) groundwater level drawdown for the WestConnex M4-M5 Link that lies within the predicted zones of groundwater level drawdown due to Stage 1. Based on this, the WestConnex M4-M5 Link tunnels are not expected to contribute cumulative impacts to Stage 1.

The Environmental Impact Statement for the Western Harbour Tunnel and Warringah Freeway Upgrade (Roads and Maritime Services, 2019) shows that the tunnels associated with this project lie to the west of The Bays Station construction site. Groundwater modelling results reported for this project indicate that it is likely to cause groundwater level drawdown in the vicinity of The Bays Station construction site. Based on the predicted groundwater level drawdown at the end of tunnel construction for the project, an additional groundwater level drawdown of up to three metres would be expected at The Bays Station construction site. This drawdown would be additive to the drawdown induced by Stage 1. The potential impacts of this cumulative drawdown and their significance are not expected to differ from those predicted for Stage 1 alone.

18.8 Management and mitigation measures

18.8.1 Approach to management and mitigation

Groundwater issues would be managed in accordance with Sydney Metro's Construction Environmental Management Framework which is described in Chapter 27 (Synthesis of the Environmental Impact Statement).

The Construction Environmental Management Framework requires the preparation of a Groundwater Management Plan and includes the following groundwater management objectives:

- Reduce the potential for drawdown of surrounding groundwater resources
- Prevent the pollution of groundwater through appropriate controls
- Reduce the potential impacts on groundwater dependent ecosystems.

18.8.2 Mitigation measures

The mitigation measures that would be implemented to address potential groundwater and ground movement impacts are listed in Table 18-13.

Table 18-13: Mitigation measures – groundwater and ground movement

Reference	Impact/issue	Mitigation measure	Applicable location(s)[1]
GW1	Loss of groundwater available to existing groundwater (bore supply) users	Site inspection would be carried out on private domestic supply bore GW305646 to confirm the current viability of that bore. If found to be viable, the bore would be monitored throughout construction. Make good measures would be implemented if a loss of yield were to occur.	BNS
GW2	Potential reduced baseflow to Toongabbie Creek, Domain Creek, A'Becketts Creek, Duck Creek, Haslams Creek, Powells Creek and the Mason Park wetlands, Bicentennial Park wetlands, Brickpit and Powells Creek Reserve	A review of additional geotechnical and hydrogeology data would be undertaken to confirm the geological and groundwater conditions and determine, based on these local conditions, whether predicted groundwater drawdown from Stage 1 is likely to occur in the vicinity of these creeks. Where the additional data review shows local conditions and predicted groundwater drawdown are likely to cause surface water-groundwater interaction, then additional site investigations (in accordance with GW3) would be undertaken for those creeks or surface water bodies.	WMS, CSMF, SOPMS, NSMS
GW3	Potential reduced baseflow to Toongabbie Creek, Domain Creek, A'Becketts Creek, Duck Creek, Haslams Creek, Powells Creek and the Mason Park wetlands, Bicentennial Park wetlands, Brickpit and Powells Creek Reserve Requirements for baseline monitoring of hydrological attributes	Additional site investigations would be carried out at creeks or surface water bodies where the additional data review in GW2 shows there is a likely surface water / groundwater interaction. This would involve baseline monitoring of creek flows (streamflow gauging) prior to construction, and baseflow streamflow analysis to confirm the existing groundwater baseflow contribution to streamflow for each creek. Where a significant reduction in baseflow is predicted due to Stage 1, design responses would be implemented at station and shaft excavations to reduce potential baseflow loss.	WMS, CSMF, SOPMS, NSMS
GW4	Requirements for baseline monitoring of hydrological attributes Migration of contaminants in groundwater and reduction in beneficial uses of aquifers	Monitoring of groundwater levels and quality at the site area would occur before, during and after construction. This would also include monitoring of potential contaminants of concern. Groundwater level data would be regularly reviewed during and after construction by a qualified hydrogeologist.	WMS, PMS, CSMF, SSF, SOPMS, NSMS, BNS, FDS, TBS
GW5	Ground movement and settlement	A detailed geotechnical model for Stage 1 would be developed and progressively updated during design and construction. The detailed geotechnical model would include: • Assessment of the potential for damage to structures, services, basements and other sub-surface elements through settlement or strain • Predicted changes to groundwater levels, including at nearby water supply works. Where building damage risk is rated as moderate or higher (as per the CIRIA 1996 risk-based criteria), a structural assessment of the affected buildings/ structures would be carried out and specific measures implemented to address the risk of damage. Where a significant exceedance of target changes to groundwater levels are predicted at surrounding land uses and nearby water supply works, an appropriate groundwater monitoring program would be developed and implemented. The program would aim to confirm no adverse impacts on groundwater levels or to appropriately manage any impacts. Monitoring at any specific location would be subject to the status of the water supply work and agreement with the landowner.	Where required
GW6	Ground movement and settlement	Condition surveys of buildings and structures in the vicinity of the tunnel and excavations would be carried out prior to the commencement of excavation at each site.	Where required

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (e.g. tunnel boring machine works); PSR: Power supply routes.

18.8.3 Interactions between mitigation measures

Mitigation measures in other chapters that are relevant to the management of potential groundwater and ground movement impacts include:

- Chapter 19 (Soils and surface water quality – Stage 1), specifically measures which address acid sulfate soils, interaction with contaminated land and requirements for treated water discharge
- Chapter 20 (Contamination – Stage 1) specifically measures which address the management of potential contamination
- Chapter 22 (Biodiversity – Stage 1), specifically measures which addresses potential drawdown effects on groundwater dependent ecosystems.

Together, these measures would minimise the potential impacts of Stage 1.

There are no mitigation measures identified in the assessment of other environmental aspects that are likely to affect the assessment of groundwater and ground movement impacts.

19 Soils and surface water quality – Stage 1

19 Soils and surface water quality – Stage 1

This chapter provides an assessment of the potential impacts of Stage 1 on soils and surface water quality and identifies mitigation measures to address these impacts. This chapter draws on information in Technical paper 7 (Hydrogeology).

19.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to soils and surface water quality, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 19-1.

Table 19-1: Secretary's Environmental Assessment Requirements – Soils and surface water quality Stage 1

Reference	Requirement	Where addressed
8. Contamination and soils		
8.1	Commitments made in Section 9.8.2 of the Scoping Report.	Sections 19.6.1 and 19.7
9. Water – Hydrology and flooding		
9.2	A water balance for ground and surface water including the proposed intake and discharge locations, volume, frequency and duration.	Section 19.6.2
10. Water – Quality		
10.1	Surface and groundwater quality impacts including: a. Identifying and estimating the discharge water quality and degree of impact that any discharge(s) may have on the receiving environment, including consideration of all pollutants that pose a risk of non-trivial harm to human health and the environment; b. identifying the rainfall event that the water quality protection measures will be designed to cope with; and c. assessing the significance of any identified impacts including consideration of the relevant ambient water quality outcomes.	Section 19.6.2
10.2	Demonstrating how Stage 1 will, to the extent that the project can influence, ensure that: a. where the NSW WQOs for receiving waters are currently being met they will continue to be protected; and b. where the NSW WQOs are not currently being met, activities will work toward their achievement over time; and c. justify, if required, why the WQOs cannot be maintained or achieved over time.	Section 19.6.2

19.2 Legislative and policy context

The legislative and policy context for soils and surface water quality is described in Section 8.10 (Soils and surface water quality - Concept).

The following additional guidelines were also considered for Stage 1:

- Acid Sulfate Soils Assessment Guidelines (Department of Planning, 2008)
- Managing Urban Stormwater: Soils and Construction, Volume 1 (Landcom, 2004)
- Managing Urban Stormwater: Soils and Construction, Volume 2 (Department of Environment and Climate Change, 2008)
- Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (Department of Environment and Conservation, 2004)
- Using the ANZECC Guidelines and Water Quality Objectives in NSW (Department of Environment and Conservation, 2006)
- Guidelines for Managing Risks in Recreational Waters (NHMRC, 2008)
- Sydney Harbour Water Quality Improvement Plan (Sydney Metropolitan Catchment Management Authority (SMCMA, 2010).

19.3 Assessment approach

The assessment methodology for the soils and surface water quality impact assessment involved:

- A review of publicly available data and web-based information searches, including:
  - NSW Department of Environment, Climate Change and Water's Soil Landscapes of Sydney 1:100,000 Sheet (Tille et al., 2009)
  - Soil Landscapes of the Penrith 1:100,000 Sheet (Hazelton et al., 2010)
  - NSW Soil and Land Information System (NSW Office of Environment and Heritage, 2019a)
  - Water quality data collected from Sydney Water, Parramatta City Council, Cumberland City Council, University of Western Sydney and the WestConnex M4 East project
- Meeting with the Environment Protection Authority in February 2019, to discuss the approach to the surface water quality assessment
- Identification of sensitive receiving environments, using aquatic habitat as an indicator as assessed against the NSW Department of Primary Industries (DPI) Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013) and Fish Passage Requirements for Waterway Crossings (Fairfull & Witheridge 2003)
- Identification of the potential for Stage 1 to disturb acid sulfate soils and the associated impacts
- Consideration of the potential impacts of Stage 1 associated with erosion and sedimentation
- Identification of potential impacts of Stage 1 on surface water quality, including an indicative water balance
- Development of mitigation measures to address potential soils and surface water quality impacts.

19.4 Avoidance and minimisation of impacts

The design development of Stage 1 has focussed on avoiding or minimising potential soil and surface water quality impacts. This has included minimising the extent of construction disturbance and avoiding direct impact on watercourses where possible.

19.5 Existing environment

19.5.1 Soils

Soil types

The geology of Stage 1 is dominated by Quaternary Age alluvial/fluvial sediments and fill, along with Wianamatta Group Ashfield Shale and Hawkesbury Sandstone – refer to Chapter 18 (Groundwater and ground movement – Stage 1). The Soil Landscapes of Sydney 1:100,000 Sheet (Tille et al., 2009) and Penrith 1:100,000 Sheet (Hazelton et al., 2010) identifies a number of soil types within Stage 1 derived from the underlying geological units. The soil units and their characteristics are described in Table 19-2 and their location in relation to Stage 1 is shown in Figure 19-1.

Table 19-2: Soil units underlying Stage 1

Soil unit	Location	Description
Birrong	Present along the entire alignment and at all construction sites	• Landscape: found on level to gently undulating alluvial floodplain draining Wianamatta Group shale, with slopes less than three per cent. Broad valley flats and extensively cleared tall open forest and woodland • Soil: deep soils (less than 250 centimetres) on older alluvial terraces and current floodplain • Limitations: localised flooding, high soil erosion hazard, saline subsoils, seasonal waterlogging, and very low soil fertility
Blacktown	Present along the entire alignment and at all construction sites	• Landscape: found on gently undulating rises on Wianamatta Group shales, with slopes of less than five per cent and local reliefs of up to 30 metres • Soils: strongly acidic and hard setting soils • Limitations: low fertility, high aluminium toxicity, localised salinity and sodicity, low wet strength, low permeability, and low available water holding capacity
Disturbed terrain	• Clyde stabling and maintenance facility • Sydney Olympic Park metro station site • The Bays Station site • Tunnel alignment between Westmead and The Bays Station	• Landscape: found on a variety of landscapes ranging from level plain to hummocky terrain that has been extensively disturbed by human activity. Slopes are typically less than five per cent and local reliefs of less than 10 metres • Soils: the original soil has been completely disturbed, removed or buried. Landfill may include soil, rock, building and waste material with a cap of sandy loam. Soil may by strongly acidic to strongly alkaline • Limitations: low fertility, low wet strength, low availability water capability, high permeability, localised toxicity/acidity and/or alkalinity, potential mass movement hazard
Glenorie	Present along the entire alignment and at all construction sites	• Landscape: found on undulating to rolling low hills on Wianamatta Group shales, with slopes typically between five per cent and 20 per cent. • Soils: shallow to moderately deep on crests (less than 100 centimetres) moderately deep on upper slopes (70 centimetres to 150 centimetres) and deep on lower slopes (greater than 200 centimetres • Limitations: high soil erosion hazard, localised impermeable soil and moderate soil reactivity
Gymea	Present along the alignment from Burwood North Station site, eastwards to Five Dock Station, and The Bays Station sites	• Landscape: found on undulating to rolling rises and low hills on Hawkesbury Sandstone, with slopes between 10 per cent and 25 per cent and local relief up to 80 metres • Soils: shallow to moderately deep (30 centimetres to 100 centimetres) • Limitations: localised steep slopes, high soil erosion hazards, shallow highly permeable soil and very low soil fertility
Hawkesbury	Present along the alignment from Burwood North Station site to Five Dock Station, and The Bays Station sites	• Landscape: found on rugged, rolling to very steep hills on Hawkesbury Sandstone, with slopes greater than 25 per cent and local reliefs up to 200 metres • Soils: Shallow (less than 50 centimetres) discontinuous lithosols/ siliceous sands associated with rock outcrops, with earthy sands and some yellow podzolic soils on the inside of benches and along rock joints and fractures • Limitations: extreme soil erosion hazard, mass movement hazard, steep slopes, high permeability soil and low soil fertility

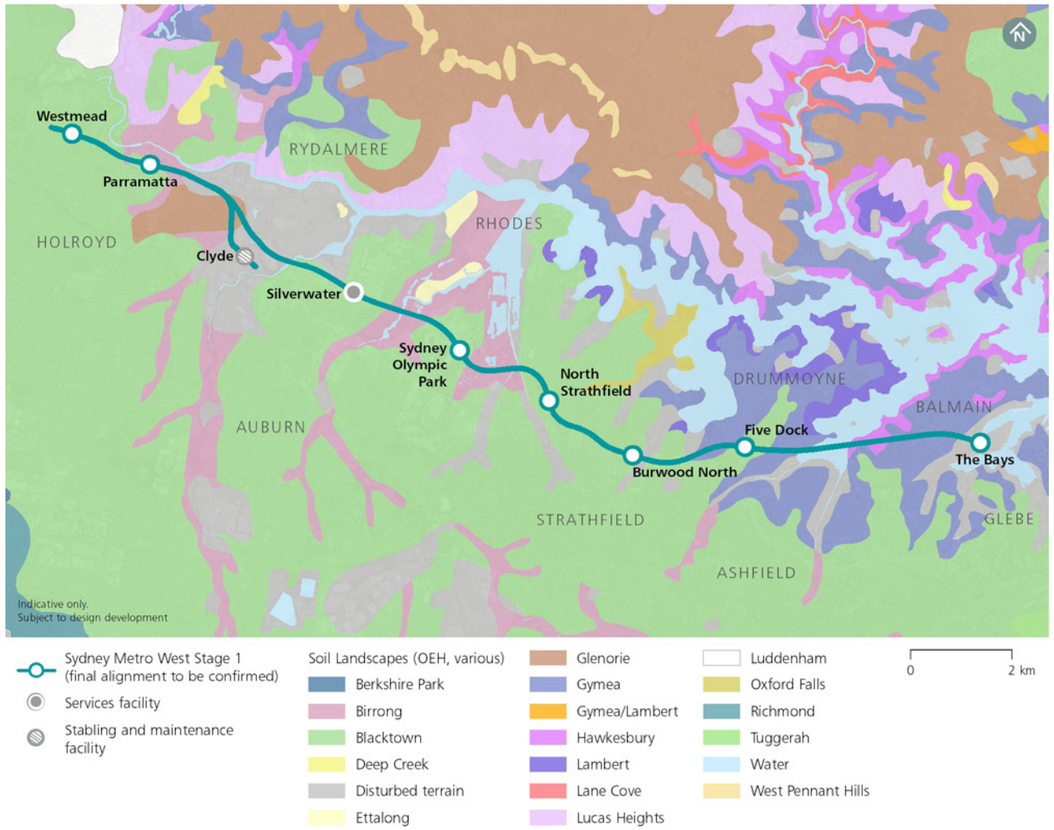

Figure 19-1: Soil units underlying Stage 1

Soil salinity

Soil salinity refers to the movement and concentration of salt in soils as a result of weathering rock materials, historic inland seas and deposition of salt from the ocean onto land by wind or rain. Saline soils can degrade ecosystems and habitats and reduce the productive agricultural capacity of land (Agriculture Victoria, 2017). The NSW Soil and Land Information System and the Salinity Hazard Report for Catchment Action Plan upgrade – Sydney Metropolitan CMA (Winkler et al, 2012) were reviewed to identify the probability for saline soils to be present within Stage 1. The results of the review are shown in Table 19-3.

Table 19-3: Probability of saline soils to be present within Stage 1

Location	Probability for saline soils
Between Westmead metro station and Parramatta metro station sites	• High
Between Parramatta metro station and Burwood North Station sites	• Very high
Between Burwood North Station and The Bays Station sites	• High to very high (elevated areas) • Very low (low elevation areas)

Acid sulfate soils

Acid sulfate soils are the common name given to naturally occurring sediments and soils containing iron sulfides (principally iron sulfide or iron disulfide or their precursors). Exposure of the sulfide in these soils to oxygen as a result of drainage, groundwater drawdown or excavation leads to the generation of sulfuric acid. Areas of acid sulfate soils are typically found in low-lying and flat locations that are often swampy or prone to flooding.

Acid sulfate soils risk maps from the former NSW Office of Environment and Heritage (now part of NSW Department of Planning, Industry and Environment) were reviewed to assess the probability of acid sulfate soils being present in proximity of Stage 1. As shown in Figure 19-2, most of Stage 1 is located in areas having “no known occurrence” of acid sulfate soils.

Areas around the Parramatta River, Rosehill, Silverwater, Sydney Olympic Park and White Bay are identified as "disturbed terrain". These areas are often located on reclaimed land, within dredged/mined areas, or on fill and/or alluvium and are often associated with the potential presence of acid sulfate soils. Based on this information, there is potential to encounter acid sulfate soils at the following Stage 1 construction sites:

- Parramatta metro station
- Clyde stabling and maintenance facility
- The Bays Station.

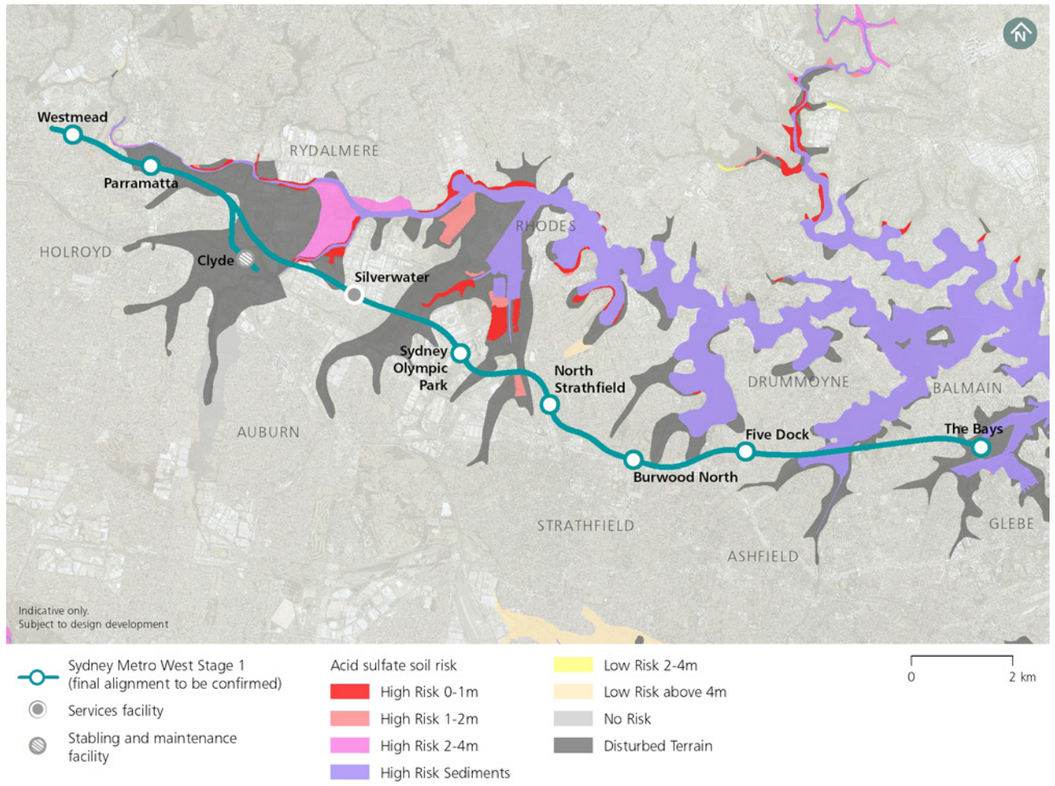

Figure 19-2: Acid sulfate soil classification risk within Stage 1

19.5.2 Surface water

Catchments and watercourses

Stage 1 (except for The Bays Station) is located within the upper estuary of the Parramatta River catchment, one of the main tributaries of Sydney Harbour. The Bays Station drains to White Bay in the lower estuary of Sydney Harbour. The Parramatta River catchment and Sydney Harbour includes the Sydney CBD and significant commercial districts of North Sydney and Parramatta. The catchment is highly urbanised and altered from its natural state, with pockets of open spaces and parkland. These land uses influence the water quality and quantity and speed of flows within the catchment. Most of the catchment is estuarine, up to the tidal limit at Charles Street weir in Parramatta, with freshwater watercourses in the upper catchments of the tributaries of Parramatta River. The catchment lies over the Cumberland Plain and is relatively flat, with elevation ranging from 140 metres Australian Height Datum in the north-west of the catchment to sea level in the east.

Stage 1 would drain to a number of watercourses which are sub-catchments of Parramatta River. Many of the watercourses are greatly modified with creek systems extensively channelised or hard-edged with concrete. Relevant watercourses within the catchment for Stage 1 are shown in Table 19-4 and Figure 19-3.

Table 19-4: Watercourses relevant to Stage 1

Stage 1 construction site	Watercourse	Receiving waters
Westmead metro station	• Domain Creek	• Parramatta River
Parramatta metro station	• Parramatta River • Clay Cliff Creek	• Parramatta River
Clyde stabling and maintenance facility	• Duck River • Duck Creek • A'Becketts Creek	• Parramatta River
Silverwater services facility	• Duck River	• Parramatta River
Sydney Olympic Park metro station	• Haslams Creek	• Homebush Bay
North Strathfield metro station	• Saleyards Creek • Powells Creek	• Homebush Bay
Burwood North Station	• St Lukes Park Canal • Barnwell Park Canal	• Canada Bay • Hen and Chicken Bay
Five Dock Station	• Dobroyd Canal/Iron Cove Creek	• Iron Cove
The Bays Station	• White Bay	• Sydney Harbour

Figure 19-3: Watercourses relevant to Stage 1

Water quality

The NSW Water Quality and River Flow Objectives (NSW Department of Environment, Climate Change and Water, 2006) provide a number of environmental values for the Sydney Harbour and Parramatta River regional catchment as described in Chapter 8 (Concept environmental assessment).

Table 19-5 shows the environmental values assigned to the watercourses relevant to Stage 1.

Table 19-5: Assigned environmental values for watercourses and receiving waters relevant to Stage 1

Watercourse and/or receiving waters	Environmental value				
	Aquatic ecosystems	Visual amenity	Primary contact recreation	Secondary contact recreation	Aquatic foods (cooked)
Domain Creek	●	●			
Parramatta River and Sydney Harbour	●	●	●	●	●
Clay Cliff Creek	●	●		●	
Duck River	●	●		●	
Haslams Creek	●	●		●	
Saleyards Creek		●		●	
Powells Creek	●	●			
St Lukes Park	●	●			
Barnwell Park	●	●			
Dobroyd Canal/Iron Cove Creek	●	●			
White Bay	●	●	●	●	

The water quality of watercourses relevant to Stage 1 is influenced by several factors including:

- Current and historical polluting land uses within the catchments
- Stormwater and sewage overflows and leachate from contaminated and/or reclaimed land
- Urbanisation of the catchments and subsequent reduction in permeable area, increasing run-off and pollutant loads entering waterways
- Illegal dumping.

A review of available existing water quality data collected from Sydney Water, Parramatta City Council, Cumberland City Council, University of Western Sydney and the WestConnex M4 East project indicates the watercourses relevant to Stage 1 are generally in poor condition and are representative of a heavily urbanised system. The water quality of each watercourse as assessed against the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000; Australian and New Zealand Governments and Australian state and territory governments, 2018) is summarised in Table 19-6.

Table 19-6: Existing water quality conditions of watercourses relevant to Stage 1

Watercourse	Water quality characteristics relevant to ANZECC/ARMCANZ (2000) indicators[1]
Domain Creek	• Low dissolved oxygen levels • Elevated nutrient concentrations
Parramatta River (monitoring locations at Johnsons Bridge and Cumberland Hospital)	• Elevated nutrient concentrations • Elevated heavy metal concentrations • High turbidity
Clay Cliff Creek	• No existing data
Duck River	• Low dissolved oxygen levels • Elevated nutrient concentrations • High turbidity
Duck Creek and A'Becketts Creek	• Elevated nutrient concentrations • Elevated concentrations of faecal coliforms
Haslams Creek	• Elevated nutrient concentrations • Elevated concentrations of faecal coliforms
Saleyards Creek	• Low dissolved oxygen levels • Elevated nutrient concentrations • Elevated heavy metal concentrations • High turbidity
Powells Creek	• Low dissolved oxygen levels • Elevated nutrient concentrations • Elevated heavy metal concentrations • High turbidity
St Lukes Park Canal	• Low dissolved oxygen levels • Elevated nutrient concentrations • Elevated heavy metal concentrations • High turbidity
Barnwell Park Canal	• Low dissolved oxygen levels • Elevated nutrient concentrations • Elevated heavy metal concentrations • High turbidity
Dobroyd Canal/Iron Cove Creek	• Low dissolved oxygen levels • Elevated nutrient concentrations • Elevated heavy metal concentrations • High turbidity
Hawthorne Canal	• Low dissolved oxygen levels • Elevated nutrient concentrations • Elevated heavy metal concentrations • High turbidity
White Bay	• Elevated nutrient concentrations • Elevated heavy metal concentrations • High turbidity

Note 1: Sources: City of Parramatta Council, Sydney Water, Cumberland City Council, WestConnex M4 East.

The Parramatta River Catchment Group is currently working to improve the water quality of Parramatta River. Water sensitive urban design measures implemented to improve water quality include:

- Installation and maintenance of stormwater harvesting and reuse systems, gross pollutant traps, bio-filtration systems along roads and within constructed wetlands
- Erosion and sedimentation controls at development sites to reduce sediment inputs to the catchment.

Water quality appears to be improving as a result of these catchment management measures, however wastewater overflows and stormwater continue to contribute to poor water quality conditions Parramatta River (Parramatta City Council, 2016).

Sensitive receiving environments

A sensitive receiving environment has a high conservation or community value or supports ecosystems or human uses of water that are particularly sensitive to pollution or degradation of water quality.

Six watercourses relevant to Stage 1 have been identified as sensitive receiving environments due to their proximity to SEPP Coastal Wetlands and their mapping by DPI (2019) as Key Fish Habitat. These watercourses have a high conservation or community value or supports ecosystems or human uses of water that are particularly sensitive to pollution or degradation of water quality. These watercourses are outlined in Table 19-7.

Table 19-7: Sensitive receiving environments for Stage 1

Watercourse	Reasons for classification
Parramatta River/Sydney Harbour	• Type 1 Key Fish Habitat • Numerous SEPP Coastal Wetlands • Potential habitat for threatened aquatic species and protected aquatic vegetation
Duck River	• Type 1 Key Fish Habitat • SEPP Coastal Wetlands within 500 metres
Duck Creek	• Type 1 Key Fish Habitat • SEPP Coastal Wetlands within 500 metres
Haslams Creek	• Type 1 Key Fish Habitat • SEPP Coastal Wetlands within 500 metres
Powells Creek	• SEPP Coastal Wetlands within 500 metres
Dobroyd Canal/Iron Cove Creek	• SEPP Coastal Wetlands within 500 metres

19.6 Potential impacts

19.6.1 Soils

Soil erosion

Mitigation measures would be implemented to manage potential impacts of construction of Stage 1 on the soil environment. It is expected that soil erosion would be adequately managed in accordance with measures, given the relatively small areas of surface disturbance anticipated during construction and the overall topography of those parts of Stage 1 (which are generally slightly undulating). Measures would be applied from the Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and Managing Urban Stormwater: Soils and Construction Volume 2 (Department of Environment and Climate Change, 2008a). Relevant measures would be designed for the 80th percentile; 5-day rainfall event.

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

Acid sulfate soils

If acid sulfate soils are encountered, they would be effectively managed in accordance with the Acid Sulfate Soil Manual (Acid Sulfate Soil Management Advisory Committee, 1998). The manual includes procedures for the investigation, handling, treatment and management of such soils.

The exposure of acid sulfate soils during excavation at the Stage 1 construction sites identified in Section 19.5.1 could potentially result in the release of acid sulfates, which would damage surrounding vegetation, or cause acidic runoff offsite which would damage aquatic environments and/or drainage lines.

19.6.2 Surface water

Standard construction management measures would be implemented to minimise potential and temporary risks to downstream water quality from the construction of Stage 1. Construction works may potentially impact on watercourses through the disturbance and mobilisation of soil or other materials, which may affect the water quality and ecosystem health of receiving environments. Water quality impacts could potentially arise from:

- Surface works, such as demolition, earthworks, stockpiling, vegetation removal, concreting and watercourse realignment works
- Tunnelling and excavation works at station and ancillary facilities construction sites.

Surface works

Mitigation measures in Section 19.7 would be implemented to manage potential impacts to water quality which would be low and temporary, with no long term impacts expected. A summary of potential impacts to surface water quality from surface works is provided in Table 19-8. Surface construction works would generally be carried out in highly modified and urban environments and would not be located within or near waterways, with the exception of the earthworks near the Clyde stabling and maintenance facility.

Table 19-8: Potential surface water quality impacts

Construction works	Potential impacts
Demolition works	The removal of existing buildings and structures would be required at most Stage 1 construction sites. Demolition works have the potential to disturb and/or spread sources of pollutants that could affect water quality. Demolition could also generate dust and airborne pollutants. These pollutants once mobilised could potentially enter stormwater runoff and be distributed to downstream receiving watercourses via the drainage network.
Earthworks and stockpiling	Potential exposure of soils during earthworks (including stripping of topsoil, excavation, removal of existing paved areas, stockpiling and transport of materials), could result in temporary soil erosion and off-site movement of eroded sediments by wind and/or stormwater into receiving waterways. If sediments enter waterways, they could directly and indirectly potentially impact on the aquatic environment by increasing turbidity, reducing dissolved oxygen levels, and increasing the concentration of nutrients and heavy metals.
Realignment and instream works at Duck Creek and A'Becketts Creek	The partial realignment of Duck Creek and A'Becketts Creek has the potential to result in a temporary change in creek flows and velocities. The earthworks could also expose soils or sediments resulting in soil erosion and movement of soils into receiving waterways. Instream works, including the construction of watercourse crossings and installation of drainage structures, has the potential to create instream barriers and interfere with natural flow regimes. Temporary sediment basins, sediment and barrier fences, and stabilised diversion drains/channels would be used to manage potential impacts where appropriate.
Construction of power supply routes	The construction of power supply routes would be carried out to the Westmead metro station, Parramatta metro station, Clyde stabling and maintenance facility, and The Bays Station construction sites. Routes would be constructed using open trenching and underboring methods and has the potential to increase the risk of temporary erosion and sedimentation, particularly in areas near watercourses.
Discharges from construction water treatment plants	Discharge of large volumes of treated wastewater at all Stage 1 construction sites via the local stormwater network has the potential to increase soil erosion through scour and increase the turbidity of downstream watercourses.
Removal of vegetation	The removal of vegetation has the potential to increase the risk of erosion and sedimentation, particularly in areas near watercourses. The clearance of limited landscaped vegetation would be required across most Stage 1 construction sites.
Accidental spills	Accidental spills or leaks could occur from the maintenance or re-fuelling of construction plant and equipment machinery at construction sites, or from vehicle/truck incidents travelling to and from construction sites. Contaminants could potentially be transported downstream to receiving waters via drainage infrastructure.
Disturbance of contaminated land	Potential disturbance of contaminated soils, groundwater, or acid sulfate soils during construction of Stage 1 could result in the mobilisation of contamination or acid sulfate soils by stormwater runoff and subsequent transportation to downstream watercourses, potentially increasing contaminant concentrations in the receiving environment. Areas of risk include Clyde stabling and maintenance facility, Silverwater services facility and The Bays Station sites – refer to Chapter 20 (Contamination – Stage 1). There are isolated areas of potential acid sulfate soils which could potentially affect surrounding watercourses if not managed appropriately (refer to Section 19.5.1).
Concrete activities	Concreting activities during Stage 1 could result in the discharge of concrete dust, concrete slurries or washout water to downstream waterways. This could potentially increase the alkalinity and pH of downstream waterways which can be harmful to aquatic life. Concrete solids contained in the discharge also have the potential to clog stormwater pipes and cause flooding.

Tunnelling and excavation works

During the construction of Stage 1, tunnelling and excavation works would result in wastewater being generated from the following sources:

- Water used in the tunnel boring machine process
- Groundwater ingress
- Rainfall runoff into tunnel portals
- Machinery wash down runoff
- Dust suppression water.

Wastewater would be tested and treated at construction wastewater treatment plants prior to reuse or discharge. Wastewater treatment plants would be configured so that treated water is compliant with the ANZECC/ARMCANZ (2000) guideline values as outlined in Section 19.5.2, which would either maintain or improve the water quality of surface waterways and the marine environment. Discharges from the wastewater treatment plants would be monitored to ensure compliance with any discharge criteria in an environment protection licence(s) issued for Stage 1. As such, the impacts on the water quality of the catchment would be negligible.

Most of this wastewater would be collected from groundwater seepage. Estimated volumes of construction wastewater are included in Table 19-10. Water volumes generated during Stage 1 would vary based on construction works both above and below the ground surface, the amount of groundwater infiltrating into the tunnels and the length of tunnels that have been excavated.

The re-use of wastewater would be maximised during construction works (e.g. dust suppression). and any surplus wastewater would be treated before discharge to the local stormwater system or directly to a local surface watercourse. This would avoid untreated or poorly treated groundwater impacting on the water quality of downstream waterways. It is possible that discharged water could also alter the baseline volume and velocity of receiving watercourses, or result in the build-up of sediment within the watercourses.

Indicative construction wastewater treatment discharges and discharge points are presented in Table 19-9.

Table 19-9: Construction wastewater treatment plants

Wastewater treatment plant location	Indicative capacity (litres per second)	Discharge location	Receiving watercourse
Westmead metro station	30	Local stormwater infrastructure	Domain Creek
Parramatta metro station	15	Local stormwater infrastructure	Parramatta River
Clyde stabling and maintenance facility	30	Local stormwater infrastructure	A'Becketts Creek, Duck Creek
Silverwater services facility	10	Local stormwater infrastructure	Parramatta River
Sydney Olympic Park metro station	15	Local stormwater infrastructure	Haslams Creek
North Strathfield metro station	15	Local stormwater infrastructure	Powells Creek
Burwood North Station	35	Local stormwater infrastructure	St Lukes Park Canal
Five Dock Station	20	Local stormwater infrastructure	Iron Cove Creek
The Bays Station	30	Local stormwater infrastructure	White Bay

Water balance for Stage 1

Acknowledging that until recently, Sydney had been under Level 2 water restrictions, non-potable sources (e.g. treated wastewater and harvested rainwater) would be used to meet construction water demand requirements where possible. The deficit for the non-potable demand and any potable demand would be sought from the Sydney Water supply network. The use of non-potable water over potable would depend on the location and nature of the water use activity as well as the quantity and quality of available water at the time. Water availability would vary as construction progresses as well as seasonally.

Considering the prevailing drought conditions in Sydney and across NSW, Sydney Metro is further investigating options to minimise potable water use and maximise wastewater reuse. This includes investigating opportunities to:

- Increase or extend storage capacity of treated wastewater on site. This would provide additional opportunities for the reuse of water both on site and off site
- Carry out additional treatment of wastewater to enable additional end uses (such as concrete batching, wash down, toilet flushing etc). This would further reduce reliance on potable water supply
- Provide wastewater to others for reuse (e.g. to local councils for parkland and sporting field irrigation, or to nearby golf courses for irrigation). This would reduce reliance on potable water for these uses.

The indicative water balance for the construction of Stage 1 based on average groundwater inflows, and the estimated treated discharge quantities are shown in Table 19-10. Non-potable water uses would include dust suppression, plant wash-down and rock bolting. Some demand activities are consumptive such as water used in the offices which would be discharged to the sewerage network. There would also be minor losses in the system due to evaporation. The remainder would be treated and either re-used or discharged at the proposed discharge locations listed in Table 19-9. The water balance shows that water supply exceeds demand.

Table 19-10: Indicative Stage 1 water balance

Activity	Type	Amount (megalitres per year)	Totals
Supply			
Recycled potable water to meet non-potable demand	Non-potable	86	940
Groundwater inflow (station excavations) to meet non-potable demand	Non-potable	568	
Sydney Water (mains supply) for site offices and to meet any deficit in non-potable water supply	Potable	286	
Demand			
Construction activities associated with the stabling and maintenance facility	Non-potable	40	369
	Potable	35	
Construction activities associated with station and tunnel excavation	Non-potable	43	
	Potable	251	
Losses via consumption			
Consumed by construction activities (e.g. dust suppression, plant wash-down and concrete batching)	Non-potable	83	83
Total discharge			
	Non-potable		515

Surface water availability and flows

The construction of Stage 1 would result in treated wastewater discharges to downstream waterways via the local stormwater network. Discharge of high volumes of treated water also has the potential to scour the waterways and increase turbidity of receiving waters.

Water extraction from surface water is not proposed during construction of Stage 1. However, environmental surface water availability and flows have the potential to be reduced if groundwater drawdown occurs where groundwater flows contribute to baseflow in surface watercourses – refer to Chapter 18 (Groundwater and ground movement – Stage 1).

Impacts on NSW water quality objectives

Table 19-11 outlines the water quality objectives relevant to Stage 1 (refer to Section 19.5.2) and the potential impacts as a result of construction work.

Table 19-11: Assessment of Stage 1 against the relevant water quality objectives

Water quality objective	Indicators	Associated trigger values or criteria	Impact of Stage 1
Aquatic ecosystems			
Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term	Total phosphorus	• Lowland Rivers – 25µg/L • Estuaries – 30µg/L	Wastewater from tunnelling activities would be treated and standard erosion and sediment control measures would be implemented for all surface works areas to minimise pollutant loading to the downstream waterways during construction. Wastewater would be treated to comply with the ANZECC/ARMCANZ (2000) and ANZG (2018) guidelines and runoff from construction works would be designed to meet the standards outlined in the Blue Book. With the implementation of these management measures, pollutant loading to the receiving waterways would be low with the possibly of better quality where existing water quality does not meet the ANZECC/ARMCANZ (2000) and ANZG (2018) guidelines. Therefore, Stage 1 construction would not impact aquatic ecosystems of receiving waterways.
	Total nitrogen	• Lowland rivers – 350µg/L • Estuaries – 300µg/L	
	Chlorophyll-a	• Lowland Rivers – 3µg/L • Estuaries – 4µg/L	
	Turbidity	• Lowland Rivers 6 to 50NTUL • Estuaries – 0.5 to 10 NTU	
	Electrical conductivity	• Lowland rivers – 125-2200µS/cm	
	Dissolved oxygen	• Lowland Rivers – 85-100% saturation • Estuaries – 80-110% saturation	
	pH	• Lowland Rivers – 6.5-8.5 • Estuaries – 7-8.5	
	Chemical contaminants or toxicants	• As per table 3.4.1 ANZECC/ARMCANZ (2000)	
Visual amenity			
Maintaining the aesthetic quality of waters	Visual clarity and colour	Natural visual clarity should not be reduced by more than 20%. Natural hue of water should not be changed by more than 10 points on the Munsell Scale. The natural reflectance of the water should not be changed by more than 50%.	Wastewater from tunnelling activities would be treated and standard erosion and sediment control measures implemented for all surface works areas to minimise pollutant loading to the downstream waterways during construction. Wastewater would be treated to comply with the ANZECC/ARMCANZ (2000) and ANZG (2018) guidelines and runoff from construction works would be designed to meet the standards outlined in the Blue Book. With the implementation of these management measures, pollutant loading to the receiving waterways would be low with the possibly of better quality where existing water quality does not meet the ANZECC/ARMCANZ (2000) and ANZG (2018) guidelines. Therefore, Stage 1 construction would not reduce the aesthetic quality of the receiving waterways.
	Surface films and debris	Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and matter 250 µg/L.	
	Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts.	

Water quality objective	Indicators	Associated trigger values or criteria	Impact of Stage 1
Primary contact recreation			
Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed	Turbidity	Approximately 6NTU	Wastewater from tunnelling activities would be treated and standard erosion and sediment control measures would be implemented for all surface works areas (refer to Section 19.7.2 to minimise pollutant loading to the downstream waterways during construction. Wastewater would be treated to comply with the ANZECC/ARMCANZ (2000), ANZG (2018) and NHMRC (2008) guidelines and runoff from construction works would be designed to meet the standards outlined in the Blue Book. With the implementation of these management measures, pollutant loading to the receiving waterways would be low and possibly of better quality where existing water quality does not meet the NHMRC (2008) guidelines. While primary contact recreation is not currently undertaken in these downstream waterways, it is a long term goal to make the Parramatta River swimmable by 2025 (Parramatta City Council, 2016). Stage 1 construction would not reduce the ability for Parramatta River to be used for primary contact recreation in future.
	Enterococci	Microbial water quality assessment category (95th percentile – intestinal enterococci/100mL) (NHMRC 2008): • Category A: <40 • Category B: 41-200 • Category C: 201-500 • Category D: >500.	
	Protozoans	Pathogenic free-living protozoans should be absent from bodies of fresh water.	
	Algae and blue-green algae	NHMRC (2008) recommend freshwater recreational water bodies should not contain: • >10 µg/L total microcystins; >50,000 cells/mL toxic Microcystis aeruginosa; or biovolume equivalent of >4 mm3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume • >10 mm3/L for total biovolume of all cyanobacterial material where known toxins are not present • Cyanobacterial scums consistently present. Estuarine recreational water bodies should not contain: • ≥ 10 cells/mL Karenia brevis and/or have Lyngbya majuscula and/or Pfiesteria present in high numbers.	
	Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts.	
	pH	6.5-8.5	
	Temperature	16-34°C	
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucus membranes are unsuitable for recreation.	

Water quality objective	Indicators	Associated trigger values or criteria	Impact of Stage 1
Secondary contact recreation			
Maintaining or improving water quality of activities such as boating and wading, where there is a low probability of water being swallowed	Enterococci	As per the NHMRC 2008 Guidelines for managing risks in recreational water.	Wastewater from tunnelling activities would be treated and standard erosion and sediment control measures would be implemented for all surface works areas (refer Section 19.7.2 to minimise pollutant loading to the downstream waterways during construction. Wastewater would be treated to comply with the ANZECC/ARMCANZ (2000), ANZG (2018) and NHMRC (2008) guidelines and runoff from construction works would be designed to meet the standards outlined in the Blue Book. With the implementation of these management measures, pollutant loading to the receiving waterways would be low with the possibly of better quality where existing water quality does not meet the NHMRC (2008) guidelines. Therefore, Stage 1 construction would ensure that secondary contact recreation at receiving waterways is not affected.
	Algae and blue-green algae	As per the NHMRC 2008 Guidelines for managing risks in recreational water.	
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreation.	
Aquatic foods (cooked)			
Protecting water quality so that it is suitable for the production of aquatic foods for human consumption and aquaculture activities	Algae and blue-green algae	No guideline is directly applicable, but toxins present in blue-green algae may accumulate in other aquatic organisms.	Wastewater from tunnelling activities would be treated and standard erosion and sediment control measures would be implemented for all surface works areas (refer Section 19.7.2 to minimise pollutant loading to the downstream waterways during construction. Wastewater would be treated to comply with the ANZECC/ARMCANZ (2000) and ANZG (2018) guidelines and runoff from construction works would be designed to meet the standards outlined in the Blue Book. With the implementation of these management measures, pollutant loading to the receiving waterways would be low with the possibly of better quality where existing water quality does not meet the ANZECC/ARMCANZ (2000) and ANZG (2018) guidelines. Note: At the time of developing the catchment water quality objectives, consumption of aquatic foods was nominated for protection. However due to contamination, particularly dioxins, current recommendations by the Department of Primary Industries is that no fish or crustaceans caught west of the Sydney Harbour Bridge should be eaten (NSW DPI, 2019).
	Faecal coliforms	*Guideline in water for shellfish:* The median faecal coliform concentration should not exceed 14 MPN/100mL; with no more than 10% of the samples exceeding 43 MPN/100 mL. *Standard in edible tissue:* Fish destined for human consumption should not exceed a limit of 2.3 MPN E Coli/g of flesh with a standard plate count of 100,000 organisms/g.	
	Toxicants	Metals: • Copper <5 µgm/L • Mercury <1 µgm/L • Zinc <5 µgm/L. • Organochlorines: • Chlordane <0.004 µgm/L (saltwater production) • PCB's < 2 µgm/L.	
	Physico-chemical Indicators	• Suspended solids: less than 40 micrograms per litre (freshwater) • Temperature: less than 2 degrees Celsius change over one hour.	

19.6.3 Cumulative impacts

Potential cumulative impacts were considered for assessment based on the likely interactions of Stage 1 with other projects and plans that met the adopted screening criteria. The approach to assessment and the other projects considered are described further in Appendix G (Cumulative impacts assessment methodology – Stage 1).

Potential cumulative water quality impacts are largely related to the erosion, sedimentation and discharge of wastewater into common waterways. However, cumulative water quality impacts are not expected as these projects would be required to implement the standard construction mitigation measures outlined in the Blue Book and in the water quality guidelines listed in Section 19.2.

19.7 Management and mitigation measures

19.7.1 Approach to management and mitigation

Soils and surface water issues would be managed in accordance with Sydney Metro's Construction Environmental Management Framework – described in Chapter 27 (Synthesis of the Environmental Impact Statement) and Appendix D. The Construction Environmental Management Framework aims to minimise surface water pollution through erosion and sediment control, maintain the existing water quality of surrounding watercourses, and prioritise the use of non-potable water sources where feasible and reasonable. The Construction Environmental Management Framework specifically requires the preparation of a Soil and Water Management Plan and progressive erosion and sediment control plans that would be updated as needed to reflect site conditions.

19.7.2 Mitigation measures

Specific mitigation measures that would be implemented to minimise potential impacts to soils and surface water quality are listed in Table 19-12.

Table 19-12: Mitigation measures – Soils and surface water quality Stage 1

Reference	Impact/issue	Mitigation measure	Applicable location(s)[1]
Soils			
SSWQ1	Acid sulfate soils	Prior to ground disturbance in areas of potential acid sulfate soil occurrence, testing would be carried out to determine the presence of actual and/or potential acid sulfate soils. If acid sulfate soils are encountered, they would be managed in accordance with the Acid Sulfate Soil Manual (ASSMAC, 1998)	PMS, CSMF, TBS
SSWQ2	Soil salinity	Prior to ground disturbance in high probability salinity areas, testing would be carried out to determine the presence of saline soils. If salinity is encountered, excavated soils would not be reused or it would be managed in accordance with Book 4 Dryland Salinity: Productive Use of Saline Land and Water (NSW DECC 2008). Erosion controls would be implemented in accordance with Blue Book (Landcom, 2004).	All
Surface water quality			
SSWQ3	Erosion and sedimentation	Erosion and sediment measures would be implemented at all construction sites in accordance with the principles and requirements in Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom 2004) and Volume 2D (NSW Department of Environment, Climate Change and Water 2008), commonly referred to as the 'Blue Book'. Additionally, any water collected from construction sites would be appropriately treated and discharged to avoid any potential contamination or local stormwater impacts. Temporary sediment basins would be designed in accordance with Managing Urban Stormwater: Soils and Construction and Managing Urban Stormwater, Volume 2D: Main Road Construction (DECC, 2008).	All
SSWQ4	Working in waterways and surrounding low lying areas	Works in waterways and surrounding low lying areas would be carried out in accordance with progressive erosion and sediment control plans.	CSMF
SSWQ5	Wastewater discharge	The water treatment plants would be designed so that wastewater is treated to a level that is compliant with the ANZECC/ARMCANZ (2000) and ANZG (2018) default guidelines for 95 per cent species protection.	All
SSWQ6	Water quality monitoring	A surface water monitoring program would be implemented to observe any changes in surface water quality that may be attributable to Stage 1 and inform appropriate management responses. The program would be developed in consultation with the EPA and relevant Councils. The program would consider monitoring being undertaken as part of other infrastructure projects such as the M4 WestConnex East monitoring. Monitoring would occur during pre-construction and during construction at all waterways with the potential to be impacted. Monitoring sites could be located upstream and downstream of the potential discharges and would include sampling for key indicators of concern.	All
SSWQ7	Local stormwater capacity	Further design development would confirm the local stormwater system capacity to receive construction water treatment plant inflows. In the event there is a stormwater infrastructure capacity issue with existing infrastructure, mitigation measures such as storage detention to control water outflow during wet weather events would be implemented.	All

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (eg tunnel boring machine works); PSR: Power supply routes.

19.7.3 Interactions between mitigation measures

Mitigation measures in other chapters that are relevant to the management of potential impacts include:

- Chapter 18 (Groundwater and ground movement – Stage 1), specifically measures which address groundwater levels and the migration of contaminants through groundwater
- Chapter 20 (Contamination – Stage 1), specifically measures which address the disturbance of contaminated land during construction.

Together, these measures would minimise the potential impacts of Stage 1.

There are no mitigation measures identified in the assessment of other environmental aspects that are likely to affect the assessment of soils and surface water quality impacts.

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20 Contamination – Stage 1

20 Contamination – Stage 1

This chapter provides a summary of the assessment of the potential impacts of Stage 1 on contamination and identifies management and mitigation measures to minimise these impacts. This chapter draws on information provided in Technical Paper 8 (Contamination). Information and assessment relating to groundwater and ground movement are discussed in Chapter 18 (Groundwater and ground movement – Stage 1). Information and assessment relating to soil erosion, acid sulfate soils, soil salinity and sensitive receiving environments are discussed in Chapter 19 (Soils and surface water quality – Stage 1).

20.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to contamination, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 20-1.

Table 20-1: Secretary's Environmental Assessment Requirements – Contamination Stage 1

Reference	Requirement	Where addressed
8. Contamination		
8.2	The risk of contamination and identify if remediation of the land is required, having regard to the ecological and human health risks posed by the contamination in the context of past, existing and future land uses. Where assessment and/or remediation is required, the Proponent must document how the assessment and/or remediation would be undertaken in accordance with current guidelines.	Section 20.5 to 20.16, and Section 20.17.

20.2 Legislative and policy context

The management of contaminated land in NSW is a tiered process where the NSW Environment Protection Authority (EPA), through the *Contaminated Land Management Act 1997*, regulates land which is considered to be significantly contaminated. Contaminated land that is not regulated by the NSW Environment Protection Authority is managed by planning authorities through the planning and development assessment process.

The NSW Environment Protection Authority also administers the NSW site auditor scheme, makes or approves guidelines for assessing and remediating contaminated land, and manages the public record of regulated sites under the *Contaminated Land Management Act 1997* (CLM Act). The NSW Environment Protection Authority may also issue and enforce licences that regulate waste treatment, storage and/or disposal facilities, under the *Protection of the Environment Operations Act 1997* or the *Environmentally Hazardous Chemicals Act 1985*. Other legislation relevant to contamination is the *Work Health and Safety Act 2011*, which provides a legislative framework to protect the health and safety and welfare of workers.

The following guidelines inform or respond to the regulatory framework and have been applied to the assessment of Stage 1:

- Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land (Department of Urban Affairs and Planning and Environment Protection Authority, 1998)
- Guidelines for Consultants Reporting on Contaminated Sites (Office of Environment and Heritage, 2000)
- National Environment Protection (Assessment of Site Contamination) Measure 1999 (as revised 2013).

Other policy and guidelines that would be relevant should further investigations, remediation work and validation be required include:

- Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997 (Environment Protection Authority, 2015a)
- Guidelines for the NSW Site Auditor Scheme (Environment Protection Authority, 2017b)
- Guidelines for the assessment and management of groundwater contamination (Department of Environment and Conservation, 2007)
- Other guidelines made or approved under section 105 of the *Contaminated Land Management Act 1997*.

20.3 Assessment approach

For the purposes of the contamination investigation, the study area included the Stage 1 construction site footprints, land within 500 metres of the Stage 1 sites and the tunnel alignment.

The contamination assessment involved:

- A desktop review of available information relevant to the study area to understand the site history, existing environment and potential risk for contamination, including a review of:
  - Landform topography, drainage, geology, soils (including erosion hazard, acid sulfate soils risk and salinity potential), hydrogeology and receiving environments in the study area
  - Site history including historical aerial photographs (from each decade from 1930 to 2005 (where available) and available aerial imagery services (Google Earth and SIX Maps)
  - The existing land uses and land use planning controls – further information on land use is provided in Chapter 14 (Property and land use – Stage 1)
  - Publicly available information via general internet searches for the key words (contamination, remediation and site investigation) for suburbs and major projects within and adjoining the study area
  - Publicly available information from the NSW Environment Protection Authority, the Commonwealth Scientific and Industrial Research Organisation 'Australian Soil Resource Information System' database and the former NSW Department of Primary Industries groundwater database
  - Data collected during site investigations for Sydney Metro West
- Site inspections in February and July 2019 of Stage 1 construction sites and nearby land uses and potential areas of environmental concern (areas with known or potential contamination associated with current or historical land uses)
- Meetings with the Environment Protection Authority to discuss the approach to the contamination assessment
- A high level risk prioritisation exercise to:
  - Identify areas of environmental concern (with respect to contamination)
  - Identify unmitigated risks to environmental and human receptors
  - Consider the nature of proposed construction activities
  - Determine the level of risk that Stage 1 could intersect areas of potential contamination (refer to Section 20.3.1)
- Identification of appropriate mitigation and management measures, or where further investigation or remediation may be required.

20.3.1 Risk prioritisation

A high-level risk prioritisation exercise was carried out to assess the potential impact from construction to expose contamination to human and/or ecological receptors. The prioritisation exercise considered source-pathway-receptor relationships in accordance with a conceptual site model as defined by the National Environment Protection (Assessment of Site Contamination) Measure 1999, as revised 2013 (NEPC, 2013). The prioritisation exercise considered the severity and extent of contamination sources (refer to Table 20-2), and the potential pathways from contamination sources to human and ecological receptors (refer to Table 20-3) for each media, that is soil, groundwater and vapour.

Table 20-2: Contamination severity and extent categories

Contamination severity and extent category	Description
SE1	Low potential for contamination to be present in the media of concern at concentrations above the relevant assessment criteria and is limited in spatial extent
SE2	Contamination possibly present in the media of concern at concentrations above the relevant assessment criteria and is limited in spatial extent
SE3	Contamination possibly present in the media of concern at concentrations above the relevant assessment criteria and potentially spatially widespread
SE4	Known contamination present in the media of concern at concentrations above the relevant assessment criteria and limited in spatial extent
SE5	Known contamination present in the media of concern at concentrations above the relevant assessment criteria and spatially widespread

Table 20-3: Contamination pathways and receptor categories

Pathways and receptors category	Description
PR1	Media of concern is unlikely to coincide with or otherwise impact on the construction scope and/or there is no or an unlikely exposure pathway for human or ecological receptors during Stage 1
PR2	Media of concern may intersect the construction scope and exposure pathway for human or ecological receptors that could be present and complete during Stage 1
PR3	Media of concern would intersect the construction scope and exposure pathway for human or ecological receptors that could be present and complete during Stage 1

To provide the overall potential contamination risk for Stage 1 construction sites, a matrix was used to combine the consideration of contamination severity and extent with contamination pathways and receptors as provided in Table 20-4.

Table 20-4: Potential contamination risk categories

Contamination severity and extent						
Pathways and receptors		SE1	SE2	SE3	SE4	SE5
	PR1	Very low	Low	Low	Moderate	Moderate
	PR2	Low	Moderate	Moderate	High	High
	PR3	Moderate	Moderate	High	High	Very high

20.4 Avoidance and minimisation of impacts

The design development process for Stage 1 aimed to avoid or minimise potential contamination risks. This included:

- Early identification of known contaminated sites and avoidance of these sites where possible
- Location of the stabling and maintenance facility at Clyde to avoid contaminated land (compared to alternative locations considered). This reduces challenges in relation to potentially constructing within substantially contaminated land, which could pose risks to the environment and worker health and safety.

20.5 Project-wide impacts

20.5.1 Contamination potential

Based on the desktop assessment and site inspection, there is the potential for contamination to be encountered at several locations within the Stage 1 construction footprint. Contaminants that could be encountered during excavation and other ground disturbing activities include those associated with:

- Leaks and spills from fuel storage infrastructure (hydrocarbons and heavy metals)
- Processing of heavy end hydrocarbons, heavy metals and metalloids
- Land reclamation and other uncontrolled fill material (metals, hydrocarbons, pesticides, polychlorinated biphenyls and asbestos)
- Demolition of buildings that may contain hazardous materials such as asbestos
- Former and current industrial land uses (that may contain contaminants such as hydrocarbons, heavy metals and metalloids, solvents, phenolics, pesticides, heavy metals and metalloids and asbestos in soil)
- Existing railways and associated activities (that may contain contaminants such as metals, hydrocarbons, pesticides, nutrients, phenols, carbamates, pesticides, herbicides and asbestos in soils).

The potential for contamination to be encountered at Stage 1 construction sites and potential construction impacts from soil, groundwater and vapour are outlined in the following sections.

20.5.2 Potential soil impact pathways

All potential soil contamination identified can be managed to acceptable levels with the implementation of appropriate management measures and/or remediation.

Potential impact pathways due to the disturbance of contaminated soil without appropriate management and/or remediation may include:

- Handling and transporting large volumes of natural and 'clean fill' spoil or naturally occurring actual or potential acid sulfate soil and rock
- Handling, transporting, treating or disposing of contaminated soils and wastes including asbestos-containing materials
- Contaminant exposure risk to construction personnel and the general public from the impacts of intercepting contaminated soil
- Contaminant exposure to environmental receptors from the impacts of intercepting contaminated soil
- Cross contamination associated with the incorrect handling or disposal of spoil/unexpected finds
- Contamination of previously clean areas.

Higher risks and increased management and/or remediation effort during construction are likely to be associated with soils containing dispersible fibres (i.e. fibrous asbestos), or soils which could generate vapours or odours (hydrocarbons and volatile organic compounds) or soils which contain concentrations of contaminants which categorise material at a higher waste classification (i.e. restricted solid waste or hazardous waste).

20.5.3 Potential groundwater impact pathways

All potential groundwater contamination identified can be managed to acceptable levels with the implementation of appropriate management measures and/or remediation.

Potential impact pathways which could cause contact with or discharge of contaminated groundwater may include:

- Contaminant exposure risk to construction personnel and the general public from the impacts of intercepting contaminated groundwater
- Contaminant exposure to environmental receptors from the impacts of intercepting contaminated groundwater.

Higher risks and increased management and/or remediation effort are likely to be associated with groundwater contamination where the source is not located on the construction site (i.e. where construction would not remove all and/or part of the contamination source) or where the source is located on-site and has the potential to migrate off-site.

20.5.4 Potential vapour and gas impact pathways

All potential vapour, odour and gas contamination identified can be managed to acceptable levels with the implementation of appropriate management measures and/or remediation.

Potential vapours from contaminated groundwater and landfill gas could accumulate within or below ground excavations and enclosed structures associated with Stage 1 at concentrations which could represent an asphyxiation risk, explosion risk or acute/chronic health risk. Vapours and gases may also represent an aesthetic risk where it accumulates or is otherwise observed by receivers.

20.6 Westmead metro station construction site

20.6.1 Existing environment and site contamination review

Land use

The construction site currently comprises low and medium residential, medical, commercial and rail infrastructure land uses. Existing land uses of interest from a contamination perspective include:

- A medical centre on the corner of Alexandra Avenue and Hawkesbury Road
- An automotive workshop on the corner of Alexandra Avenue and Hassall Street
- An unoccupied house on Hawkesbury Road.

Land use zones within and adjoining the construction site include:

- B4 – Mixed Use
- R2 – Low Density Residential
- R4 – High Density Residential
- SP2 – Infrastructure (rail).

Based on permitted land use with or without consent, the business (B4 – Mixed Use) and infrastructure (SP2 – Infrastructure (rail)) land use zones represent a higher potential contamination risk.

Site history

Historical aerial photography shows the construction site has had low density residential land uses since at least 1955, with scattered trees and vegetation. This land use has remained largely unchanged, with a number of extensions and subdivisions to properties within the construction site and widening of Alexandra Avenue in the 1960s.

Land uses in the area surrounding the construction site since the 1950s include low density residential development, commercial and industrial premises, large areas of open space including parks and ovals, and the existing Westmead Station. Former commercial and industrial premises may be associated with higher contamination risks.

Key developments in the surrounding area since the 1950s include:

- The development of local schools in the 1970s
- The development of Westmead Hospital in the 1980s and early 1990s.

Database searches

NSW EPA Contaminated Sites Register

There are no sites listed on the NSW Environment Protection Authority Contaminated Sites Register within 500 metres of the Stage 1 footprint.

NSW EPA Protection of the Environment Operations Act public register

There are no sites listed on the NSW EPA *Protection of the Environment Operations Act* public register within 500 metres of the Stage 1 footprint that have current environment protection licences.

20.6.2 Potential impacts

The potential contamination risk at the Westmead metro station construction site during Stage 1 is summarised in Table 20-5 and Figure 20-1. Overall, the soils and groundwater in the vicinity of the construction site and tunnel alignment have a moderate potential contamination risk due to current and historical activities. There is also the potential to expose contamination during the construction of the power supply route for the Westmead metro station construction site. Further data review and an appropriate management approach would be implemented in accordance with the measures in Section 20.17.

Table 20-5: Potential contamination risk – Westmead metro station construction site

Construction element and anticipated depth	Site of concern and potential source of contamination	Contamination severity and extent assessment			Pathways and receptors Assessment of relationship to construction footprint and scope				Potential contamination risk
		Media and COPCs	Contamination status	Rating	Location relative to Stage 1	Potential for contamination to be intersected by Stage 1	Exposure pathways	Rating	
Station (shallow excavation)	AEI 1 Existing Westmead Station – Residuals from historical and present railway usage	Surface soils Heavy metals, hydrocarbons (TRH, BTEX, PAH), pesticides, herbicides, asbestos	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and ecological receptors	PR1	Very low
Station and tunnel (shallow and depth)	AEI 2 Mechanical workshop / services – Leaks and spills from underground petroleum storage infrastructure / automotive repair work	Surface soils Heavy metals, hydrocarbons (TRH, BTEX, PAH), asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Contamination (if present) would be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate
		Groundwater Hydrocarbons (TRH, BTEX, PAH), volatile organic compounds (VOC)	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Contamination (if present) could be exposed during excavation of materials to the depth of construction	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Moderate
Station (shallow excavation)	AEI 3 Dumping of construction waste	Surface soils Heavy metals, hydrocarbons (TRH, PAH), pesticides, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Surficial contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust. Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate
Station (shallow excavation)	AEI 4 Dumping of construction waste and demolition of former structures	Surface soils Heavy metals, hydrocarbons (TRH, PAH), pesticides, asbestos	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate from source site and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Very low
Station (shallow excavation)	AEI 5 Former and existing structures – Hazardous building materials within or from on-site buildings / structures, demolition wastes	Surface soils Heavy metals, hydrocarbons (TRH, PAH), pesticides, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction site and tunnel alignment	Surficial contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust. Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate
Westmead metro station construction site: Power supply route (shallow excavation)	Railway line and areas adjacent to waterways – Filling (material of unknown quality, construction wastes)	Surface soils Heavy metals, hydrocarbons (TRH, PAH), pesticides, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within PSR	Contamination (if present) would be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (der, ing, inh) with contaminated soils and dust Adjacent site users could be exposed to contamination via dust emissions (inh), namely asbestos	PR3	Moderate

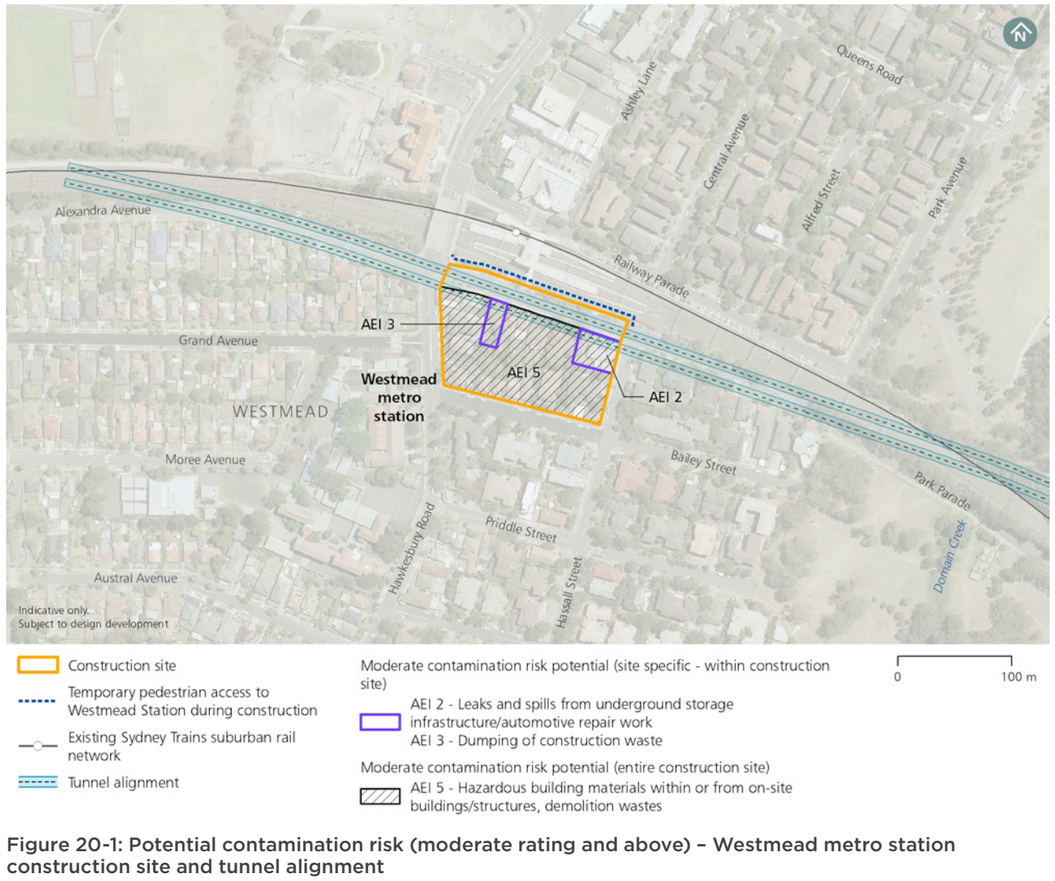

Figure 20-1: Potential contamination risk (moderate rating and above) – Westmead metro station construction site and tunnel alignment

20.7 Parramatta metro station construction site

20.7.1 Existing environment and site contamination review

Land use

The construction site currently comprises commercial, retail, services and education land uses and includes a multi-storey car park. Existing land uses of interest from a contamination perspective include (but are not limited to) a dry cleaning premises.

Land use zones within and adjoining the construction site include:

- B3 – Commercial Core
- B4 – Mixed Use.

Based on permitted land use with or without consent, the B4 – Mixed Use land use zone represents a higher potential contamination risk.

Site history

Historical aerial photography shows the construction site has comprised substantial commercial and industrial land uses since at least 1955. Commercial development at the site appears to intensify during the 1980s, with extensions and modifications to existing buildings and the development of multi-storey buildings and car parking. Minor changes are evident in the 1990s and 2000s, including increased streetscaping and vegetation.

In the area surrounding the construction site, land uses since the 1950s include large commercial and industrial premises, low density residential development, Parramatta Station, and large areas of open space in the vicinity of the current Parramatta Park and adjacent to Parramatta River. Commercial and industrial premises, and rail activities at Parramatta Station may be associated with higher contamination risks.

Key developments in the surrounding area since the 1950s include:

- Land reclamation along Parramatta River in the 1970s
- Construction of road bridges across Parramatta River in the 1980s.

Database searches

NSW EPA Contaminated Sites Register

There are two sites listed on the NSW EPA Contaminated Sites Register within 500 metres of the Stage 1 construction footprint at Parramatta. Details of the listings are provided in Table 20-6.

Table 20-6: Sites on the NSW EPA Contaminated Sites Register within 500 metres of the Stage 1 footprint – Parramatta

Site address	Site activity	Listing on the NSW EPA Contaminated Sites Register	Contamination status	Location relative to Stage 1
Corner of Pitt Street and Macquarie Street, Parramatta	Unclassified	Notified	Regulation under CLM Act not required	About 500 metres south-west of Parramatta metro station construction site and 100 metres south of the tunnel alignment
Parramatta Park toilet block demolition	Unclassified	Notified	Regulation under CLM Act not required	About 250 metres north of the tunnel alignment between Westmead and Parramatta metro station construction sites

NSW EPA Protection of the Environment Operations Act public register

There are no sites listed on the NSW EPA *Protection of the Environment Operations Act* public register within 500 metres of the Stage 1 footprint that have current environment protection licences.

20.7.2 Potential impacts

The potential contamination risk at the Parramatta metro station construction site during Stage 1 is summarised in Table 20-7 and Figure 20-2. Overall, the soils, groundwater and vapour in the vicinity of the construction site and tunnel alignment have a moderate potential contamination risk due to current and historical activities. Further data review and an appropriate management approach would be implemented in accordance with the measures in Section 20.17.

Table 20-7: Potential contamination risk – Parramatta metro station construction site

Construction element and anticipated depth	Site of concern and potential source of contamination	Contamination severity and extent assessment			Pathways and receptors Assessment of relationship to construction footprint and scope				Potential contamination risk
		Media and COPCs	Contamination status	Rating	Location relative to Stage 1	Potential for contamination to be intersected by Stage 1	Exposure pathways	Rating	
Station (shallow excavation)	AEI 6 Former and existing structures – Hazardous building materials within or from on-site buildings / structures, demolition wastes	Surface soil Heavy metals, hydrocarbons (TRH, PAH), pesticides, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Surficial contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust. Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate
Station and tunnel (shallow and depth)	AEI 7 Dry cleaners – Residuals from current dry cleaning activities. Inappropriate disposal of solvents, depth distribution associated with potential underground tanks	Surface soil Chlorinated hydrocarbons, VOCs	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent (volatilisation of compounds)	SE1	Within construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Very low
		Groundwater Chlorinated hydrocarbons, VOCs	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Contamination (if present) could be exposed during excavation of materials to the depth of construction	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Moderate
		Vapour Chlorinated hydrocarbons, VOCs	Contamination possibly present at concentrations above the relevant assessment criteria and potentially widespread	SE3	Within construction footprint and tunnel alignment	Contamination (if present) could be exposed during excavation of materials to the depth of construction	Construction workers could be exposed to contamination via vapour emissions. Adjacent site users could be exposed to contamination via vapour emissions (inhalation)	PR2	Moderate
Station and tunnel (shallow and depth)	AEI 8 Historical commercial / industrial use within locality – Inappropriate chemical storage and use, industrial operations, waste disposal and management etc	Surface soil Heavy metals, hydrocarbons (TRH, BTEX, PAH)	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust	PR3	Moderate
		Groundwater Heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Contamination (if present) could be exposed during excavation of materials to the depth of construction	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Moderate
Station and tunnel (shallow and depth)	AEI9 Historical commercial / industrial use within locality – Inappropriate chemical storage and use, industrial operations, waste disposal and management etc	Surface soil Heavy metals, hydrocarbons (TRH, BTEX, PAH)	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Very low
		Groundwater Heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Adjacent to construction footprint and tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Moderate
Sub-stations connections: All power supply routes (shallow excavation)	Sub-station including potential firefighting activities	Heavy metals, hydrocarbons (TRH, PAH), PCB, PFAS, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Surficial contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust. Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate

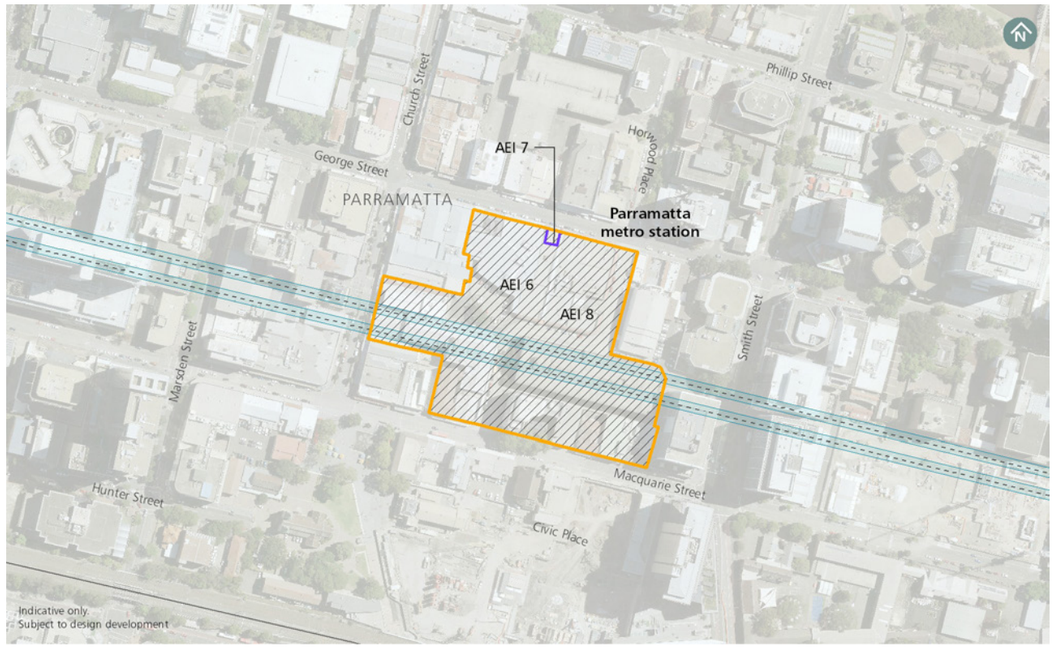

Figure 20-2: Potential contamination risk (moderate rating and above) – Parramatta metro station construction site and tunnel alignment

20.8 Clyde stabling and maintenance facility construction site

20.8.1 Existing environment and site contamination review

Land use

The construction site currently comprises commercial, industrial, rail infrastructure and private recreational land uses. Sydney Speedway (location on NSW Government owned land) is a key land use feature of the site. These existing land uses are all of interest from a contamination perspective. Duck Creek is also located within the construction site and is heavily vegetated.

Land use zones within and adjoining the construction site include:

- IN1 – General Industrial
- IN3 – Heavy Industrial
- SP2 – Infrastructure (Road and rail)
- B5 – Business Development
- W1 – Natural Waterways
- RE2 – Private Recreation.

Based on permitted land uses with or without consent, the infrastructure (SP2 – Infrastructure (Road and rail)), business (B5 – Business Development) and industrial (IN1 – General Industrial and IN3 – Heavy Industrial) land use zones represent a higher potential contamination risk.

Site history

Historical aerial photography shows that the construction site has comprised commercial, industrial and recreational land uses since the 1940s, including a race track on the current Sydney Speedway site. A'Becketts Creek and Duck Creek are also visible within the construction site from the 1950s, including areas of riparian vegetation. Reclamation and realignment work appears to have been carried out on some sections of these watercourses in the 1970s, along with increasing development of large industrial and warehousing land uses. There does not appear to have been substantial modification to land uses at the site since this time.

In the area surrounding the construction site, land uses since the 1940s include low density residential development, commercial and industrial premises, rail infrastructure, Rosehill Gardens racecourse and the former Shell Refinery (Viva Energy). Commercial and industrial premises, rail infrastructure and activities at Rosehill Gardens racecourse may be associated with higher contamination risks.

Key developments in the surrounding area since the 1940s include:

- Intensified commercial and industrial development in the 1970s
- Revegetation along the Parramatta River in the 1980s.

Database searches

NSW EPA Contaminated Sites Register

There are eight sites listed on the NSW EPA Contaminated Sites Register within 500 metres of the Stage 1 footprint at Clyde. Details of the listings are provided in Table 20-8.

Table 20-8: Sites on the NSW EPA Contaminated Sites Register within 500 metres of the Stage 1 footprint – Clyde

Site address	Site activity	Listing on the NSW EPA Contaminated Sites Register	Contamination status	Location relative to Stage 1
2 Ritchie Street, Rosehill	Unclassified	Formerly regulated	Contamination formerly regulated under the CLM Act	About 500 metres west of the Clyde stabling and maintenance facility construction site and tunnel alignment
Devon Street, Rosehill	Landfill (James Hardie Australia and former James Hardie lands)	Regulated	Asbestos contamination	About 500 metres north-east of the Clyde stabling and maintenance facility construction site and tunnel alignment
3 Parramatta (corner Harbord Street) Road, Clyde	Service station	Notified	Ongoing maintenance required to manage residual contamination (CLM Act)	About 250 metres south of the Clyde stabling and maintenance facility construction site and tunnel alignment
15-17 Berry Street, Granville	Other industry	–	Buried asbestos waste	About 500 metres south of the Clyde stabling and maintenance facility construction site and tunnel alignment
1 Grand Avenue, Camellia	Other industry activities (former James Hardie factory)	Regulated	Regulation under CLM Act not required	About 500 metres north-east of the tunnel alignment
9 Short Street, Auburn	Other industry (former Ajax chemical factory)	Regulated	Contamination being managed via the planning process (EP&A Act)	About 300 metres south-east of the Clyde stabling and maintenance facility construction site and 500 metres south of the tunnel alignment
Durham Street, Rosehill	Other industry (Former Shell Clyde Refinery)	Regulated	Ongoing maintenance required to manage residual contamination (CLM Act)	About 200 metres north-east of the Clyde stabling and maintenance facility construction site and within the tunnel alignment
Carnarvon Road, Silverwater	Landfill	Notified	Asbestos contamination in the fill material throughout most of the site	About 300 metres east of the Clyde stabling and maintenance facility construction site and 200 metres south of the tunnel alignment

NSW EPA Protection of the Environment Operations Act public register

There are eight sites listed on the NSW EPA *Protection of the Environment Operations Act* public register within 500 metres of the Stage 1 footprint at Clyde that have current environment protection licences. Details of the listings are provided in Table 20-9.

Table 20-9: Sites with current environment protection licences within 500 metres of the Stage 1 footprint – Clyde

Site address	Licence holder	Activity	Location relative to construction footprint and tunnel alignment
322 Parramatta Road, Clyde	Boral Cement Ltd	Cement of lime handling	• 360 metres from construction site
Parramatta Road, Clyde	Veolia Environmental Services (Australia) Pty Ltd	Non-thermal treatment of general waste Waste storage – other types of waste	• 400 metres from construction site
1A Unwin Street, Rosehill	Downer EDI Works Pty Ltd	Recovery of general waste Waste storage – other types of waste	• Within construction site • 200 metres from tunnel alignment
10 Colqhoun Street, Rosehill	James Hardie Australia Pty Ltd	Cement or lime handling Crushing, grinding or separating Concrete works	• 300 metres from construction site • 400 metres from tunnel alignment
Durham Street, Camellia	Viva Energy Australia Pty Ltd	Non-thermal treatment of hazardous and other waste Petroleum products storage	• 240 metres from tunnel alignment
181 James Ruse Drive, Camellia	Statewide Planning Pty Ltd	Contaminated soil treatment	• 360 metres from tunnel alignment
25 Wentworth Street, Granville	Heliport Developers Pty Ltd	Helicopter-related activity	• Within construction footprint
Corner of Newton Street North and Carnarvon Street, Silverwater	MET Recycling Pty Ltd	Recovery of general waste Waste storage – other types of waste	• 130 metres from tunnel alignment

20.8.2 Potential impacts

The potential contamination risk at the Clyde stabling and maintenance facility construction site during Stage 1 is summarised in Table 20-10 and Figure 20-3. Overall, the soils, groundwater and vapour in the vicinity of the construction site and tunnel alignment have a moderate potential contamination risk associated with current and historical activities. There is also potential to expose contamination during the construction of the power supply route for the Clyde stabling and maintenance facility construction site. Further data review and an appropriate management approach would be implemented in accordance with the measures in Section 20.17.

Table 20-10: Potential contamination risk – Clyde stabling and maintenance facility construction site

Construction element and anticipated depth	Site of concern and potential source of contamination	Contamination severity and extent assessment			Pathways and receptors Assessment of relationship to construction footprint and scope				Potential contamination risk
		Media and COPCs	Contamination status	Rating	Location relative to Stage 1	Potential for contamination to be intersected by Stage 1	Exposure pathways	Rating	
Tunnel (depth)	AEI 10 Historical industrial use (former James Hardie factory – 1 Grand Avenue, Camellia) – Known contamination in the fill material and groundwater at 1 Grand Avenue, Camellia	Surface soil Asbestos, arsenic	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Approx. 500 metres north east of tunnel alignment	Surficial contamination from source site unlikely to migrate and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and ecological receptors	PR1	Very low
		Groundwater Zinc, phenol, PAH	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Approx. 500 metres north east of tunnel alignment	Contaminated groundwater from the source site unlikely to migrate towards alignment (groundwater flow direction likely to be towards Parramatta River)	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and ecological receptors	PR1	Low
Clyde stabling and maintenance facility – civil construction works (land formation, services installation, drainage infrastructure) **Rosehill dive and tunnel portal structures (depth)**	AEI 11 Rosehill Gardens Racecourse – Equestrian related activities	Surface soil Pesticides, nutrients, disinfectants	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and ecological receptors	PR1	Very low
Clyde stabling and maintenance facility – civil construction works (land formation, services installation, drainage infrastructure)	AEI 12 Sydney Speedway – Leaks and spills from vehicle maintenance and use	Surface soil Heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils Ecosystems of A'Becketts Creek, Duck Creek and Duck River could be exposed to contamination via uncontrolled releases (sediment) during construction	PR3	Moderate
Clyde stabling and maintenance facility – civil construction works (land formation, services installation, drainage infrastructure)	AEI 13 Former and existing structures – Hazardous building materials within or from on-site buildings / structures, demolition wastes	Surface soil Heavy metals, hydrocarbons (TRH, PAH), pesticides, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Surficial contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate
Tunnel and Rosehill services facility (depth)	AEI 14 Historical industrial use (former Shell Clyde Refinery – Durham Street, Rosehill) – Known groundwater contamination and current EPL	Groundwater Light non-aqueous phase liquid, hydrocarbons (TPH, BTEX, PAH), lead, chromium and perfluoroctane sulfonate.	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Approx. 200 metres north east of the construction footprint. Approx. 200 metres east of services facility shaft. Within tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater. Ecosystems of A'Becketts Creek, Duck Creek and Duck River could be exposed to contamination via uncontrolled releases (water) during construction	PR2	Moderate
		Vapor Hydrocarbons (TPH, BTEX)	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Approx. 200 metres north east of the construction footprint and within alignment	Contamination (if present) could be exposed during excavation of materials to the depth of construction	Construction workers could be exposed to contamination via contact (inhalation) with vapours. Adjacent site users could be exposed to contamination via vapour emissions (inhalation)	PR2	Moderate

Construction element and anticipated depth	Site of concern and potential source of contamination	Contamination severity and extent assessment			Pathways and receptors Assessment of relationship to construction footprint and scope				Potential contamination risk
		Media and COPCs	Contamination status	Rating	Location relative to Stage 1	Potential for contamination to be intersected by Stage 1	Exposure pathways	Rating	
Clyde stabling and maintenance facility – civil construction works (land formation, services installation, drainage infrastructure) **Rosehill services facility (surface and depth)**	AEI 15 Current commercial / industrial use within locality – Inappropriate chemical storage and use, industrial operations, waste disposal (e.g. James Hardie asbestos disposal sites) and management etc and current EPL (Downer EDI Works)	Surface soil Heavy metals, hydrocarbons (TRH, BTEX, PAH) and asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust	PR3	Moderate
		Groundwater Heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater Ecosystems of A'Becketts Creek, Duck Creek and Duck River could be exposed to contamination via uncontrolled releases (sediment and water) during construction	PR2	Moderate
Clyde stabling and maintenance facility – civil construction works (land formation, services installation, drainage infrastructure) **Rosehill dive structure and tunnel portal (surface and depth)** **Rosehill services facility (surface and depth)**	AEI 16 Current commercial / industrial use within locality – Inappropriate chemical storage and use, industrial operations, waste disposal and management etc	Surface soil Heavy metals, hydrocarbons (TRH, BTEX, PAH)	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Very low
		Groundwater Heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Adjacent to construction footprint and tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Moderate
Clyde stabling and maintenance facility – civil construction works (land formation, services installation, drainage infrastructure)	AEI 17 Land reclamation – Historical use of potentially contaminated fill within former waterways	Surface soil and soils at depth Heavy metals, hydrocarbons (TRH, PAH), pesticides, PCB, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Contamination (if present) will be exposed during excavation of surface and deeper materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust. Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos. Ecosystems of A'Becketts and Duck Creeks and Duck River could be exposed to contamination via uncontrolled releases (sediment) during construction	PR3	Moderate
Clyde stabling and maintenance facility – civil construction works (land formation, services installation, drainage infrastructure) **Tunnel (depth)**	AEI 18 Rosehill Helipad (Wentworth Street, Rosehill) – Leaks and spills from petroleum storage infrastructure, maintenance and refuelling, PFAS from hydraulic fluids and current EPL	Surface soil Hydrocarbons (TRH, BTEX, PAH), VOC, PFAS	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust Ecosystems of A'Becketts Creek, Duck Creek and Duck River could be exposed to contamination via uncontrolled releases (sediment) during construction	PR3	Moderate

Construction element and anticipated depth	Site of concern and potential source of contamination	Contamination severity and extent assessment			Pathways and receptors Assessment of relationship to construction footprint and scope				Potential contamination risk
		Media and COPCs	Contamination status	Rating	Location relative to Stage 1	Potential for contamination to be intersected by Stage 1	Exposure pathways	Rating	
	AEI 18 cont.	Groundwater Hydrocarbons (TRH, BTEX, PAH), VOC, PFAS	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Contamination (if present) could be exposed during excavation of materials to the depth of construction	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater Ecosystems of A'Becketts Creek, Duck Creek and Duck River could be exposed to contamination via uncontrolled releases (sediment and water) during construction Possible hydraulic separation for groundwater contamination between the tunnel and the source site by Duck River	PR2	Moderate
Clyde stabling and maintenance facility – civil construction works (land formation, services installation, drainage infrastructure) **Tunnel (depth)**	AEI 19 Rapid Oil Distributors (Deniehy Street, Rosehill) – Leaks and spills from petroleum storage infrastructure	Surface soil Hydrocarbons (TRH, BTEX, PAH)	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust Ecosystems of A'Becketts Creek, Duck Creek and Duck River could be exposed to contamination via uncontrolled releases (sediment) during construction	PR3	Moderate
		Groundwater Hydrocarbons (TRH, BTEX, PAH)	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Within construction footprint and tunnel alignment	Contamination (if present) could be exposed during excavation of materials to the depth of construction	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater. Ecosystems of A'Becketts Creek, Duck Creek and Duck River could be exposed to contamination via uncontrolled releases (water) during construction Possible hydraulic separation for groundwater contamination between the tunnel and the source site by Duck River	PR2	Low
Tunnel (depth) – East of Duck River only	AEI 20 Landfill (Carnavon Road, Silverwater) – PFAS containing waste materials	Groundwater PFAS	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Approx. 200 metres south south-east of the construction footprint and 100 metres west of tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint Groundwater contamination from source site unlikely to migrate and be exposed during construction of stabling facility (hydraulic separation from the source site by Duck River)	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater Ecosystems of Duck River could be exposed to contamination via uncontrolled releases (water) during construction	PR2	Moderate
Clyde stabling and maintenance facility construction site: Power supply route (shallow excavation)	Industrial wastes (potential asbestos wastes) may have been used in the construction of the roadways and as fill in the general locality	Surface soils Heavy metals, hydrocarbons (TRH, PAH), asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within PSR	Contamination (if present) would be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate
Clyde stabling and maintenance facility construction site: Power supply route (shallow excavation)	Historical industrial use (former Shell Clyde Refinery – Durham Street, Rosehill) – Known groundwater contamination	Groundwater Zinc, phenol, PAH	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Within PSR	Contamination (if present) unlikely to be exposed during excavation of surface materials at significant volumes	Significant contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and ecological receptors	PR1	Low

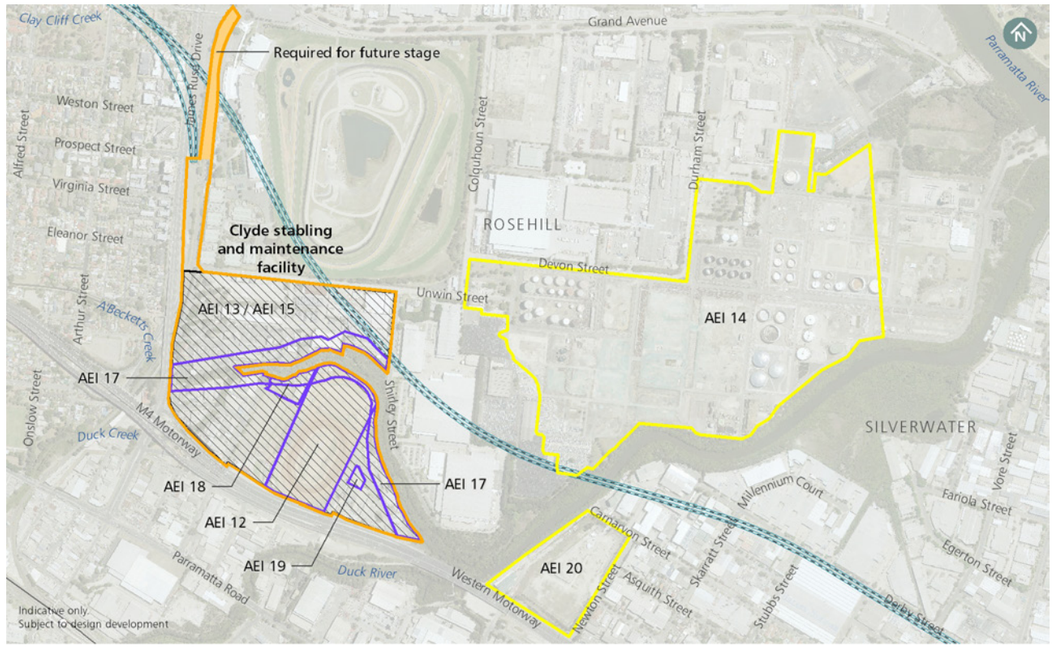

Figure 20-3: Potential contamination risk (moderate rating and above) – Clyde stabling and maintenance facility construction site and tunnel alignment

20.9 Silverwater services facility construction site

20.9.1 Existing environment and site contamination review

Land use

The construction site is currently vacant. The construction site comprises exposed, sandy soils, with a shipping container on the north-eastern boundary and a soil stockpile on the south-eastern boundary. The site is partially vegetated, with overgrown grasses, shrubs and trees on the western part of the construction site.

Land use zones within and adjoining the construction site include:

- IN1 – General Industrial
- SP2 – Infrastructure.

Based on permitted land use with or without consent, these land use zones represent a higher potential contamination risk.

Site history

Historical aerial photography shows that the construction site comprised a number of buildings, unsealed surfaces and vacant land in the 1950s. The site appears to have been developed in the 1970s, with the development of paved car parking and additional buildings. These buildings were demolished sometime after the 1970s.

Land uses in the area surrounding the construction site since the 1950s include low density residential development, medium-sized commercial and industrial premises and large areas of vacant land. Key developments in the surrounding area since the 1950s include the development of larger industrial, commercial and warehouses premises on surrounding vacant land in the 1970s and 1980s. Commercial and industrial premises may be associated with higher contamination risks.

Database searches

NSW EPA Contaminated Sites Register

There are three sites listed on the NSW EPA Contaminated Sites Register within 500 metres of the Stage 1 footprint at Silverwater. Details of the listings are provided in Table 20-11.

Table 20-11: Sites on the NSW EPA Contaminated Sites Register within 500 metres of the Stage 1 footprint – Silverwater

Site address	Site activity	Listing on the NSW EPA Contaminated Sites Register	Contamination status	Location relative to Stage 1
103-105 Silverwater Road, Silverwater	Other industry	Notified	Regulation under CLM Act not required	Within the Silverwater services facility construction site and above tunnel alignment
46-58 Derby Street, Silverwater	Unclassified (Former printing facility)	Notified	Under assessment	Adjacent to the Silverwater services facility construction site and above the tunnel alignment
54-58 Derby Street, Silverwater	Unclassified (Storage facility)	Regulated	Under assessment	Adjacent to the Silverwater services facility construction site and above the tunnel alignment

NSW EPA Protection of the Environment Operations Act public register

There are two sites listed on the NSW EPA *Protection of the Environment Operations Act* public register within 500 metres of the Stage 1 footprint at Silverwater that have current environment protection licences. Details of the listings are provided in Table 20-12.

Table 20-12: Sites with current environment protection licences within 500 metres of the Stage 1 footprint – Silverwater

Site address	Licence holder	Activity	Location relative to construction footprint and tunnel alignment
2-16 Wiblin Street, Silverwater	Cleanaway Daniels NSW Pty Ltd	Thermal treatment of hazardous and other waste Non-thermal treatment of hazardous and other waste Waste storage – hazardous, restricted solid, liquid, clinical and related waste and asbestos waste	• 150 metres from construction site • 60 metres from tunnel alignment
19-23 Fariola Street, Silverwater	Silverwater Recycling Pty Ltd	Waste storage – other types of waste Recovery of general waste	• 480 metres from tunnel alignment

20.9.2 Potential impacts

The potential contamination risk at the Silverwater services facility construction site during Stage 1 is summarised in Table 20-13 and Figure 20-4. Overall, the soils, groundwater and vapour in the vicinity of the construction site and tunnel alignment have a moderate to high potential contamination risk associated with current and historical activities. Further data review and an appropriate management approach would be implemented in accordance with the measures in Section 20.17.

Table 20-13: Potential contamination risk – Silverwater services facility construction site

Construction element and anticipated depth	Site of concern and potential source of contamination	Contamination severity and extent assessment			Pathways and receptors Assessment of relationship to construction footprint and scope				Potential contamination risk
		Media and COPCs	Contamination status	Rating	Location relative to Stage 1	Potential for contamination to be intersected by Stage 1	Exposure pathways	Rating	
Services facility (shallow excavation)	AEI 21 Former and existing structures – Hazardous building materials within or from on-site buildings / structures, demolition wastes	Surface soil Heavy metals, hydrocarbons (TRH, PAH), pesticides, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Surficial contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate
Services facility and tunnel (shallow and depth)	AEI 22 Historical industrial use (former storage facility – 54-58 Derby Street, Silverwater) – Known groundwater contamination	Vapour Chlorinated hydrocarbons, VOCs	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Within construction footprint and tunnel alignment	Contamination (if present) could be exposed during excavation of materials to the depth of construction	Construction workers could be exposed to contamination via vapour emissions (inhalation) Adjacent site users could be exposed to contamination via vapour emissions (inhalation)	PR2	Moderate
		Groundwater Chlorinated hydrocarbons, VOCs	Known contamination present at concentrations above the relevant assessment criteria and widespread	SE5	Within construction footprint and tunnel alignment	Contamination could be exposed during excavation of materials to the depth of construction	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	High
Services facility (shallow excavation)	AEI 23 Dumping / storage of construction waste (soil stockpile and general wastes)	Surface soils Heavy metals, hydrocarbons (TRH, PAH), pesticides, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Surficial contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust. Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate
Services facility and tunnel (shallow and depth)	AEI 24 Current commercial / industrial use within locality (construction machinery hire, mechanical workshops, offices, storage facilities, service station warehouses, offices, plastic fabrications and metal works, concrete recycling, metal manufacturing) – Inappropriate chemical storage and use, industrial operations, waste disposal and management etc and current EPL (Cleanaway Daniels NSW)	Surface soil Heavy metals, hydrocarbons (TRH, BTEX, PAH)	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Very low
		Groundwater Heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Adjacent to construction footprint and tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Moderate
Services facility and tunnel (shallow and depth)	AEI 25 Historical commercial / industrial use within locality – Inappropriate chemical storage and use, industrial operations, waste disposal and management etc	Surface soil Heavy metals, hydrocarbons (TRH, BTEX, PAH)	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Very low
		Groundwater Heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Adjacent to construction footprint and tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Moderate
Sub-stations connections: All power supply routes (shallow excavation)	Sub-station including potential firefighting activities	Heavy metals, hydrocarbons (TRH, PAH), PCB, PFAS, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Surficial contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust. Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate

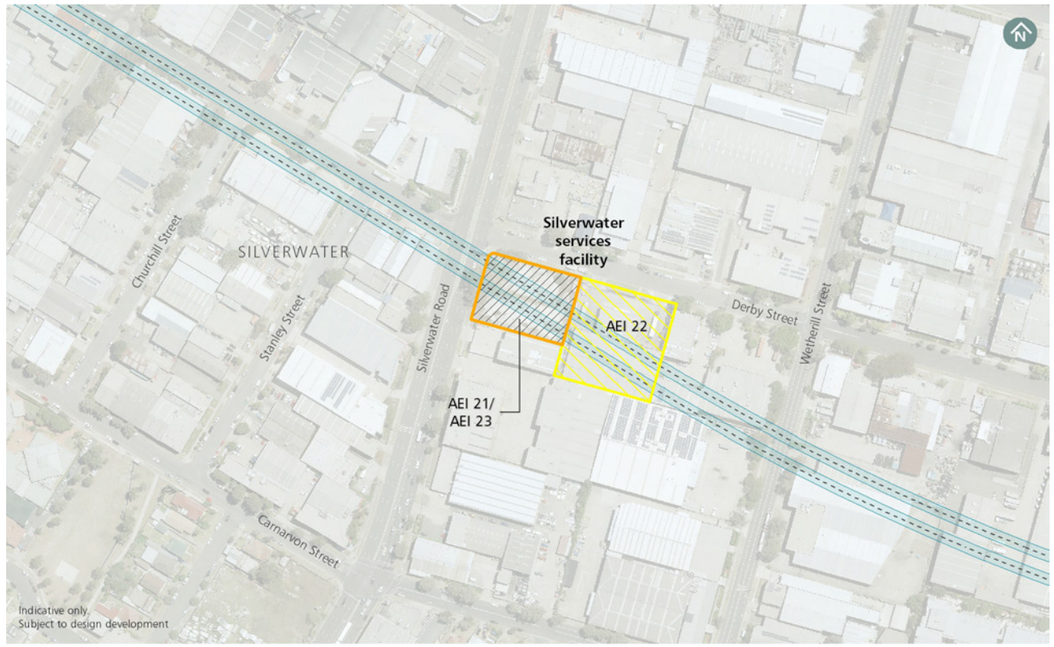

Figure 20-4: Potential contamination risk (moderate rating and above) – Silverwater services facility construction site and tunnel alignment

20.10 Sydney Olympic Park metro station construction site

20.10.1 Existing environment and site contamination review

Land use

The construction site currently comprises large commercial buildings and large carparking areas surrounded by street trees. The gardens and gatehouse associated with a federation-style building is located on the northern portion of the construction site.

Land use zones within and adjoining the construction site include B4 – Mixed Use. Based on permitted land use with or without consent, this land use zone represents a higher potential contamination risk.

Site history

Historical aerial photography shows that the construction site comprised large areas of open space and various road infrastructure in the 1950s. Railway infrastructure was developed in the 1970s and removed in the 1980s. Substantial development occurred at the site during the 1990s in preparation for the redevelopment of Homebush Bay for the 2000 Sydney Olympic Games. This current land use has remained consistent since the late 1990s.

Land uses in the area surrounding the construction site in the 1950s include large commercial and industrial premises, livestock holding yards and paddocks, a brick pit and mangroves along Parramatta River. These land uses (except for mangroves) may be associated with higher contamination risks.

Key developments in the surrounding area since the 1950s include:

- The substantial removal of vegetation and disturbance of terrain in the 1970s
- Landfill works in the 1970s
- Substantial development for the 2000 Sydney Olympic Games.

Database searches

NSW EPA Contaminated Sites Register

There are seven sites listed on the NSW EPA Contaminated Sites Register within 500 metres of the Stage 1 footprint at Sydney Olympic Park. Details of the listings are provided in Table 20-14.

Table 20-14: Sites on the NSW EPA Contaminated Sites Register within 500 metres of the Stage 1 footprint – Sydney Olympic Park

Site address	Site activity	Listing on the NSW EPA Contaminated Sites Register	Contamination status	Location relative to Stage 1
Kevin Coombes Drive, Sydney Olympic Park	Landfill (Haslams Creek South Area 3)	Formerly regulated	Contamination formerly regulated under the CLM Act	About 500 metres north of the tunnel alignment
Kevin Coombes Drive, Sydney Olympic Park	Landfill (Kronos Hill Landfill)	Regulated	Uncontrolled landfilling	About 500 metres north of the tunnel alignment
Sarah Durack Avenue, Sydney Olympic Park	Landfill (Former Golf Driving Range Landfill)	Regulated	Ongoing maintenance required to manage residual contamination (CLM Act)	About 400 metres south-east of the Sydney Olympic Park metro station construction site and above the tunnel alignment
Shane Gould Avenue, Sydney Olympic Park	Landfill (Aquatic Centre)	Regulated	Uncontrolled landfilling	About 100 metres south west of the Sydney Olympic Park metro station construction site and the tunnel alignment
Bicentennial Drive, Sydney Olympic Park	Landfill (Bicentennial Park)	Regulated	Ongoing maintenance required to manage residual contamination (CLM Act)	About 400 metres east of the Sydney Olympic Park metro station construction site and adjacent to the tunnel alignment
1 Underwood Road, Homebush	Other Industry (Mason park Substation)	Notified	Uncontrolled landfilling	About 400 metres south of the tunnel alignment
Corner Pondage Link and Hill Road, Homebush Bay	Landfill	Notified	Ongoing maintenance required to manage residual contamination (CLM Act)	Adjacent (north) to the tunnel alignment

NSW EPA Protection of the Environment Operations Act public register

There are two sites listed on the NSW EPA *Protection of the Environment Operations Act* public register within 500 metres of the Stage 1 footprint at Sydney Olympic Park that have current environment protection licences. Details of the listings are provided in Table 20-15.

Table 20-15: Sites with current environment protection licences within 500 metres of the Stage 1 footprint – Sydney Olympic Park

Site address	Licence holder	Activity	Location relative to construction footprint and tunnel alignment
Corner of Pondage Link and Hill Roads, Homebush Bay	Cleanaway Operations Pty Ltd	Waste storage – hazardous, restricted solid, liquid, clinical and related waste and asbestos waste Non-thermal treatment of hazardous and other waste	• Above tunnel alignment
Hill Road, Homebush Bay	Suez Recycling and Recovery Pty Ltd	Recovery of general waste Non-thermal treatment of general waste Waste storage – waste tyres Waste storage – hazardous, restricted solid, liquid, clinical and related waste and asbestos waste Waste storage – other types of waste	• 70 metres from tunnel alignment

20.10.2 Potential impacts

The potential contamination risk at the Sydney Olympic Park metro station construction site during Stage 1 is summarised in Table 20-16 and Figure 20-5. Overall, the groundwater and landfill gas in the vicinity of the construction site and tunnel alignment have a high potential contamination risk associated with current and historical activities. Further data review and an appropriate management approach would be implemented in accordance with the measures in Section 20.17.

Table 20-16: Potential contamination risk – Sydney Olympic Park metro station construction site

Construction element and anticipated depth	Site of concern and potential source of contamination	Contamination severity and extent assessment			Pathways and receptors Assessment of relationship to construction footprint and scope				Potential contamination risk
		Media and COPCs	Contamination status	Rating	Location relative to Stage 1	Potential for contamination to be intersected by Stage 1	Exposure pathways	Rating	
Tunnel (depth)	AEI 26 Waste storage – hazardous, restricted solid, liquid, clinical and related waste and asbestos waste Non-thermal treatment of hazardous and other waste	Groundwater Nutrients, heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC, PFAS.	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE2	Above the tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within the alignment	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater. Ecosystems of Haslams Creek and receiving waters could be exposed to contamination via uncontrolled releases (water) during construction	PR2	Moderate
Tunnel (depth)	AEI 27 Uncontrolled landfilling (former Haslams Creek South Area 3 Landfill – Kevin Coombes Drive, Sydney Olympic Park) – Known areas of waste and groundwater contamination	Waste Heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC, PFAS, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Approx. 500 metres north of the tunnel alignment	Surficial contamination from source site unlikely to migrate from source site and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Low
		Groundwater Nutrients, heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC, PFAS	Known contamination present at concentrations above the relevant assessment criteria and widespread	SE5	Approx. 500 metres north of the tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within the alignment	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater. Ecosystems of Haslams Creek and receiving waters could be exposed to contamination via uncontrolled releases (water) during construction	PR2	High
		Vapour and landfill gas Methane, Hydrogen sulphide, carbon dioxide, VOC	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Approx. 500 metres north of the tunnel alignment	Potential for landfill gas and vapour from off-site source to be present at depth within the alignment	Construction workers could be exposed to contamination via landfill gas and vapour emissions (inhalation) Adjacent site users could be exposed to contamination via landfill gas and vapour emissions (inhalation)	PR2	Moderate
Tunnel (depth)	AEI 28 Uncontrolled landfilling (former Kronos Hill Landfill – Kevin Coombes Drive, Sydney Olympic Park) – Known areas of waste and groundwater contamination	Waste Heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC, PFAS, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Approx. 500 metres north of the tunnel alignment	Surficial contamination from source site unlikely to migrate from source site and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Low

Construction element and anticipated depth	Site of concern and potential source of contamination	Contamination severity and extent assessment			Pathways and receptors Assessment of relationship to construction footprint and scope				Potential contamination risk
		Media and COPCs	Contamination status	Rating	Location relative to Stage 1	Potential for contamination to be intersected by Stage 1	Exposure pathways	Rating	
	AEI 28 cont.	Groundwater Nutrients, heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC, PFAS	Known contamination present at concentrations above the relevant assessment criteria and widespread	SE5	Approx. 500 metres north of the tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within the alignment	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater Ecosystems of Haslams Creek and receiving waters could be exposed to contamination via uncontrolled releases (water) during construction	PR2	High
		Vapour and landfill gas Methane, Hydrogen sulphide, carbon dioxide, VOC	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Approx. 500 metres north of the tunnel alignment	Potential for landfill gas and vapour from off-site source to be present at depth within the alignment	Construction workers could be exposed to contamination via landfill gas and vapour emissions (inhalation) Adjacent site users could be exposed to contamination via landfill gas and vapour emissions (inhalation)	PR2	Moderate
Tunnel (depth)	AEI 29 Uncontrolled landfilling (Corner Pondage Link and Hill Road, Sydney Olympic Park) – Known areas of waste and groundwater contamination	Waste Heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC, PFAS, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Adjacent (north) of the tunnel alignment	Surficial contamination from source site unlikely to migrate from source site and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Low
		Groundwater Nutrients, heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC, PFAS	Known contamination present at concentrations above the relevant assessment criteria and widespread	SE5	Adjacent (north) of the tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within the alignment	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater. Ecosystems of Haslams Creek and receiving waters could be exposed to contamination via uncontrolled releases (water) during construction	PR2	High
		Vapour and landfill gas Methane, Hydrogen sulphide, carbon dioxide, VOC	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Adjacent (north) of the tunnel alignment	Potential for landfill gas and vapour from off-site source to be present at depth within the alignment	Construction workers could be exposed to contamination via landfill gas and vapour emissions (inhalation). Adjacent site users could be exposed to contamination via landfill gas and vapour emissions (inhalation)	PR2	Moderate
Station and tunnel (shallow and depth)	AEI 30 Uncontrolled landfilling (former Golf Driving Range Landfill – Sarah Durack Avenue, Sydney Olympic Park) – Known areas of waste and groundwater contamination	Waste Heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC, PFAS, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Approx. 400 metres south-east of construction footprint and above the tunnel alignment	Surficial contamination from source site unlikely to migrate from source site and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Low
		Groundwater Nutrients, heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC, PFAS	Known contamination present at concentrations above the relevant assessment criteria and widespread	SE5	Approx. 400 metres south-east of construction footprint and above the tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater. Ecosystems of Lake Belvedere and receiving waters could be exposed to contamination via uncontrolled releases (water) during construction	PR2	High
		Vapour and landfill gas Methane, Hydrogen sulphide, carbon dioxide, VOC	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Approx. 400 metres south-east of construction footprint and above the tunnel alignment	Potential for landfill gas and vapour from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via landfill gas and vapour emissions (inhalation). Adjacent site users could be exposed to contamination via landfill gas and vapour emissions (inhalation)	PR2	Moderate

Construction element and anticipated depth	Site of concern and potential source of contamination	Contamination severity and extent assessment			Pathways and receptors Assessment of relationship to construction footprint and scope				Potential contamination risk
		Media and COPCs	Contamination status	Rating	Location relative to Stage 1	Potential for contamination to be intersected by Stage 1	Exposure pathways	Rating	
Station and tunnel (shallow and depth)	AEI 31 Uncontrolled landfilling (Aquatic Centre Landfill – Shane Gould Avenue, Sydney Olympic Park) – Known areas of waste and groundwater contamination	Waste Heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC, PFAS, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Approx. 100 metres south west of construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate from source site and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Low
		Groundwater Nutrients, heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC, PFAS	Known contamination present at concentrations above the relevant assessment criteria and widespread	SE5	Approx. 100 metres south west of construction footprint and tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater. Ecosystems of Lake Belvedere and receiving waters could be exposed to contamination via uncontrolled releases (water) during construction	PR2	High
		Vapour and landfill gas Methane, Hydrogen sulphide, carbon dioxide, VOC	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Approx. 100 metres south west of construction footprint and tunnel alignment	Potential for landfill gas and vapour from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via landfill gas and vapour emissions (inhalation). Adjacent site users could be exposed to contamination via landfill gas and vapour emissions (inhalation)	PR2	Moderate
Station and tunnel (shallow and depth)	AEI 32 Uncontrolled landfilling (Bicentennial Park Landfill – Bicentennial Drive, Sydney Olympic Park) – Known areas of waste	Waste Heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC, PFAS, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Approx. 400 metres east of construction footprint and adjacent to tunnel alignment	Surficial contamination from source site unlikely to migrate from source site and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Low
		Groundwater Nutrients, heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC, PFAS	Known contamination present at concentrations above the relevant assessment criteria and widespread	SE5	Approx. 400 metres east of construction footprint and adjacent to tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater. Ecosystems of Lake Belvedere and receiving waters could be exposed to contamination via uncontrolled releases (water) during construction	PR2	High
		Vapour and landfill gas Methane, Hydrogen sulphide, carbon dioxide, VOC	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Approx. 400 metres east of construction footprint and adjacent to tunnel alignment	Potential for landfill gas and vapour from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via landfill gas and vapour emissions (inhalation). Adjacent site users could be exposed to contamination via landfill gas and vapour emissions (inhalation)	PR2	Moderate
Station and tunnel (shallow and depth)	AEI 33 Former abattoir – Inappropriate chemical storage and use, waste disposal and burials	Surface soil Pathogens, pesticides	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate from source site and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Very low
		Groundwater Nutrients, pathogens	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Adjacent to construction footprint and tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater. Ecosystems of Lake Belvedere and receiving waters could be exposed to contamination via uncontrolled releases (water) during construction	PR2	Moderate

Construction element and anticipated depth	Site of concern and potential source of contamination	Contamination severity and extent assessment			Pathways and receptors Assessment of relationship to construction footprint and scope				Potential contamination risk
		Media and COPCs	Contamination status	Rating	Location relative to Stage 1	Potential for contamination to be intersected by Stage 1	Exposure pathways	Rating	
Tunnel (depth)	AEI 34 Mason Park Substation – Potential firefighting activities	PFAS	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Approx. 400 metres metres south of the tunnel alignment	Potential for contaminated groundwater to be present within the alignment	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater. Ecosystems of Lake Belvedere and receiving waters could be exposed to contamination via uncontrolled releases (water) during construction	PR2	Moderate
Sub-stations connections: All power supply routes (shallow excavation)	Sub-station including potential firefighting activities	Heavy metals, hydrocarbons (TRH, PAH), PCB, PFAS, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Surficial contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust. Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate

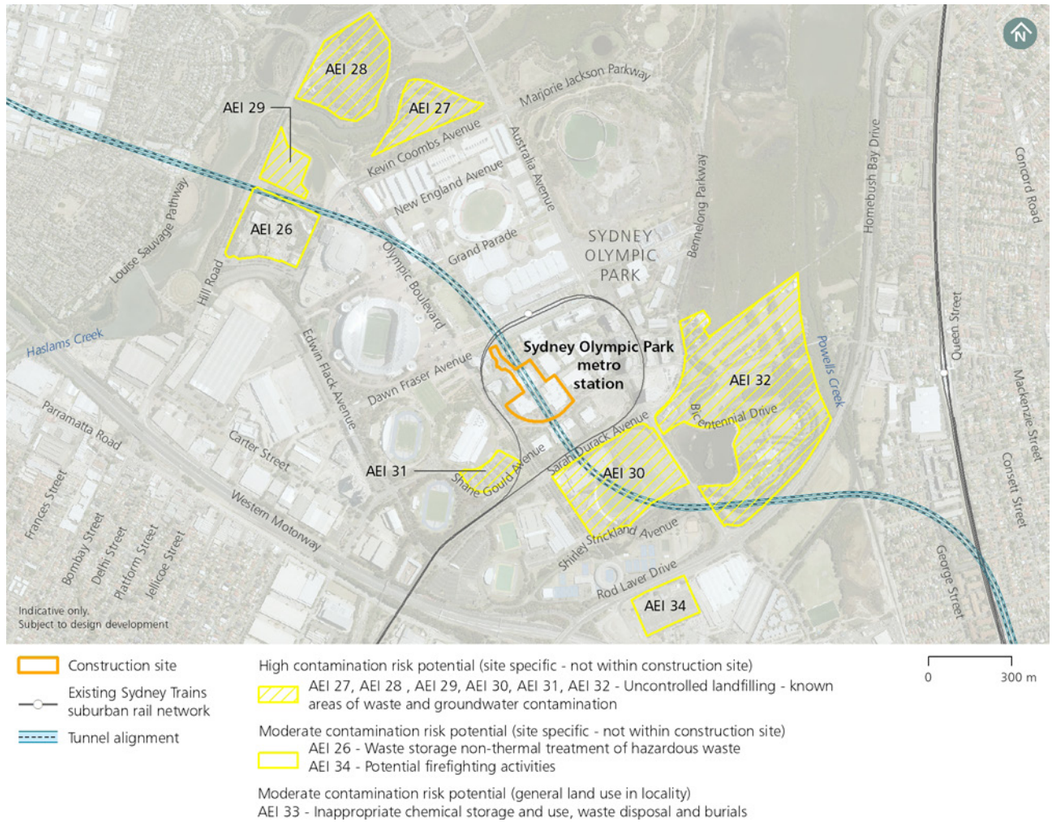

Figure 20-5: Potential contamination risk (moderate rating and above) – Sydney Olympic Park metro station construction site and tunnel alignment

20.11 North Strathfield metro station construction site

20.11.1 Existing environment and site contamination review

Land use

The construction site currently comprises areas within the existing North Strathfield Station. The northern construction site is currently vacant and includes vegetation along Queen Street. The southern construction site comprises restricted car parking and rail infrastructure.

Land use zones within and adjoining the construction site include:

- R2 – Low Density Residential
- R3 – Medium Density Residential
- SP2 – Infrastructure (rail)
- RE1 – Public Recreation
- B1 – Neighbourhood Centre
- B3 – Commercial Core
- B4 – Mixed Use.

Based on permitted land use with or without consent, the infrastructure (SP2 – Infrastructure (rail)) and mixed use (B4 – Mixed Use) land use zones represent a higher potential contamination risk.

Site history

Historical aerial photography shows that the construction site between the existing North Strathfield station and Queen Street has been vacant land since at least 1950. This land use has remained largely unchanged, with the development of a number of small buildings and structure in the 1980s and 1990s.

Land uses in the area surrounding the construction site since the 1950s include low density residential development, commercial and industrial premises, and the existing North Strathfield Station. Key developments in the surrounding area since the 1950s include the demolition of large commercial and industrial buildings to the west of the construction site in the 1980s, and development of medium density residential premises in the late 1990s and early 2000s. Commercial and industrial premises may be associated with higher contamination risks.

Database searches

NSW EPA Contaminated Sites Register

There are two sites listed on the NSW EPA Contaminated Sites Register within 500 metres of the Stage 1 footprint at North Strathfield. Details of the listings are provided in Table 20-17.

Table 20-17: Sites on the NSW EPA Contaminated Sites Register within 500 metres of the Stage 1 footprint – North Strathfield

Site address	Site activity	Listing on the NSW EPA Contaminated Sites Register	Contamination status	Location relative to Stage 1
143 Concord Road, North Strathfield	Service station	Notified	Regulation under CLM Act not required	About 340 metres south-east from the North Strathfield metro station construction site and tunnel alignment
92A Concord Road, North Strathfield	Service station (former)	Notified	Regulation under CLM Act not required	About 450 metres south-east from the North Strathfield metro station construction site and 50 metres north of the tunnel alignment

NSW EPA Protection of the Environment Operations Act public register

There is one site listed on the NSW EPA *Protection of the Environment Operations Act* public register within 500 metres of the Stage 1 footprint at North Strathfield that have current environment protection licences. Details of the listings are provided in Table 20-18.

Table 20-18: Sites with current environment protection licences within 500 metres of the Stage 1 footprint – North Strathfield

Site address	Licence holder	Activity	Location relative to construction footprint and tunnel alignment
25-27 Pomeroy Street, Homebush	Ausgrid Operator Partnership	Waste storage – hazardous, restricted solid, liquid, clinical and related waste and asbestos waste	460 metres from tunnel alignment

20.11.2 Potential impacts

The potential contamination risks at the North Strathfield metro station construction site during Stage 1 is summarised in Table 20-19 and Figure 20-6. Overall, the soils and groundwater in the vicinity of the construction site and tunnel alignment have a moderate potential contamination risk associated with current and historical activities. Further data review and an appropriate management approach would be implemented in accordance with the measures in Section 20.17.

Table 20-19: Potential contamination risk – North Strathfield metro station construction site

Construction element and anticipated depth	Site of concern and potential source of contamination	Contamination severity and extent assessment			Pathways and receptors Assessment of relationship to construction footprint and scope				Potential contamination risk
		Media and COPCs	Contamination status	Rating	Location relative to Stage 1	Potential for contamination to be intersected by Stage 1	Exposure pathways	Rating	
Station (shallow excavation)	AEI 35 Existing North Strathfield Station – Residuals from historical and current railway use	Surface soils Heavy metals, hydrocarbons (TRH, BTEX, PAH), pesticides, herbicides, asbestos	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and ecological receptors	PR1	Very low
Station and tunnel (depth)	AEI 36 Funeral home – Embalming chemicals	Groundwater Hydrocarbons (TRH, BTEX), solvents (namely formaldehyde)	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Adjacent to construction footprint and tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Moderate
Station and tunnel (shallow and depth)	AEI 37 Dry cleaners – Residuals from current dry cleaning activities	Surface soil Chlorinated hydrocarbons, VOCs	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Very low
		Groundwater Chlorinated hydrocarbons, VOCs	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Adjacent to construction footprint and tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Moderate
		Vapour Chlorinated hydrocarbons, VOCs	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Within construction footprint and tunnel alignment	Contamination (if present) could be exposed during excavation of materials to the depth of construction	Construction workers could be exposed to contamination via vapour emissions (inhalation) Adjacent site users could be exposed to contamination via vapour emissions (inhalation)	PR2	Moderate

Construction element and anticipated depth	Site of concern and potential source of contamination	Contamination severity and extent assessment			Pathways and receptors Assessment of relationship to construction footprint and scope				Potential contamination risk
		Media and COPCs	Contamination status	Rating	Location relative to Stage 1	Potential for contamination to be intersected by Stage 1	Exposure pathways	Rating	
Station (shallow excavation)	AEI 38 Former and existing structures – Hazardous building materials within or from on-site buildings / structures, demolition wastes	Surface soil Heavy metals, hydrocarbons (TRH, PAH), pesticides, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Surficial contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate
Station and tunnel (shallow and depth)	AEI 39 Historical commercial / industrial use within locality – Inappropriate chemical storage and use, industrial operations, waste disposal and management etc	Surface soil Heavy metals, hydrocarbons (TRH, BTEX, PAH)	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Very low
		Groundwater Heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Adjacent to construction footprint and tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Moderate
Station and tunnel (shallow and depth)	AEI 40 Switch Yard (Underwood Road, North Strathfield) – Potential firefighting activities	Groundwater PFAS	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Approx. 500 metres west of construction site and the tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Moderate
Sub-stations connections: All power supply routes (shallow excavation)	Sub-station including potential firefighting activities	Heavy metals, hydrocarbons (TRH, PAH), PCB, PFAS, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Surficial contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust. Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate

Figure 20-6: Potential contamination risk (moderate rating and above) – North Strathfield metro station construction site and tunnel alignment

20.12 Burwood North Station construction site

20.12.1 Existing environment and site contamination review

Land use

The northern construction site currently comprises commercial, industrial and low-density residential land uses. The southern construction site currently includes commercial and industrial land uses. Existing land uses of interest from a contamination perspective include:

- Car mechanics
- An automotive dealership.

Parramatta Road is located between the northern and southern construction sites. Burwood Road is located adjacent to both construction sites.

Land use zones within and adjoining the construction site include:

- B6 – Enterprise Corridor
- SP2 – Infrastructure (road)
- B4 – Mixed Use
- R3 – Medium Density Residential
- R2 – Low Density Residential
- RE1 – Public Recreation.

Based on permitted land use with or without consent, the business (B6 – Enterprise Corridor and B4 – Mixed Use) and infrastructure (SP2 – Infrastructure (road)) land use zones represent a higher potential contamination risk.

Site history

Historical aerial photography shows that the construction site has comprised small-scale commercial, retail and industrial land uses in the 1950s, with low density residential premises in the north. This land use has remained largely unchanged, except for small structural extensions, modifications and demolitions in the 1980s and 1990s.

Land uses in the area surrounding the construction site since the 1950s include low density residential development, commercial, industrial and retail premises, and a large area of open space in the vicinity of the current Concord Oval site. Commercial and industrial premises may be associated with higher contamination risks.

Key developments in the surrounding area since the 1950s include:

- The formalisation of Burwood Road in the 1970s
- Development of Burwood Bus Depot in 1970s
- The development of Concord Oval in the 1980s, including grandstands and associated landscaping.

Database searches

NSW EPA Contaminated Sites Register

There are two sites listed on the NSW EPA Contaminated Sites Register within 500 metres of the Stage 1 footprint at Burwood. Details of the listings are provided in Table 20-20.

Table 20-20: Sites on the NSW EPA Contaminated Sites Register within 500 metres of the Stage 1 footprint – Burwood North

Site address	Site activity	Listing on the NSW EPA Contaminated Sites Register	Contamination status	Location relative to Stage 1
89 Parramatta Road, Concord	Service station	Notified	Regulation under CLM Act not required	About 100 metres south-west of the tunnel alignment
Corner Shaftesbury and Parramatta Road, Burwood	Other industry (Burwood STA Depot)	Formerly regulated	Contamination formerly regulated under the CLM Act.	About 100 metres south of the Burwood North Station construction site and the tunnel alignment

NSW EPA Protection of the Environment Operations Act public register

There are no sites listed on the NSW EPA *Protection of the Environment Operations Act* public register within 500 metres of the Stage 1 footprint that have current environment protection licences.

20.12.2 Potential impacts

The potential contamination risks at the Burwood North Station construction site during Stage 1 is summarised in Table 20-21 and Figure 20-7. Overall, the soils and groundwater in the vicinity of the construction site and tunnel alignment have a moderate potential contamination risk associated with current and historical activities. Further data review and an appropriate management approach would be implemented in accordance with the measures in Section 20.17.

Table 20-21: Potential contamination risk – Burwood North Station construction site

Construction element and anticipated depth	Site of concern and potential source of contamination	Contamination severity and extent assessment			Pathways and receptors Assessment of relationship to construction footprint and scope				Potential contamination risk
		Media and COPCs	Contamination status	Rating	Location relative to Stage 1	Potential for contamination to be intersected by Stage 1	Exposure pathways	Rating	
Station and tunnel (shallow and depth)	AEI 41 Mechanical workshop – Leaks and spills from automotive facilities, car dealerships and bus depot	Surface soil Heavy metals, hydrocarbons (TRH, BTEX, PAH), asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate
		Groundwater Hydrocarbons (TRH, BTEX, PAH), volatile organic compounds (VOC)	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Moderate
Station and tunnel (shallow and depth)	AEI 42 Car wash and detailing – Chemical and wax use	Surface soil Solvents (VOC), surfactants, PFAS	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate from source site and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Very low
		Groundwater Solvents (VOC), surfactants, PFAS compounds (VOC)	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Adjacent to construction footprint and tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Moderate
Station (shallow excavation)	AEI 43 Former and existing structures – Hazardous building materials within or from on-site buildings / structures, demolition wastes	Surface soil Heavy metals, hydrocarbons (TRH, PAH), pesticides, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Surficial contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate
Station (shallow excavation)	AEI 44 Parramatta Road – Vehicle particulate deposition	Surface soil Lead, PAHs, asbestos	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint	Surficial contamination (if present) could be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust	PR2	Moderate
Station and tunnel (shallow and depth)	AEI 45 Historical commercial / industrial use within locality – Inappropriate chemical storage and use, industrial operations, waste disposal and management etc	Surface soil Heavy metals, hydrocarbons (TRH, BTEX, PAH)	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Very low
		Groundwater Heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Adjacent to construction footprint and tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Moderate
Sub-stations connections: All power supply routes (shallow excavation)	Sub-station including potential firefighting activities	Heavy metals, hydrocarbons (TRH, PAH), PCB, PFAS, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Surficial contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust. Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate

Figure 20-7: Potential contamination risk (moderate rating and above) – Burwood North Station construction site and tunnel alignment

20.13 Five Dock Station construction site

20.13.1 Existing environment and site contamination review

Land use

The western construction site currently comprises commercial land uses with external car parking facilities and street landscaping. The eastern construction site comprises low-density residential land uses with an external car parking facility and street landscaping.

Land use zones within and adjoining the construction site include:

- B4 – Mixed Use
- R3 – Medium Density Residential
- R2 – Low Density Residential
- RE1 – Public Recreation.

Based on permitted land use with or without consent, the mixed use land use zone represents a higher potential contamination risk.

Site history

Historical aerial photography shows that the construction site comprised low density residential and small-scale commercial, retail and industrial land uses fronting Great North Road in the 1950s. This land use remained largely unchanged until the late 1990s and early 2000s, with substantial demolition and redevelopment commercial, industrial and residential premises on the western construction site.

Land uses in the area surrounding the construction site since the 1950s include low density residential development, small commercial and industrial premises, and a large open space in the vicinity of the current Five Dock Park. These land uses have remained largely consistent, except for localised demolition and redevelopment works. Commercial and industrial premises may be associated with higher contamination risks.

Database searches

NSW EPA Contaminated Sites Register

There are two sites listed on the NSW EPA Contaminated Sites Register within 500 metres of the Stage 1 footprint at Five Dock. Details of the listings are provided in Table 20-22.

Table 20-22: Sites on the NSW EPA Contaminated Sites Register within 500 metres of the Stage 1 footprint – Five Dock

Site address	Site activity	Listing on the NSW EPA Contaminated Sites Register	Contamination status	Location relative to Stage 1
231-235 Great North Road, Five Dock	Service Station	Notified	Regulation under CLM Act not required	About 200 metres north of the Five Dock Station construction site and tunnel alignment
47 Ramsay Road, corner Fairlight Street, Five Dock	Service Station	Notified	Regulation under CLM Act not required	Approximately 120 metres south of the Five Dock Station construction site and tunnel alignment

NSW EPA Protection of the Environment Operations Act public register

There are no sites listed on the NSW EPA *Protection of the Environment Operations Act* public register within 500 metres of the Stage 1 footprint that have current environment protection licences.

20.13.2 Potential impacts

The potential contamination risk at the Five Dock Station construction site during Stage 1 is summarised in Table 20-23 and Figure 20-8. Overall, the soils and groundwater in the vicinity of the construction site and tunnel alignment have a moderate potential contamination risk associated with current and historical activities. Further data review and an appropriate management approach would be implemented in accordance with the measures in Section 20.17.

Table 20-23: Potential contamination risk – Five Dock Station construction site

Construction element and anticipated depth	Site of concern and potential source of contamination	Contamination severity and extent assessment			Pathways and receptors Assessment of relationship to construction footprint and scope				Potential contamination risk
		Media and COPCs	Contamination status	Rating	Location relative to Stage 1	Potential for contamination to be intersected by Stage 1	Exposure pathways	Rating	
Station and tunnel (depth)	AEI 46 Funeral home – Embalming chemicals	Groundwater Hydrocarbons (TRH, BTEX), solvents (namely formaldehyde)	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Approx. 150 metres north and south of the construction footprint and tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Moderate
Station (shallow excavation)	AEI 47 Former and existing structures – Hazardous building materials within or from on-site buildings / structures, demolition wastes	Surface soil Heavy metals, hydrocarbons (TRH, PAH), pesticides, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Surficial contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate
Station (shallow excavation)	AEI 48 Chamber Substation – Operational sub-station	Surface soil PCB	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate from source site and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Very low
Station and tunnel (depth)	AEI 49 Former service station – Leaks and spills from underground petroleum storage infrastructure	Groundwater Hydrocarbons (TRH, BTEX)	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint and tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Low
Station and tunnel (shallow and depth)	AEI 50 Historical commercial / industrial use within locality – Inappropriate chemical storage and use, industrial operations, waste disposal and management etc	Surface soil Heavy metals, hydrocarbons (TRH, BTEX, PAH)	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Very low
		Groundwater Heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Adjacent to construction footprint and tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Moderate
Sub-stations connections: All power supply routes (shallow excavation)	Sub-station including potential firefighting activities	Heavy metals, hydrocarbons (TRH, PAH), PCB, PFAS, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Surficial contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust. Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate

Figure 20-8: Potential contamination risk (moderate rating and above) – Five Dock Station construction site and tunnel alignment

20.14 The Bays Station construction site

20.14.1 Existing environment and site contamination review

Land use

The construction site is located within the White Bay industrial area adjacent to the former White Bay Power Station. The site is largely vacant and comprises paved asphalt surfaces with some grassed areas. Land use features includes:

- A large fenced-off stockpile comprising soil and ballast
- A bus stop
- Two historical rail lines extending from the south-west to the north-east of the site
- Several historical groundwater wells
- A historical pond associated with the power station along the north-western boundary of the site
- A storage area for old timber and electrical infrastructure in the south-western portion of the site.

Land use zones within and adjoining the construction site include:

- Port and Employment
- IN2 – Light Industrial
- W1 – Maritime Waters.

Based on permitted land use with or without consent, the IN2 – Light Industrial land use zone represents a higher potential contamination risk.

Site history

Historical aerial photography shows that the construction site has comprised heavy industrial land uses associated with the former White Bay Power Station since at least 1930, including stockpiling, rail and wharf infrastructure. This land use remained largely unchanged until the 1980s, following the decommissioning of White Bay Power Station. Since the 1980s, the site has undergone minor changes, including increases in vacant land and the addition of road or rail infrastructure across the site.

Land uses in the area surrounding the construction site since the 1930s include residential development, commercial and industrial premises, and White Bay. Commercial and industrial premises may be associated with higher contamination risks. Key developments in the surrounding area since the 1930s include:

- The use of bulk storage tanks between the 1940s and 1970s
- Potential land reclamation in White Bay in the 1970s
- Commercial and industrial development, including disturbance of terrain and earth works in the 1970s and 1990s
- Extensions and modifications to residential and commercial/industrial areas in the 1980s
- The use of Glebe Island for the storage of motor vehicles in the 1990s.

Database searches

NSW EPA Contaminated Sites Register

There are five sites listed on the NSW EPA Contaminated Sites Register within 500 metres of the Stage 1 footprint at The Bays. Details of the listings are provided in Table 20-24.

Table 20-24: Sites on the NSW EPA Contaminated Sites Register within 500 metres of the Stage 1 footprint – The Bays

Site address	Site activity	Listing on the NSW EPA Contaminated Sites Register	Contamination status	Location relative to Stage 1
Robert Street, Rozelle	Other Industry (White Bay Power Station)	Formerly regulated	EHC Act Revocation Notice (Former)	Within The Bays Station construction site and above tunnel alignment
Reynolds Street, Rozelle	Former Unilever Sulphonation Plant	Formerly regulated	Asbestos and PCB contamination	About 400 metres north-west of The Bays Station construction site and tunnel alignment
178-180 Victoria Road, Rozelle	Service station	Notified	EHC Act Revocation Notice (Former)	About 300 metres north of the tunnel alignment
121 Victoria Road, Rozelle	Service station	Notified	Heavy metals, polycyclic aromatic hydrocarbons, linear alkylbenzene and linear alkylbenzene sulphonate compound contamination	About 350 metres north of the tunnel alignment
15-39 Wellington Street, Rozelle	Other petroleum	Notified	Regulation under CLM Act not required	About 450 metres north of the tunnel alignment

NSW EPA Protection of the Environment Operations Act public register

There are nine sites listed on the NSW EPA *Protection of the Environment Operations Act* public register within 500 metres of the Stage 1 footprint at The Bays that have current environment protection licences. Details of the listings are provided in Table 20-25.

Table 20-25: Sites with current environment protection licences within 500 metres of the Stage 1 footprint – The Bays

Site address	Licence holder	Activity	Location relative to construction footprint and tunnel alignment
Sommerville Road, Rozelle	Cement Australia Holdings Pty Ltd	Shipping in bulk Cement or lime handling	• Adjacent to construction site • 50 metres from tunnel alignment
Sommerville Road, Rozelle	Gypsum Resources Australia Pty Ltd	Shipping in bulk	• Adjacent to construction site • 50 metres from tunnel alignment
WestConnex between the M4-M5 Mainline Tunnels and Rozelle, Rozelle	John Holland Pty Ltd	Road construction (WestConnex)	• Adjacent to construction site
Sommerville Road, Rozelle	Newcastle Port Corporation	Shipping in bulk	• Adjacent to construction site
James Craig Road, Rozelle	Transport for NSW	Boat construction/maintenance (general)	• 150 metres from construction site • 200 metres from tunnel alignment
Lot 1 Sommerville Road, Rozelle	Sugar Australia Pty Ltd	General agricultural processing Shipping in bulk	• Adjacent to construction site • 50 metres from tunnel alignment
James Craig Road, Rozelle	Sydney Boathouse Holdings Pty Ltd	Boat mooring and storage	• 130 metres from construction site • 160 metres from tunnel alignment
37 James Craig Road, Rozelle	Sydney City Marine Pty Ltd	Boat construction/maintenance (general)	• 210 metres from construction site • 200 metres from tunnel alignment
Berth 4 White Bay Robert Street, Balmain	Port Authority of NSW	Shipping in bulk	• Adjacent to construction site • 50 metres from tunnel alignment

20.14.2 Potential impacts

The potential contamination risks at The Bays Station construction site during Stage 1 is summarised in Table 20-26 and Figure 20-9. Overall, the soils and groundwater in the vicinity of the construction site and tunnel alignment have a moderate potential contamination risk associated with current and historical activities. There is also potential to expose contamination during the construction of the power supply route for the Bays Station construction site. Further data review and an appropriate management approach would be implemented in accordance with the measures in Section 20.17.

Table 20-26: Potential contamination risk – The Bays Station construction site

Construction element and anticipated depth	Site of concern and potential source of contamination	Contamination severity and extent assessment			Pathways and receptors Assessment of relationship to construction footprint and scope				Potential contamination risk
		Media and COPCs	Contamination status	Rating	Location relative to Stage 1	Potential for contamination to be intersected by Stage 1	Exposure pathways	Rating	
Tunnel (depth)	AEI 51 Historical commercial / industrial use (including 469-483 Balmain Road, Lilyfield) – Inappropriate chemical storage and use, industrial operations, waste disposal and management etc	Groundwater Heavy metals, hydrocarbons (TRH, BTEX, PAH), volatile organic compounds (VOC)	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Adjacent to construction footprint and alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (der, ing) with contaminated groundwater	PR2	Moderate
Station and tunnel (shallow and depth)	AEI 52 Mechanical workshop – Leaks and spills from automotive facilities	Surface soil Heavy metals, hydrocarbons (TRH, BTEX, PAH), asbestos	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate from source site and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Very low
		Groundwater Hydrocarbons (TRH, BTEX, PAH), VOC	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Adjacent to construction footprint and tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater Ecosystems of White Bay could be exposed to contamination via uncontrolled releases (sediment and water) during construction	PR2	Moderate

Construction element and anticipated depth	Site of concern and potential source of contamination	Contamination severity and extent assessment			Pathways and receptors Assessment of relationship to construction footprint and scope				Potential contamination risk
		Media and COPCs	Contamination status	Rating	Location relative to Stage 1	Potential for contamination to be intersected by Stage 1	Exposure pathways	Rating	
Station and tunnel (shallow and depth)	AEI 53 Former White Bay Power Station activities (with substation) and structures (including potential firefighting activities)	Surface soil Heavy metals, hydrocarbons (TRH, PAH), PCB, asbestos, PFAS	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Surficial contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate
		Groundwater Heavy metals, hydrocarbons (TRH, PAH), PFAS	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Contamination (if present) could be exposed during excavation of materials to the depth of construction	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater Ecosystems of White Bay could be exposed to contamination via uncontrolled releases (water) during construction	PR2	Moderate
Station and tunnel (shallow and depth)	AEI 54 Land reclamation – Historical use of potentially contaminated fill adjacent to waterways	Surface soil Heavy metals, hydrocarbons (TRH, PAH), pesticides, PCB, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Surficial contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate
		Groundwater Heavy metals, hydrocarbons (TRH, PAH)	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Contamination (if present) could be exposed during excavation of materials to the depth of construction	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater Ecosystems of White Bay could be exposed to contamination via uncontrolled releases (water) during construction	PR2	Moderate
Station and tunnel (shallow and depth)	AEI 55 Historical commercial / industrial use – Inappropriate chemical storage and use, industrial operations, waste disposal and management etc	Surface soil Heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC, PFAS	Low potential for contamination to be present at concentrations above the relevant assessment criteria and limited in extent	SE1	Adjacent to construction footprint and tunnel alignment	Surficial contamination from source site unlikely to migrate and be exposed during construction	Contamination unlikely to be exposed during construction and therefore unlikely to impact upon human and environmental receptors	PR1	Very low
		Groundwater Heavy metals, hydrocarbons (TRH, BTEX, PAH), VOC, PFAS	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Adjacent to construction footprint and tunnel alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Moderate
Station and tunnel (depth)	AEI 56 Switch Yard (Manning Street, Rozelle) – Potential firefighting activities	Groundwater PFAS	Contamination possibly present at concentrations above the relevant assessment criteria and widespread	SE3	Approx. 300 metres north of the alignment	Potential for contaminated groundwater migration from off-site source to be present at depth within construction footprint	Construction workers could be exposed to contamination via contact (direct contact, ingestion) with contaminated groundwater	PR2	Moderate
The Bays metro station construction site: Power supply route (shallow excavation)	Wastes associated with historical industry within the general locality or from harbourside industry (potential coal/coke wastes, ash and slag) to have been used in the construction of the roadways and as fill in the general locality	Surface soils Heavy metals, hydrocarbons (TRH, PAH), PCB, PFAS, asbestos	Contamination possibly present at concentrations above the relevant assessment criteria and limited in extent	SE2	Within construction footprint and tunnel alignment	Surficial contamination (if present) will be exposed during excavation of surface materials	Construction workers could be exposed to contamination via contact (direct contact, ingestion, inhalation) with contaminated soils and dust. Adjacent site users could be exposed to contamination via dust emissions (inhalation), namely asbestos	PR3	Moderate

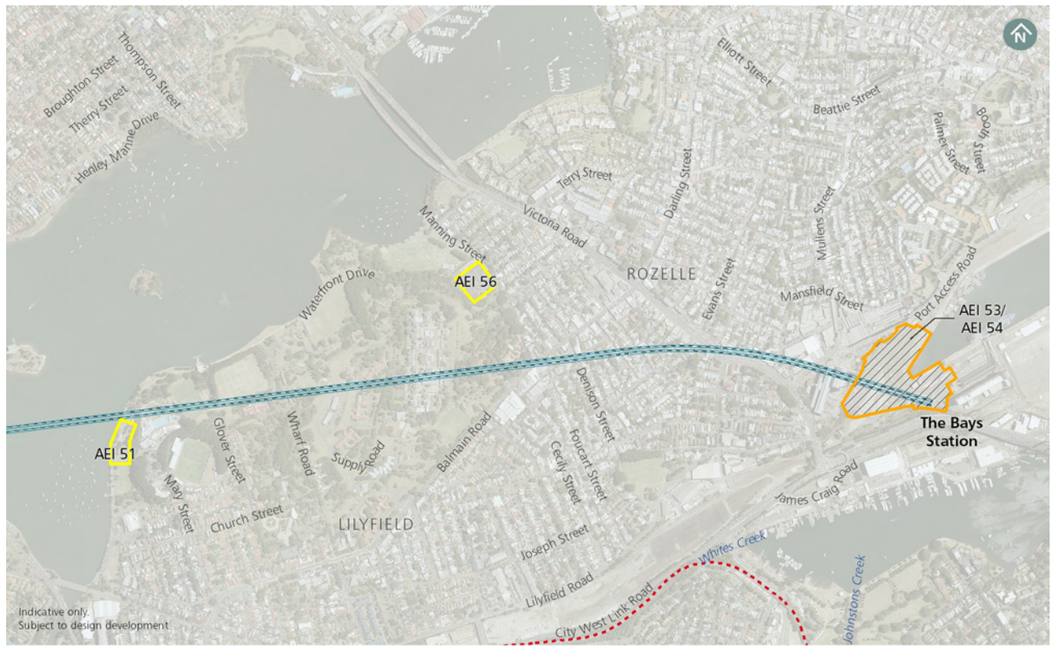

Figure 20-9: Potential contamination risk (moderate rating and above) – The Bays Station construction site and tunnel alignment

20.15 Contamination overall assessment

A summary of the potential contamination risks at the Stage 1 construction sites is provided in Table 20-27.

Table 20-27: Summary of potential contamination risks to Stage 1

Construction site	Potential contamination risks to Stage 1			Overall potential contamination risk
	Soil	Groundwater	Vapour/gas	
Westmead metro station	●	●		Moderate
Parramatta metro station	●	●	●	Moderate
Clyde stabling and maintenance facility	●	●	●	Moderate
Silverwater services facility	●	●	●	Moderate to high
Sydney Olympic Park metro station		●	●	High
North Strathfield metro station	●			Moderate
Burwood North Station	●	●		Moderate
Five Dock Station	●			Moderate
The Bays Station	●	●		Moderate

20.16 Cumulative impacts

Potential cumulative impacts were considered for assessment based on the likely interactions of Stage 1 with other projects and plans that met the adopted screening criteria. The approach to assessment and the other projects considered are described further in Appendix G (Cumulative impacts assessment methodology – Stage 1).

Potential cumulative contamination impacts could occur if Stage 1 activities were to interact with existing contamination or remediation activities of adjoining or nearby sites which could potentially cause a greater impact.

Provided that contamination assessed as part of this report is managed in accordance with the measures in Section 20.17, Stage 1 is unlikely to generate cumulative impacts with other projects and plans.

20.17 Management and mitigation measures

20.17.1 Approach to management and mitigation

Stage 1 contamination impacts would be managed in accordance with the Construction Environmental Management Framework.

The Construction Environmental Management Framework includes a requirement to prepare a Soil and Water Management Plan which would include management measures for contaminated material (soils, water and building materials) and a contingency plan in the case of unanticipated discovery of contaminated material.

More details of the Construction Environmental Management Framework are provided in Chapter 27 (Synthesis of the Environmental Impact Statement) and Appendix D.

20.17.2 Mitigation measures

Specific mitigation measures to address potential contamination risks associated with Stage 1 are listed in Table 20-28.

Table 20-28: Mitigation measures – Contamination Stage 1

Reference	Impact/issue	Mitigation measure	Applicable location(s)[1]
C1	Management of low risk contamination	For sites where potential contamination risk is moderate, high or very high, a further review of data would be performed. Where the additional data review provides sufficient information to confirm that contamination is likely to have a very low or low risk, the site would then be managed in accordance with the Soil and Water Management Plan. This would typically occur where there is minor, isolated contamination that can be readily remediated through standard construction practices such as excavation and off-site disposal.	All
C2	Detailed Site Investigation	Where data from the additional data review (mitigation measure C1) is insufficient to understand the risk of contamination, a Detailed Site Investigation would be carried out in accordance with the National Environment Protection Measure (2013) and other guidelines made or endorsed by the NSW EPA. The sites requiring a Detailed Site Investigation would be confirmed following the additional data review (mitigation measure C1), however on the basis of the Stage 1 assessment, it is anticipated that Detailed Site Investigations would be required at the applicable locations.	CSMF, SSF, SOPMS, TBS
C3	Remediation	Where data from the additional data review (mitigation measure C1) or the Detailed Site Investigation (mitigation measure C2) confirms that contamination would have a moderate, high or very high risk, a Remediation Action Plan would be developed for the area of the construction footprint. Each Remediation Action Plan would detail the remediation works required to mitigate risks from contamination throughout and following completion of construction. The Remediation Action Plan would be prepared in accordance with relevant NSW EPA guidelines and where applicable, detail remediation methodologies in accordance with Australian Standards and other relevant government guidelines and codes of practice. Remediation would be performed as an integrated component of construction and to a standard commensurate with the proposed end use of the land. The sites requiring Remediation Action Plans and remediation would be confirmed following the additional data review (mitigation measure C1) and Detailed Site Investigation (mitigation measure C2), however on the basis of the Stage 1 assessment, it is anticipated that Remediation Action Plans and remediation could be required at the specified application locations.	CSMF, SSF, SOPMS, TBS
C4	Site Audit Statement	Where contamination is highly complex, such as significant groundwater contamination; contamination associated with vapour; contamination that requires specialised remediation techniques; or contamination that requires ongoing active management during and beyond construction; an accredited Site Auditor would review and approve the Remediation Action Plan and would develop a Site Audit Statement and Site Audit Report upon completion of remediation. The sites requiring Site Audit Statements would be confirmed following the preparation of Remediation Action Plans (mitigation measure C3), however on the basis of the Stage 1 assessment, it is anticipated that site auditing would be required at the specified applicable locations.	CSMF, SOPMS, TBS, and as applicable
C5	Residual contamination following construction	Ongoing management and monitoring measures would be documented in an appropriate form and implemented for any areas where minor, residual contamination remains following construction.	As applicable

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (e.g. tunnel boring machine works); PSR: Power supply routes.

20.17.3 Interactions between mitigation measures

Mitigation measures in other chapters that are relevant to the management of potential contamination impacts include:

- Chapter 18 (Groundwater and ground movement – Stage 1), specifically measures which address monitoring of groundwater for contaminants of concern
- Chapter 19 (Soils and surface water quality – Stage 1), specifically measures which address the disturbance of contaminated soils during construction
- Chapter 24 (Spoil, waste management and resource use – Stage 1), specifically measures which address waste classification and disposal.

Together, these measures would minimise the potential impacts of Stage 1.

There are no mitigation measures identified in the assessment of other environmental aspects that are likely to affect the assessment of contamination impacts.

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21 Hydrology and flooding – Stage 1

21 Hydrology and flooding – Stage 1

This chapter provides an assessment of hydrology and potential flooding impacts during Stage 1 and identifies measures to address these impacts. This chapter draws on information in Technical Paper 9 (Hydrology and flooding).

21.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to hydrology and flooding, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 21-1.

Table 21-1: Secretary's Environmental Assessment Requirements – Hydrology and flooding Stage 1

Reference	Secretary's' Environmental Assessment Requirement	Where addressed
9. Water – Hydrology and Flooding		
9.1	The existing hydrological regime for any surface and groundwater resource (including mapping, the reliance by users, and for ecological purposes) likely to be impacted, including stream orders.	Section 21.4 Chapter 18 (Groundwater and ground movement – Stage 1) Technical Paper 9 (Hydrology and flooding) and Technical Paper 7 (Hydrogeology)
9.2	Detailed water balance for ground and surface water including the proposed intake and discharge locations, volume, frequency and duration.	Chapter 19 (Soils and surface water quality – Stage 1)
9.3	Requirements for baseline monitoring of hydrological attributes.	Chapter 18 (Groundwater and ground movement – Stage 1)
9.4	The impact on surface and groundwater hydrology in accordance with the current guidelines, including: a. natural processes within rivers, wetlands, estuaries, marine waters and floodplains;	Section 21.6 Chapter 18 (Groundwater and ground movement – Stage 1)
	b. impacts from any permanent and temporary interruption of groundwater flow;	Chapter 18 (Groundwater and ground movement – Stage 1)
	c. stormwater and wastewater management on natural hydrological attributes and the conveyance capacity of existing stormwater systems where discharges are proposed through such systems; and	Section 21.6
	d. water take (direct or passive) from all surface and groundwater sources with estimates of annual volumes during construction.	Chapter 18 (Groundwater and ground movement – Stage 1)
9.5	Flood behaviour for a full range of flood events up to the probable maximum flood (taking into account sea level rise and storm intensity due to climate change) including: a. potential flood affectation of other properties, assets and infrastructure;	Section 21.6
	b. consistency (or inconsistency) with applicable Council floodplain risk management plans;	
	c. compatibility with the flood hazard of the land; and	
	d. compatibility with the hydraulic functions of flow conveyance in flood ways and storage areas of the land.	

21.2 Legislative and policy context

The assessment of potential hydrology and flooding impacts of Stage 1 has been conducted in accordance with the requirements of the Floodplain Development Manual (Department of Infrastructure, Planning and Natural Resources, 2005). The Floodplain Development Manual incorporates the NSW Government's Flood Prone Land Policy. The key objectives of this policy are to identify potential hazards and risks associated with flooding, reduce the impact of flooding and flood liability on owners and occupiers of flood prone property, and to reduce public and private losses resulting from floods. This policy also recognises the benefits of the use, occupation and development of flood prone land.

Most existing flood studies reviewed in this assessment are based on the design rainfall data provided in Australian Rainfall and Runoff 1987. A limited number of the existing studies are more recent and are based on Australian Rainfall and Runoff 2019 design rainfall data, which typically estimates 20 – 30 per cent lower design rainfalls across the Sydney Region compared to Australian Rainfall and Runoff 1987. Potential flood affectation of the Stage 1 construction sites would be lower when modelled using the 2019 data. Consideration of flood affectation and flood impacts during detailed construction planning would use 2019 data.

21.3 Assessment approach

The assessment approach for hydrology and flooding involved:

- Desktop review of publicly available flood study reports from local council(s) and other sources to characterise existing hydrology and flooding conditions at Stage 1 construction sites and the surrounding areas. Characterisation was based on the flood extent for the one per cent annual exceedance probability (AEP) event (a flood event with a one in a hundred per cent chance of occurring in any one year) and probable maximum flood (PMF) event (the largest flood that could conceivably occur at a particular location). The existing flood conditions have been considered with reference to the following:
  - The topography, flow paths and drainage infrastructure in the vicinity of Stage 1 construction sites
  - Flood depths and levels
  - Flood hazard
  - Flood hydraulic categories including floodway and flood storage
  - Flood planning area and flood planning level
  - The existing types of flooding affecting Stage 1 construction sites, including:
    - Intense rainfall – due to intense rainfall falling directly onto sites or adjacent to sites during storm events that are not adequately managed by the provided drainage systems
    - Overland flooding – when local catchment runoff exceeds the capacity of existing drainage systems, with excess flows being conveyed on surface flow paths and ponding in low points
    - Mainstream flooding – due to floodwaters in rivers, creeks and canals rising out of the watercourse and inundating the broader floodplain above bank level
    - Coastal inundation – due to elevated ocean levels and storm surges during low pressure weather systems and/or highest astronomical tides (i.e. 'king tides')
- Qualitative assessment of the potential hydrology and flooding impacts of Stage 1 for all construction sites (except Clyde stabling and maintenance facility construction site)
- Quantitative assessment of the potential hydrology and flooding impacts of Stage 1 for the Clyde stabling and maintenance facility construction site
- Development of mitigation measures to address potential hydrology and flooding impacts.

21.3.1 Qualitative assessment

Potential hydrology and flooding impacts during Stage 1 were assessed qualitatively for all construction sites, except Clyde stabling and maintenance facility construction site. This level of assessment is appropriate for most construction sites given their low level of flood exposure in addition to the low risk of significant flooding impacts during Stage 1. The qualitative assessment considered the following potential changes:

- Potential increase in flood risk and flood affectation on adjacent properties and assets, and potential impacts to existing emergency management arrangements
- Land use compatibility with respect to flood hazard and floodway/flood storage areas
- Compatibility with relevant council floodplain risk management
- Potential morphologic (increased flow velocity and scour), environmental, social and economic impacts due to changed flood behaviour resulting from Stage 1.

21.3.2 Quantitative assessment

A quantitative assessment of potential flood impacts was prepared for the Clyde stabling and maintenance facility construction site. The scale of construction works at this site has the potential to result in substantial flooding impacts, and existing flood studies do not provide sufficient information about the current flooding conditions in the locality.

The quantitative flood assessment involved:

- Detailed hydraulic modelling to define baseline flooding conditions
- Detailed hydraulic modelling of potential flooding impacts at the construction site during Stage 1, including a climate change scenario for future projected sea level rise.

21.4 Existing environment

21.4.1 Surface hydrology and drainage infrastructure

Stage 1 would be located within drainage catchments that ultimately drain to Parramatta River and Sydney Harbour. A description of the catchments and watercourses relevant to Stage 1 is provided in Chapter 19 (Soils and surface water quality – Stage 1).

The drainage catchments across Stage 1 are highly urbanised, with large impervious surfaces created by roads, footpaths and buildings. These impervious surfaces are interspersed with pervious surfaces associated with parkland areas and other unsealed surfaces (such as vacant land and landscaped areas). Surface water is generally collected by developed stormwater networks, which consist of road kerb and guttering, lined and unlined drainage channels, and sub-surface pit and pipe networks.

The existing topography and drainage infrastructure relevant to the Stage 1 construction sites is provided in Table 21-2.

Table 21-2: Existing topography and drainage characteristics for the Stage 1 construction sites

Construction site	Existing topography	Drainage characteristics
Westmead metro station	The construction site is located on a hill with Hawkesbury Road to the west acting as a ridge. The land slopes to the south towards Westmead Public School and east towards Domain Creek, which then flows northwards to the Parramatta River. The existing rail line forms a cutting to the north of the construction site. Elevation is around 32 – 37 metres Australian Height Datum (AHD).	No natural overland flow paths affect the construction site. The construction site is adjacent near the top of a stormwater drainage line which flows northwards to Parramatta River.
Parramatta metro station	The construction site is located on a largely flat area with a slight northerly slope towards Parramatta River. Elevation is around nine to 10 metres AHD.	The construction site is located within the Parramatta River floodplain. Stormwater drainage flows to the north of the site, discharging to the Parramatta River.
Clyde stabling and maintenance facility	The construction site and surrounding terrain are located on generally flat to undulating terrain. The ground surface is highly modified from previous land use, particularly on Sydney Speedway (located on NSW Government owned land). The construction site is generally three to six metres AHD, with some raised mounds up to 10 metres AHD. The area around the tunnel dive structure includes elevations ranging from five to 15 metres AHD.	The construction site is on the Duck Creek/ A'Becketts Creek floodplain. Drainage on the construction site is generally towards these creeks, although undulations on the current site surface (particularly at the Sydney Speedway site) cause ponding of local runoff and reduce free surface drainage of flows to the creeks. No natural overland flow paths affect the construction site. Existing stormwater drainage arrangements are unknown.
Silverwater services facility	The construction site is located on gently sloping terrain, with land sloping to the north-west towards Duck River. Elevation is around five to 5.3 metres AHD.	The construction site is within the broader Parramatta River floodplain but would only be affected by mainstream flooding in extreme events. Existing stormwater drainage arrangements are unknown but are assumed to be located in Derby Street and Silverwater Road and drain to the north-west to Duck River.
Sydney Olympic Park metro station	The construction site is located on relatively high ground with land generally sloping away from the site in each direction. Elevation is around 16 – 25 metres AHD.	Some localised drainage low points are present within the construction site. The existing stormwater drainage arrangements are unknown. No natural overland flow paths affect the construction site.
North Strathfield metro station	The northern and southern construction sites are located on relatively high ground. The natural catchment boundary is situated 200 metres to the east, with the land sloping towards Powells Creek to the west. Elevation is around 14 – 20 metres AHD.	Stormwater drainage pipelines cross the T9 Northern Line rail corridor and discharge to Powells Creek. There are also drainage channels alongside the rail corridor which intercept surface flows, including overland flows and discharge via pipe drainage to Powells Creek. The rail corridor and Queen Street include features such as kerbs and retaining walls which may act as obstructions to flow and contribute to overland flooding.
Burwood North Station	The northern and southern construction sites are located on a slope, with an easterly decline in topography toward Concord Oval. The northern construction site has an elevation of around 6.5 to 17 metres AHD. The southern construction site has an elevation of around 11.5 to 14 metres AHD.	The construction sites are located adjacent to major overland flow path and St Luke's Park Canal. Existing stormwater drainage flows eastward along Parramatta Road and discharges to St Luke's Park Canal.
Five Dock Station	The western and eastern construction sites are located on a hill and ridge with land sloping to the north to Hen and Chicken Bay. Elevation is around 16.5 – 20 metres AHD.	No natural overland flow paths affect the construction sites. Existing stormwater drainage drains to the north and south away from the sites.
The Bays Station	The construction site is situated on low-lying former docklands and is generally flat land with little to no slope around White Bay. The construction site is generally three to four metres AHD, with some low-lying sections along White Bay (one metre AHD).	Existing drainage arrangements are not fully known. Substantial trunk drainage channel/ culverts and floodways are visible to the north of the construction site, which is presumed to run under Robert Street before discharging to White Bay to the north-east of the construction site. The former White Bay Power Station forms a trapped drainage point to the west of the construction site, which forms part of a major overland flow path that drains an area stretching north-west towards Rozelle. The internal drainage arrangements within the former White Bay Power Station are unknown.

21.4.2 Flooding

Due to the highly urbanised drainage catchments surrounding the Stage 1 construction sites, flooding behaviour is expected to be largely controlled by the capacity of stormwater drainage systems and roadways that form overland flow paths. Existing flood behaviour at the construction sites has been investigated to varying degrees in previous flood studies including:

- Parramatta River Flood Study – Draft (Cardno, 2019)
- Parramatta Light Rail Flooding Technical Paper (Arup, 2017)
- Duck River and Duck Creek Flood Study Review (WMAwater, 2015a)
- Concord West Precinct Master Plan Flood Study (Jacobs, 2015)
- WestConnex M4 East EIS Appendix Q – Surface Water: Flooding and Drainage (Lyall & Associates, 2015)
- Exile Bay, St Luke's and William Street Flood Study (WMAwater, 2017)
- Leichhardt Floodplain Risk Management Study and Plan (Cardno, 2017)
- Leichhardt Flood Study (Cardno, 2014)
- Hawthorne Canal Flood Study (WMAwater, 2015b)
- Dobroyd Canal Flood Study (WMAwater, 2014).

Based on the above studies, the existing flood behaviour around the Stage 1 construction sites is described in Table 21-3. Maps showing flood extents/depths and flooding hazard for the one per cent AEP flood and PMF (where identified from previous flood studies) are included in Technical Paper 9 – Hydrology and flooding.

Table 21-3: Existing flood behaviour for Stage 1 construction sites

Construction site	Existing flood behaviour
Westmead metro station	• The construction site and immediate surrounds are outside of flooding extents, flood hazard, floodway and flood storage areas in the one per cent AEP event and PMF event • There are no overland flooding, mainstream flooding or coastal inundation risks relevant to the construction site and immediate surrounds.
Parramatta metro station	• The construction site and immediate site surrounds are affected by overland flooding and mainstream flooding, with flood depths of about 0.15 metres in the one per cent AEP event and about one metre in the PMF event • The construction site and immediate surrounds are outside of high flood hazard, floodway and flood storage areas • There are no coastal inundation risks relevant to the construction site and immediate surrounds.
Clyde stabling and maintenance facility	• The construction site and immediate surrounds are affected by overland flooding and mainstream flooding. About one quarter of the site is flood-affected in the one per cent AEP event to depths of up to 2.4 metres. Most of the site is flood-affected in the PMF event to depths of about four metres • The construction site and immediate surrounds contain areas of high flood hazard, but is expected to be outside floodway and flood storage areas based on the terrain and flood behaviour • There are no coastal inundation risks relevant to the construction site and immediate surrounds.
Silverwater services facility	• The construction site and immediate surrounds are affected by overland flooding and mainstream flooding. The construction site would not be affected in the one per cent AEP event, but would be flood-affected in the PMF event to depths of about 0.7 metres • The construction site and immediate surrounds are located in floodway and flood storage areas. It is unclear if the site is located within a flood hazard area • There are no coastal inundation risks relevant to the construction site and immediate surrounds.
Sydney Olympic Park metro station	• One per cent AEP and PMF flood depths, flood hazards, floodway and flood storage areas for the construction site and immediate surrounds could not be determined from the available flood studies and reporting. The construction site appears to be outside the nearest floodplain and is expected to be outside of high hazard, floodway and flood storage areas • There are no overland flooding, mainstream flooding or coastal inundation risks relevant to the construction site and immediate surrounds.
North Strathfield metro station	• There is minor overland flooding potential across the construction site from Queen Street of up to 0.1 metres during the one per cent AEP event (low hazard area) and 0.3 metres during the PMF event (predominantly low hazard area) • There is major overland flooding potential across the northern portion of the construction site of up to one metre during the PMF event (high hazard area) • The construction site and immediate surrounds are not located in floodway or flood storage areas • There are no mainstream flooding or coastal inundation risks relevant to the construction site and immediate surrounds.
Burwood North Station	• There is minor overland flooding potential across the northern construction site. Flood depths could not be determined from the available flood studies and reporting • There is minor overland flooding potential across the southern construction site of up to 0.2 metres during the one per cent AEP event and up to 0.3 metres during the PMF event. Flooding is expected to be contained within the roadway, with a small area of ponding within the construction site • The northern and southern construction sites and immediate surrounds are outside of high flood hazard, floodway and flood storage areas • There is no mainstream flooding or coastal inundation risks relevant to the construction sites and immediate surrounds.
Five Dock Station	• One per cent AEP and PMF flood depths, flood hazards, floodway and flood storage areas for the western and eastern construction sites and immediate surrounds could not be determined from the available flood studies and reporting. • There is minor overland flooding potential across the construction site during the one per cent AEP event and PMF event, which is expected to be contained within the roadway • The construction sites and immediate surrounds are expected to be located outside of high flood hazard, floodway and flood storage areas • There are no mainstream flooding or coastal inundation risks relevant to the construction sites and immediate surrounds.
The Bays Station	• There is major overland flooding potential across the construction site of up to one metre during the one per cent AEP event. Overland flooding of up to one metre would affect most of the construction site during the PMF event • There is coastal inundation potential across low-lying portions of the construction site during the one per cent AEP event • Parts of the construction site are located within high flood hazard, floodway and flood storage areas • There are no mainstream flooding risks relevant to the construction site and immediate surrounds.

21.5 Avoidance and minimisation of impacts

Potential flooding impacts have been minimised through the selection of Stage 1 construction sites to avoid existing flood prone land where possible.

The design of the Clyde stabling and maintenance facility site considered the results of initial modelling of existing flood conditions at and near the site. Refinements were made to the design to ensure adequate flood immunity and minimise offsite flooding impacts. These included:

- Refinements to the design of the proposed structures over A'Becketts Creek and Duck Creek
- Modifications to the channels of A'Becketts Creek and Duck Creek
- Provision of an open channel and structure to carry PMF flood flows from the western side of James Ruse Drive to the eastern side of the future stabling and maintenance facility.

Further design refinement at the Clyde stabling and maintenance facility site would occur during detailed design with the aim of further reducing potential offsite flooding impacts related to Stage 1.

21.6 Potential impacts

21.6.1 Potential impacts on flood behaviour during Stage 1

Stage 1 construction works and infrastructure has the potential to impact existing flooding behaviour through disruption of existing conditions (such as drainage systems and/or overland flow paths). In addition, flooding events during construction could impact areas within and near the Stage 1 construction sites, including the potential inundation of construction sites.

Potential flood-related impacts during construction may include:

- Interruption of overland flowpaths by installation of temporary construction site infrastructure (i.e. noise barriers, acoustic sheds, retaining walls) and/or modifications to landforms (i.e. placement of fill materials, stockpiles)
- An increase in runoff volumes following rainfall events due to an increase in impervious surfaces (i.e. construction sites)
- The interruption or diversion of existing flood routes away from the location of bunding or spoil within construction sites, resulting in a reduction of flood storage and an increased flood risk to adjacent areas
- Blocking of drainage networks through increased sedimentation of surface water
- Flow of water into station excavations, services facility shafts and tunnel portals.

A summary of the potential flooding impacts at Stage 1 construction sites is provided in Table 21-4 with detailed information provided in Technical Paper 9 (Hydrology and flooding). Key areas of potential flooding risk include the Parramatta metro station, Clyde stabling and maintenance facility, Silverwater services facility and The Bays Station construction sites. Flooding impacts are expected to be minor to negligible at all other Stage 1 construction sites.

Flooding risks at Clyde stabling and maintenance facility are discussed in further detail in the following section.

Table 21-4: Potential flooding impacts for Stage 1

Construction site	Potential flooding impacts
Westmead metro station	• Impacts to existing flooding behaviour at the construction site and immediate surrounds are unlikely.
Parramatta metro station	• Potential inundation of the construction site and ingress of floodwaters into station excavations during the PMF event • Potential minor to moderate localised flooding impacts to Horwood Place between Macquarie Street and George Street and the Macquarie Lane access to Smith Street from the obstruction of existing flow paths through the construction site.
Silverwater services facility	• Potential ingress of floodwaters into the shaft during the PMF event • Potential flooding impacts to Derby Street from the obstruction of parts of the existing flow paths through the construction site.
Sydney Olympic Park metro station	• Impacts to flooding at the construction site and immediate surrounds are unlikely.
North Strathfield metro station	• Potential inundation of the construction site from existing flow paths on Queen Street and ingress of floodwaters into station excavation during the PMF event • Potential flooding impacts to Queen Street, including ponding, from the obstruction of existing flow paths through the construction site. Flow paths may be obstructed by construction site hoardings.
Burwood North Station	• Impacts to existing flooding behaviour at the northern and southern construction sites and immediate surrounds are unlikely.
Five Dock Station	• Impacts to existing flooding behaviour at the western and eastern construction sites and immediate surrounds are unlikely.
The Bays Station	• Potential inundation of the construction site and ingress of floodwaters into the station excavation during the one per cent AEP event and the PMF event • Potential flooding impacts to Robert Street and surrounding areas from the obstruction of existing flow paths through the construction site. Flow paths may be obstructed by site filling works to raise and regrade the construction site.

Clyde stabling and maintenance facility

As discussed in sections 21.3.2 and 21.4.2, Stage 1 works for the Clyde stabling and maintenance facility has the potential to result in flooding impacts. The potential flooding impacts at the Clyde stabling and maintenance facility are provided in Table 21-5.

Overall, the potential flooding risks are expected to be minor in all flooding events. Where there are increases in flooding risks, impacts would be managed in accordance with the mitigation measures in Section 21.7.2. Design refinement would also be considered at detailed design stage to mitigate potential impacts where feasible and reasonable.

Table 21-5: Potential flooding impacts for Stage 1 – Clyde stabling and maintenance facility

Potential impact	Description

Change in peak flooding levels	• Potential reduction in peak flood levels on the Duck Creek and A'Becketts Creek floodplains of up to 0.1 metres during the five per cent and one per cent AEP events (upstream of the Clyde stabling and maintenance facility)
	• Potential increase in peak flood levels in and adjacent to Duck Creek and Duck River of up to 0.08 metres during the five per cent and one per cent AEP events (downstream of the Clyde stabling and maintenance facility)
	• Potential increase in peak flood levels in the PMF event (upstream and downstream of the Clyde stabling and maintenance facility):
	  • Up to 0.07 metres in the A'Becketts Creek floodplain
	  • Up to 0.15 metres in the Duck Creek floodplain upstream of the culvert crossing
	  • Up to 0.06 metres in Duck Creek downstream of the culvert crossing
	  • Up to 0.1 metres in the Duck River floodplain (upstream of the M4 Motorway)
	  • Up to 0.2 metres on the south-western section of Rosehill Gardens racecourse grounds.

Change in flood extent	• Potential minimal increases in the flood extent for all events up to the PMF • Potential maximum increases in the PMF extent of around 10 metres and typical increases of less than five metres.
Change in flood hazard	• Potential minor increases in high flood hazard extent in the five per cent and one per cent AEP and PMF events (refer to Figure 21-1 to Figure 21-3) • Some potential reductions in the high hazard extent in the five per cent and one per cent AEP events (refer to Figure 21-1 and Figure 21-2).
Change in duration of inundation	• No significant increases in the duration of inundation.

Potential impact	Description
Property impacts	• Potential minor increases in flood levels of 0.01 to 0.02 metres at industrial properties adjacent to Duck River in Auburn in the five per cent and one per cent AEP events (refer to Figure 21-4) • Potential increases in flood levels of 0.08 metres at commercial and industrial properties near the Duck Creek and Duck River confluence in the five per cent and one per cent AEP events • No newly-affected properties in the one per cent AEP event • Potential for seven newly-affected properties in the PMF event.
Critical infrastructure impacts	• No significant impacts to critical infrastructure.
Climate change impacts	• No increase in the flood protection level required to account for the effects of climate change on flooding.

Figure 21-1: Potential change in flood hazard at the Clyde stabling and maintenance facility construction site – five per cent AEP event

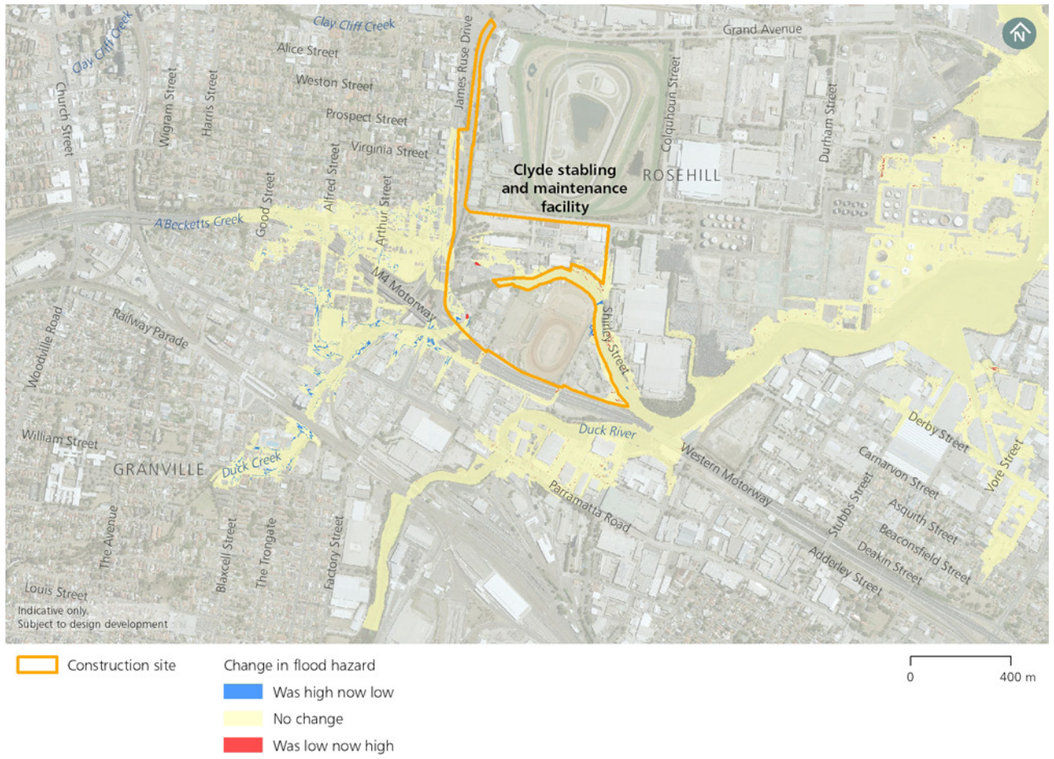

Figure 21-2: Potential change in flood hazard at the Clyde stabling and maintenance facility construction site – one per cent AEP event

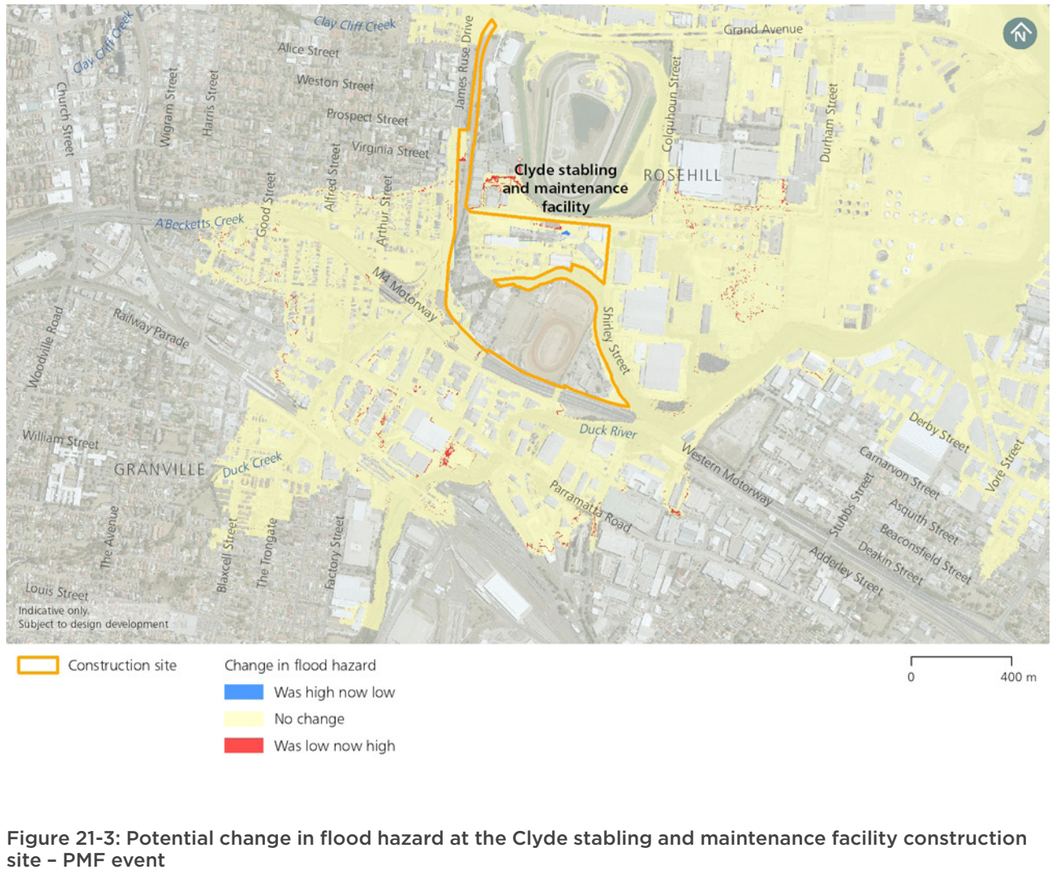

Figure 21-3: Potential change in flood hazard at the Clyde stabling and maintenance facility construction site – PMF event

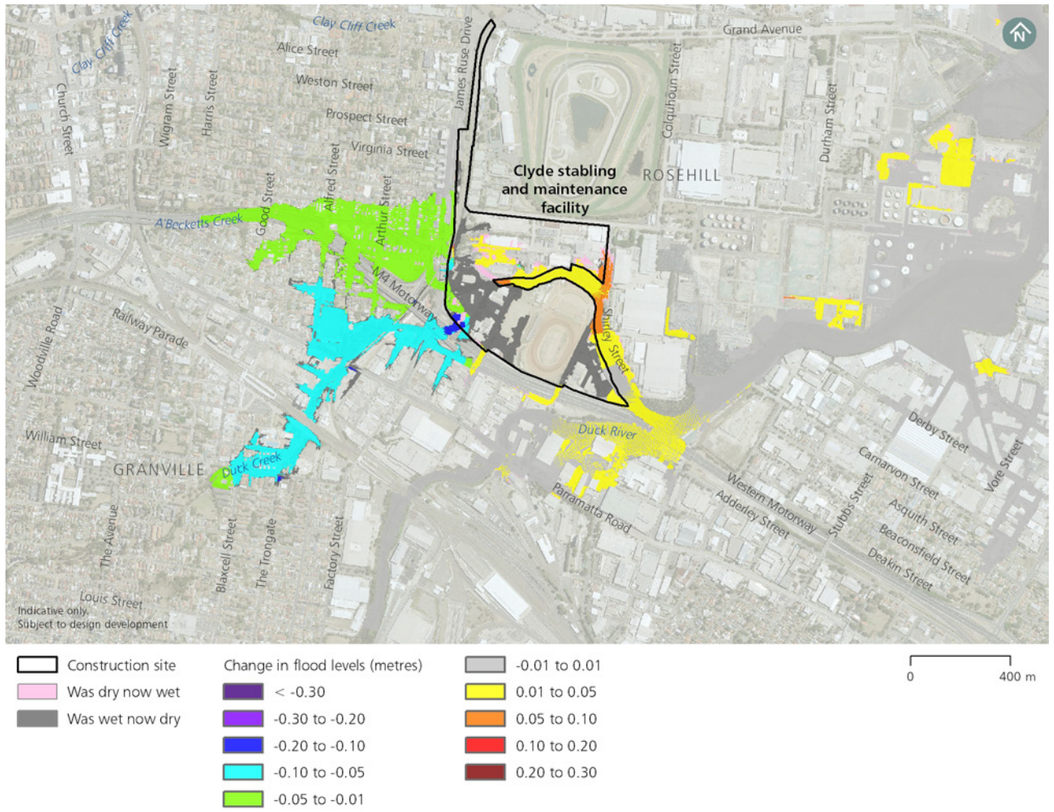

Figure 21-4: Potential change in flood levels at Clyde stabling and maintenance facility construction site – one per cent AEP event

21.6.2 Compatibility of construction sites with flood conditions

All Stage 1 construction sites were assessed as compatible with flood conditions due to construction sites either not being flood prone, or having a low risk or existing low hazard exposure and as mitigation measures can readily be provided to manage flood risks. The compatibility of construction sites to the existing flood conditions was determined based on the exposure of the site to existing high hazard or high risk flooding, potential impacts on flooding behaviour on surrounding properties, potential impact of flooding on the construction sites and the ability to provide effective mitigation measures to any existing conditions or potential impacts.

21.6.3 Potential downstream velocity and scour impacts

Mitigation measures would manage potential increases in flow velocity and scour potential that may occur where Stage 1 construction works could alter flood flow patterns and significantly divert or concentrate flood flows. As most construction sites are not located within or adjacent to major overland or mainstream flow paths, there is a low potential to impact downstream velocity and scour.

Flow velocities are expected to potentially increase at the Clyde stabling and maintenance facility by about 18 per cent from 0.8 metres per second to over 0.9 metres per second during the one per cent AEP event. This is due to the proposed culvert crossings of A'Becketts Creek and Duck Creek and formalisation of sections of these creek channels. In addition, there is potential for localised scouring of bed material at the transition from hard drainage structures to the natural or unlined channel surfaces. These impacts would be managed in accordance with mitigation measures outlined in Section 21.7.

21.6.4 Floodplain risk management

A review of publicly available floodplain risk management plans did not identify any conflicts or inconsistencies with proposed floodplain risk management measures.

The Leichhardt Floodplain Risk Management Study (Cardno, 2017) identifies proposed flood modification works which would involve duplication of existing drainage running under Robert Street that discharges to White Bay. Inner West Council would be consulted prior to construction so that construction work at The Bays Station construction site is coordinated with these proposed flood modification works.

21.6.5 Potential impacts to emergency management arrangements for flooding

As identified in Section 21.6.1, the construction sites at Parramatta metro station, Clyde stabling and maintenance facility and The Bays Station are at potential risk of flooding during construction. The potential impacts to emergency management arrangements are summarised in Table 21-6.

Mitigation measures would manage any potential increases in flood depths affecting emergency management routes and sensitive properties in the vicinity of these sites. The mitigation measures outlined in Section 21.7 includes consultation with NSW State Emergency Service and relevant local councils prior to construction.

Table 21-6: Potential impacts to emergency management arrangements

Construction site	Identified emergency management routes, facilities and sensitive properties	Potential impacts

Parramatta metro station	• Emergency management routes:
	  • Macquarie Street
	  • Church Street
	  • George Street
	  • Smith Street
	• Sensitive properties:
	  • Arthur Phillip High School
	  • YMCA Child Care Services (Smith Street)
	  • Reggio Emilia Child Care (George Street).
		• One per cent AEP flood event: potential impacts to emergency access routes, emergency facilities and sensitive properties are unlikely
		• PMF event: potential impacts to emergency arrangements are unlikely as substantial flooding depths and high hazard is already present in the existing environment case.

Clyde stabling and maintenance facility	• Emergency management routes:
	  • James Ruse Drive
	  • M4 Motorway
	  • Parramatta Road
	• Sensitive properties:
	  • Rosehill Public School and Preschool
	  • Fun2learn Early Learning Centre
	  • Kinderoo
	  • Little Angels Kindergarten
	  • Rosehill Montessori Kindergarten.
		• One per cent AEP flood event: potential impacts to emergency access routes, emergency facilities and sensitive properties are not expected
		• PMF event: potential impacts to emergency arrangements are unlikely as substantial flooding depths and high hazard is already present in the existing environment case. Parts of the Kinderoo property would potentially be affected by the PMF event with increases in flood depths of up to 0.02 metres.

The Bays Station	• Emergency management routes:
	  • Robert Street
	  • Mullens Street
	  • Victoria Road.
		• Potential increase in flood depths in Robert Street east of Mullens Street without appropriate mitigation measures.

21.6.6 Potential social and economic costs from flooding impacts

Given the generally low flood affectation of construction sites and expected low impact on flood behaviour on surrounding properties and infrastructure, the potential social and economic costs from flooding impacts are considered low. Based on the assessment of potential flooding impacts in Section 21.6.1, the potential flooding impacts of Stage 1 are generally expected to be minor or negligible for most construction sites. Potential flooding impacts at Parramatta metro station, Clyde stabling and maintenance facility and The Bays Station construction sites would be managed through the mitigation measures outlined in Section 21.7.

21.6.7 Cumulative impacts

Potential cumulative impacts were considered for assessment based on the likely interactions of Stage 1 with other projects and plans that met the adopted screening criteria. The approach to assessment and the other projects considered are described further in Appendix G (Cumulative impacts assessment methodology).

There is potential for cumulative impacts to occur at the following Stage 1 construction sites:

- Parramatta metro station
- Clyde stabling and maintenance facility.

Parramatta metro station

The Parramatta metro station construction site has the potential for cumulative impacts with the following projects and plans:

- Parramatta Light Rail Stage 1
- Draft Camellia Town Centre Master Plan.

Flood impact modelling carried out for Parramatta Light Rail Stage 1 indicates that in the one per cent AEP flood event, peak flood levels in the immediate vicinity of the Parramatta metro station construction site would reduce due to proposed light rail track drainage and changes to the ground surface elevations. There would not be increased flood-affectation of the Stage 1 construction site due to Parramatta Light Rail Stage 1, therefore cumulative impacts are unlikely.

The draft Camellia Town Centre site is substantially affected by the PMF event and future development associated with the draft Master Plan is expected to have potential impacts on flood behaviour. Flood modelling carried out for the Clyde stabling and maintenance facility indicates the PMF levels at the Parramatta metro station construction site may increase by up to about 0.5 metres if Stage 1 construction coincides with or follows development included in the draft Master Plan. Future modelling is recommended during detailed construction planning of Stage 1 to confirm the impacts at the Parramatta metro station construction site as further information regarding the draft Master Plan becomes available.

Clyde stabling and maintenance facility

The Clyde stabling and maintenance facility construction site has the potential for cumulative impacts with the draft Camellia Town Centre Master Plan. Flood modelling carried out for the Clyde stabling and maintenance facility indicates the future development associated with the draft Master Plan is not likely to impact on the Clyde stabling and maintenance facility construction site. However, future modelling is recommended during detailed construction planning of Stage 1 to confirm the impacts at the Clyde stabling and maintenance facility construction site as further information regarding the draft Master Plan become available.

21.7 Management and mitigation measures

21.7.1 Approach to management and mitigation

Stage 1 hydrology and flooding impacts would be managed in accordance with the Construction Environmental Management Framework. In relation to hydrology and flooding, the Construction Environmental Management Framework identifies that Stormwater and Flooding Management Plans would be prepared where required. These plans would identify the appropriate design standard for flood mitigation based on the duration of construction, proposed works and flood risks.

More details of the Construction Environmental Management Framework are provided in Chapter 27 (Synthesis of the Environmental Impact Statement) and Appendix D.

21.7.2 Mitigation measures

The mitigation measures that would be implemented to address potential hydrology and flooding impacts are described in Table 21-7.

Table 21-7: Mitigation measures – Hydrology and flooding Stage 1

Reference	Impact/issue	Mitigation measure	Applicable location(s)[1]
HF1	Flooding behaviour impacts	Detailed construction planning would consider flood risk at construction sites. This would include: • Identification of measures to not worsen flood impacts on the community and on other property and infrastructure during construction up to and including the one per cent AEP flood event • Provide flood-proofing to excavations at risk of flooding or coastal inundation during construction, where feasible and reasonable, such as raised entry into shafts and/or pump-out facilities to minimise ingress of floodwaters into shafts and the dive structure • Review of site layout and staging of construction works to avoid or minimise obstruction of overland flow paths and limit the extent of flow diversion required. This includes design of site hoardings to minimise disruption to flow paths (if possible). Not worsen is defined as: • A maximum increase in flood levels of 50mm in a one per cent AEP flood event • A maximum increase in time of inundation on one hour in a one per cent AEP flood event • No increase in potential soil erosion and scouring from any increase in flow velocity in a one per cent AEP flood event.	PMS, CSMF, SSF, NSMS, TBS
HF2	Flooding behaviour impacts	On-site stormwater detention would be provided for the Clyde stabling and maintenance facility to manage peak site runoff rates and volumes due to increased imperviousness of the site.	CSMF
HF3	Flooding behaviour impacts	Further design refinement at the Clyde stabling and maintenance facility construction site would occur during detailed design to mitigate the identified potential impacts including: • The increases in flood levels of up to 0.08 metres in Duck Creek and adjacent properties in the one per cent AEP flood event • Increases in flow velocities and the potential increased risk of scour at the proposed creek crossings and in the downstream channels • The potential flooding impacts from filled features including the road overbridge approach.	CSMF
HF4	Flooding behaviour impacts	Drainage at construction sites would be designed, where feasible and reasonable, to mitigate potential alterations to local runoff conditions due to construction sites.	All
HF5	Flooding behaviour impacts	Detailed construction planning for The Bays Station construction would aim to minimise changes to existing levels in relation to potential impacts on flood behaviour, along the north-western side of site adjacent to low-lying property, to minimise reduction in floodplain storage.	TBS
HF6	Flood protection	Consultation would occur with the proponent of the Camellia Town Centre redevelopment to understand potential flood impacts from the redevelopment on Stage 1 and to identify any additional flood protection (if required).	PMS
HF7	Flooding emergency management	Construction planning regarding flooding matters would be carried out in consultation with the NSW State Emergency Service and the relevant local council.	PMS, CSMF, TBS
HF8	Impacts to flood mitigation works	Detailed construction planning for The Bays Station construction site would aim to avoid conflicts with the potential construction of flood mitigation works in Robert Street, in consultation with Inner West Council.	TBS

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (eg tunnel boring machine works); PSR: Power supply routes.

21.7.3 Interactions between mitigation measures

Mitigation measures in other chapters that are relevant to the management of potential hydrology and flooding impacts include:

- Chapter 18 (Groundwater and ground movement – Stage 1), specifically measures which address impacts to groundwater levels
- Chapter 19 (Soils and surface water quality – Stage 1), specifically measures which address the management of surface water in accordance with the Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004) and Volume 2 (Department of Environment and Climate Change, 2008), and confirmation of local stormwater system capacity.

These measures would work collectively to minimise the potential hydrology and flooding impacts of Stage 1.

There are no mitigation measures identified in the assessment of other environmental aspects that are likely to affect the assessment of hydrology and flooding.

22 Biodiversity – Stage 1

22 Biodiversity – Stage 1

This chapter provides an assessment of the potential impact of Stage 1 on biodiversity and identifies mitigation measures to minimise these impacts. This chapter is based on information in Technical Paper 10 (Biodiversity development assessment report).

22.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to biodiversity, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 22-1.

Table 22-1: Secretary's Environmental Assessment Requirements – Biodiversity Stage 1

Reference	Requirement	Where addressed
11. Biodiversity		
11.1	Biodiversity impacts in accordance with section 7.9 of the *Biodiversity Conservation Act 2016* (BC Act), the Biodiversity Assessment Method (BAM), and be documented in a Biodiversity Development Assessment Report (BDAR).	Section 22.6
11.2	Impacts on biodiversity values not covered by the BAM. This includes a threatened aquatic species assessment (Part 7A of the *Fisheries Management Act 1994*) to address whether there are likely to be any significant impact on listed threatened species, populations or ecological communities listed under the *Fisheries Management Act 1994* (FM Act).	Section 22.6.5
11.3	If the project, or any component of the project, would be classified as a KTP in accordance with the listings in the BC Act, FM Act and the *Environment Protection and the Biodiversity Conservation Act 1999* (EPBC Act).	Section 22.6.9

22.2 Legislative and policy context

A Biodiversity Development Assessment Report has been prepared for Stage 1 as required under the *Biodiversity Conservation Act 2016* and a requirement of the Biodiversity Assessment Method.

Stage 1 has been assessed in relation to key biodiversity legislation and policy including:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
- *Biodiversity Conservation Act 2016*
- *Biosecurity Act 2015*
- *Environmental Planning and Assessment Act 1979*
- *Fisheries Management Act 1994*
- NSW Biodiversity Assessment Method (Office of Environment and Heritage, 2017).

22.3 Assessment approach

The biodiversity assessment for Stage 1 involved:

- Definition of the study area for Stage 1 (refer to Section22.3.1)
- A desktop assessment to describe the existing environment and landscape features, and to identify threatened flora and fauna that may be potentially affected
- Field surveys to identify the biodiversity values within the study area and to determine the likelihood of threatened species and their habitats occurring in the construction footprint or being affected
- Identification and assessment of likely direct and indirect impacts to biodiversity
- Identification of mitigation measures for avoiding, managing or reducing impacts on biodiversity values
- Identification of any residual impacts that cannot be avoided, minimised or mitigated which must be offset
- Consultation with the Environment, Energy and Science Group (part of the Department of Planning, Industry and Environment) to discuss the approach to the biodiversity assessment.

22.3.1 Study area

The study area for the biodiversity assessment (refer to Figure 22-1) considered all areas where biodiversity values are potentially affected by Stage 1 and includes each construction site footprint (the area which would be directly impacted by construction activities) with a 50 metre buffer applied to capture areas that may be subject to indirect impacts, the surface area above and adjacent to the tunnel alignment and a 1,500 metre landscape buffer around each of the construction site footprints.

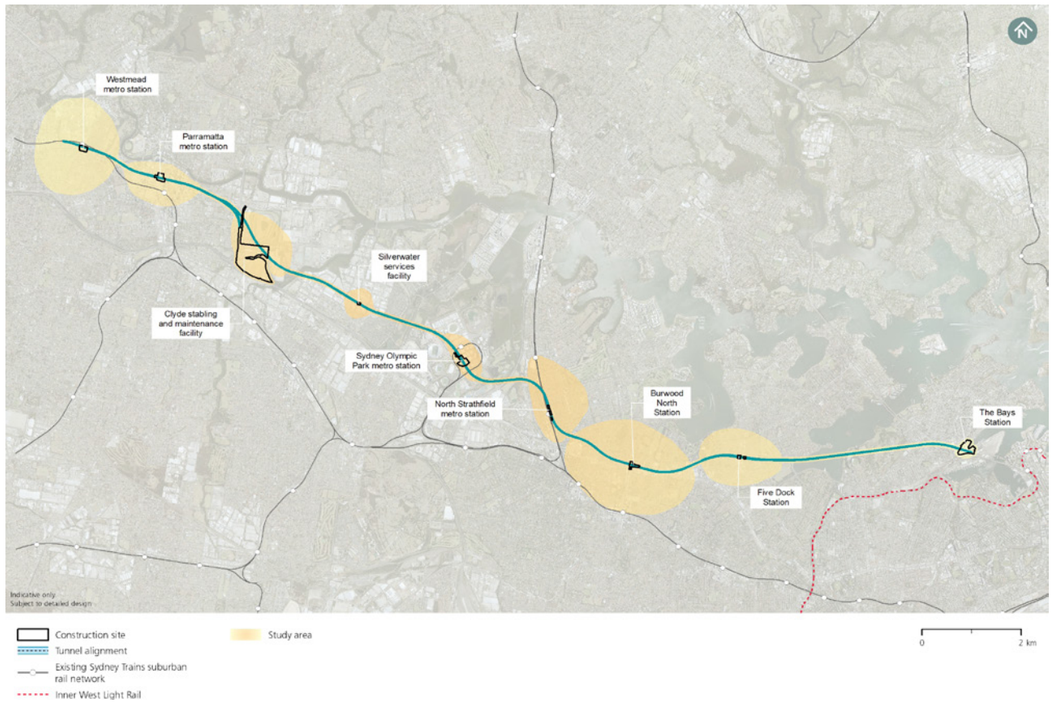

Figure 22-1: Biodiversity assessment study area

22.3.2 Assessment method

The existing environment and likely biodiversity impacts of Stage 1 were assessed using the Biodiversity Assessment Method. The impact assessment included an assessment of likely impacts to the aquatic environment and impacts on biodiversity related Matters of National Environmental Significance in accordance with the *Environment Protection and Biodiversity Conservation Act 1999*, including nationally listed threatened and migratory species and ecological communities.

The Biodiversity Assessment Method also requires assessment of species credit species and ecosystem credit species. Species credit species are species where the likelihood of occurrence of a species or elements of suitable habitat for that species cannot be confidently predicted by vegetation surrogates and landscape features. Ecosystem credit species are those threatened species where the likelihood of occurrence of a species or elements of the species habitat can be predicted by vegetation surrogates and landscape features, or for which targeted survey has a low probability of detection. Species credit and ecosystem credit species within the Stage 1 construction footprint are discussed in Section 22.4.7.

22.3.3 Desktop research

A review of publicly available information was carried out to identify the existing biodiversity and natural environment features, such as landscape features, plant community types, threatened species, populations and communities as well as important habitat for migratory species, within 10 kilometres of the study area ('the locality'). The review focused on database searches, relevant ecological reports and relevant GIS layers.

Database searches

The following databases were searched:

- BioNet – the website for the Atlas of NSW Wildlife and Threatened Species Data Collection (NSW Department of Planning, Industry and Environment, 2019b) (searched April 2019)
- Biodiversity Assessment Calculator (NSW Department of Planning, Industry and Environment, 2019a) (viewed December 2019)
- NSW Department of Primary Industries freshwater threatened species distribution maps (NSW Department of Primary Industries, 2019b) (viewed December 2019)
- The federal Department of Agriculture, Water and the Environment's Protected Matters Search Tool (Australian Government Department of the Environment and Energy, 2019b) (searched December 2019)
- BioNet NSW Vegetation Classification database (NSW Department of Planning, Industry and Environment, 2019c) (viewed December 2019)
- Atlas of Living Australia (Atlas of Living Australia website, 2019) (viewed December 2019)
- Atlas of Groundwater Dependent Ecosystems (Bureau of Meteorology, 2017) (viewed December 2019)
- Fisheries Spatial Data Portal (NSW Department of Primary Industries, 2019a) (viewed December 2019)
- Australian Wetlands Database and directory of important wetlands (Australian Government Department of the Environment and Energy, 2019a) (viewed December 2019).

Literature review

Reports, regional vegetation maps, geology and soil maps and literature were reviewed to provide an understanding of ecological values occurring or potentially occurring in the study area and wider region. Reviewed information included:

- The Native Vegetation of the Sydney Metropolitan Area – Version 3 (State Government of NSW Office of Environment and Heritage, 2016)
- Southeast NSW Native Vegetation Classification and Mapping – SCIVI (NSW and Office of Environment and Heritage, 2010)
- Penrith 1:100 000 Geological Sheet 9030 (Clarke and Jones, 1991)
- Soil landscapes of the Penrith 1:100,000 Sheet 9030 (Hazelton et al., 1989)
- Sydney 1:100 000 Geological Sheet 9130 (Herbert, 1983)
- Soil landscapes of the Sydney 1:100,000 Sheet (Chapman and Murphy, 1989)
- Risk Assessment Guidelines for Groundwater Dependant Ecosystems (Kuginis et al., 2012)
- Australian Soil Classification Soil Type map of NSW (NSW Office of Environment and Heritage, 2012)
- Preliminary and provisional determinations of threatened species and ecological communities listed under the *Biodiversity Conservation Act 2016* from the NSW Threatened Species Scientific Committee web resources (NSW Threatened Species Scientific Committee, 2019)
- Clyde Terminal Conversion Environmental Impact Statement (AECOM Australia Pty Ltd, 2013)
- Biodiversity Development Assessment Report – Viva Energy Clyde Western Area Remediation Project (Biosis, 2018)
- Biodiversity Development Assessment Report – Parramatta Light Rail (WSP, 2017).

22.3.4 Habitat suitability for threatened species

The Biodiversity Assessment Calculator was used to derive the list of candidate species for this assessment. The results were also supplemented with database searches, including a review of the Threatened Biodiversity Data Collection, to identify the threatened species that have been previously recorded or are considered likely to occur in the broader study area and Stage 1 construction footprints.

Once the initial list of predicted species was generated, an on-site habitat assessment was undertaken to determine the habitat quality and presence of any habitat constraints or microhabitats for the threatened species predicted to occur in the Stage 1 construction footprints.

22.3.5 Field survey

Field surveys to identify terrestrial flora and fauna within the study area were undertaken in January, March and June 2019.

The site inspections involved:

- Establishing the extent of native vegetation within the Stage 1 construction footprints
- Identifying and mapping the type and distribution of plant community types
- Establishing vegetation zones (an area of native vegetation that is the same plant community type and has a similar broad condition state) within each plant community type
- Undertaking plot based floristic vegetation surveys within each vegetation zone to identify the condition and integrity of native vegetation
- Assessment of potential habitat for threatened flora and fauna species previously recorded within the locality
- Targeted threatened flora surveys.

Targeted threatened fauna surveys were not undertaken as the habitat assessment identified that limited habitat was present for most threatened fauna species. However, where suitable habitat for a threatened species was present, the species was assumed to be present.

22.3.6 Biodiversity offsets

An offset, in the form of a biodiversity credit, is required for impacts to plant community types and threatened (species credit) species. The biodiversity credit obligation has been calculated using the Biodiversity Assessment Method Calculator. Areas of the study area that do not possess plant community types have not been assessed and offset credits are not required.

For marine vegetation such as mangroves, the offsetting rules of the NSW Department of Primary Industries Policy and Guidelines for Fish Habitat Conservation and Management (NSW Department of Primary Industries, 2013) are applicable as these guidelines are intended to feed into the assessment of State significant infrastructure projects to ensure the sustainable management, and 'no net loss', of key fish habitats in NSW.

22.4 Existing environment

22.4.1 General landscape features

Table 22-2 summarises the general landscape features of the study area.

Table 22-2: Landscape features of the study area

Landscape features	Description
Bioregion and sub-regions	The study area is located in the Sydney Basin bioregion (as defined by the Interim Biogeographic Regionalisation for Australia, Thackway and Creswell 1995), with most of the study area located within the Cumberland subregion. The study area east of William Street, Five Dock to The Bays is located in the Pittwater subregion.
BioNet NSW landscapes	The study area contains the following two landscapes (as mapped by NSW National Parks and Wildlife Service 2002 and described by the NSW Department of Environment and Climate Change (2001)): • Ashfield Plains – Undulating hills and valleys on horizontal Triassic shale and siltstone, occasional quartz sandstones especially near the margin of the Port Jackson landscape. General elevation 0 to 45 m and a local relief of less than 20 m • Port Jackson Basin – Deep elongated harbour with steep cliffed margins on horizontal Triassic quartz sandstone. Small pocket beaches and more extensive Quaternary estuary fill of muddy sand at the head of most tributary streams. General elevation 0 to 80 m and local relief between 10 m to 50 m.
Rivers, streams and estuaries	Stage 1 is located entirely within the Parramatta River/Port Jackson subcatchment of the Sydney Metro catchment (Department of Primary Industries, 2019c). The tunnel alignment would pass at depth beneath Domain Creek, Clay Cliff Creek, Duck River, Haslams Creek, Saleyards Creek, Powells Creek and Iron Cove. As part of Stage 1, structures would be built within and over A'Becketts Creek and Duck Creek.

Landscape features	Description
Wetlands	Mapped areas of wetland listed under State Environmental Planning Policy (Coastal Management) 2018 are present within 200 metres of Stage 1, which includes vegetation along the Duck River and Mason Park wetlands. Several other wetlands are located within 1,500 metres of Stage 1 including Bicentennial Park wetlands, Newington Nature Reserve wetlands, the Brickpit at Sydney Olympic Park, Haslams Creek, and wetlands associated with Duck River including the Clyde Wetland.
Habitat connectivity	The habitat within the construction footprint has a low degree of connectivity to other areas of habitat due to impacts of urbanisation. Habitat within the study area generally occurs as small isolated fragments within the largely urban environment of residential, commercial and industrial land uses. At the north-western corner of the study area, there is a broken corridor of habitat that connects Coopers Creek and Toongabbie Creek to Darling Mills Creek and eventually the Parramatta River. The corridor then follows Duck River to the south. This corridor does not interact with Stage 1. The wide tidal channel of Duck River is a barrier to connectivity for some species. A corridor begins at Haslams Creek which provides a north south corridor from the Parramatta River to the vegetation along the M4 Motorway. Haslams Creek is also linked to Powells Creek forming a wetland corridor which would likely be used by birds and bats. The Stage 1 tunnels would pass beneath Haslams Creek (at about 30 metres below ground level). Planted trees and gardens surrounding Stage 1 also provide some connectivity for mobile species such as the Grey-headed Flying-fox and birds that can use the resources available in urban areas.
Areas of outstanding biodiversity value	Stage 1 does not contain any areas of outstanding biodiversity value as declared by the Minister for Energy and Environment.
Native vegetation extent	Within the 1,500 m landscape buffer, there is approximately 160 ha of native vegetation present, which is about 2.5 per cent of the landscape buffer. Native vegetation cover in the landscape is very low and in the 0 – 10 per cent cover class. The purpose of the percentage vegetation cover calculation is to apply a figure of native vegetation cover in the Biodiversity Assessment Calculator, to predict threatened species likely to occur or use habitat in the study area.

22.4.2 Vegetation characteristics

A general description of the vegetation at each of the construction sites is provided in Table 22-3.

Table 22-3: Vegetation characteristics

Construction site	Description
Westmead metro station	There are limited areas of naturally occurring native vegetation present at the construction site and most of the vegetation is exotic. Street trees and residential garden plantings include some native species found in NSW. There is a small area of vegetation within the existing T1 rail corridor north of Alexandra Avenue at the existing Westmead Station that contains regrowth native plant species which are typical of the Grey Box-Forest Red Gum grassy woodland on flats of the Cumberland Plain and Sydney Basin Bioregion (Plant Community Type 849) which would have once occurred at the location. This corresponds with the Cumberland Plain Woodland in the Sydney Basin Bioregion listed under the Biodiversity Conservation Act 2016.
Parramatta metro station	There is no naturally occurring native vegetation present at the construction site. Isolated street trees and garden plantings are present along Horwood Place, which include native species however these are not naturally occurring. The remainder of the vegetation consists of exotic trees and opportunistic weeds occurring in garden beds and alongside buildings and the roadside.
Clyde stabling and maintenance facility	The Clyde stabling and maintenance facility construction site is mostly occupied by commercial and industrial development that lacks natural vegetation. Planted native vegetation occurs along Wentworth Street and along Unwin Street, towards the north-west corner of the site. The riparian zone of A'Becketts Creek in the construction footprint is weed dominated, however a few planted native species occur along the creek bank. The vegetation surveyed along Duck Creek is dominated by weeds with some native species present on the banks. Patches of mangrove vegetation at A'Becketts and Duck Creeks correspond to the Plant Community Type: Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion (Plant Community Type 920). It is not classified as a threatened ecological community however, it is considered protected marine vegetation under the *Fisheries Management Act 1994*.
Silverwater services facility	There is no naturally occurring native vegetation present at the construction site. Woody vegetation (including *Corymbia citriodora*, saplings of *Casuarina glauca*, and a mature specimen of the introduced shrub *Acacia saligna*) and street trees are present at the site. The ground is largely bare, with some patches of groundcover vegetation dominated by introduced grasses and herbaceous weeds.
Sydney Olympic Park metro station	There is no naturally occurring native vegetation present at the construction site. Street trees and garden plantings occur at this site, which include some native species.
North Strathfield metro station	There is no naturally occurring native vegetation present at the construction site. The plantings adjacent to Queen Street are a mix of species including some native species.
Burwood North Station	There is no naturally occurring native vegetation present at the construction site. The vegetation at this site consists of residential plantings with some native species.
Five Dock Station	There is no naturally occurring native vegetation present at the construction site. Some planted trees and shrubs are present, consisting of exotic and native species.
The Bays Station	There is no naturally occurring native vegetation present at the construction site. This site is almost devoid of vegetation except for opportunistic weed species. The land directly adjacent (to the south, west and north) contains a mix of planted vegetation and weeds.

22.4.3 Native vegetation

Most of Stage 1 contains residential, commercial and industrial development, with limited areas of existing naturally occurring native vegetation. There are two plant community types present within the study area as follows:

- Small area of regrowth within the rail corridor in the footprint of the Westmead metro station construction site (0.03 hectares)
- Small areas of mangrove forest along A'Becketts Creek and Duck Creek at Clyde stabling and maintenance facility construction site (0.15 hectares).

Table 22-4 describes the plant community types within the Stage 1 footprint as defined in the BioNet Vegetation Classification database. The location of this vegetation is shown in Figure 22-2.

Table 22-4: Plant Community Types within the Stage 1 footprint

Plant community type ID No.	Plant Community Type name	Broad condition class	Vegetation zone area in Stage 1 construction footprint (ha)	Stage 1 component	Corresponding Threatened Ecological Community
849	Grey Box-Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Poor (vegetation integrity score 11.4)	0.03	Westmead metro station construction site	Cumberland Plain Woodland in the Sydney Basin Bioregion listed as critically endangered under *Biodiversity Conservation Act 2016*
920	Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion	Poor (vegetation integrity score 34.6)	0.15	Clyde stabling and maintenance facility and downstream	None

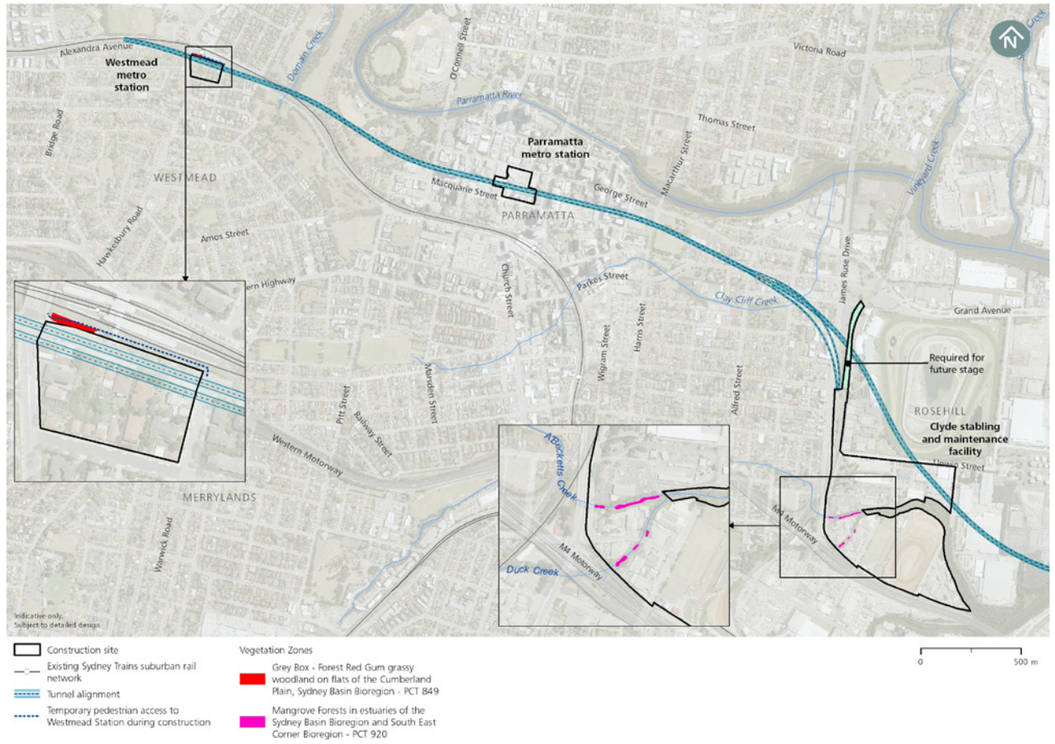

Figure 22-2: Location of plant community types within the Stage 1 footprint

22.4.4 Threatened ecological communities

There is one threatened ecological community (Cumberland Plain Woodland in the Sydney Basin Bioregion) listed under the *Biodiversity Conservation Act 2016* that occurs in the Stage 1 construction footprint, in the existing rail corridor at the Westmead metro station construction site. This corresponds to Plant Community Type 849 and the threatened ecological community is in poor condition represented by regrowth native species amongst plantings and weed growth.

There are also two threatened ecological communities downstream of the development site along Duck River including:

- Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions.

None of the plant community types within the Stage 1 construction footprint correspond to *Environment Protection and Biodiversity Conservation Act 1999* listed threatened ecological communities. The patch of Plant Community Type 849 at Westmead metro station construction site is too small and degraded to be part of the listed Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest.

No other threatened ecological communities listed under the *Biodiversity Conservation Act 2016* or *Environment Protection Biodiversity Conservation Act 1999* were recorded within the Stage 1 construction footprint.

A patch of the *Environment Protection and Biodiversity Conservation Act 1999* listed 'Subtropical and Temperate Coastal Saltmarsh' community occurs about 1.2 kilometres downstream of the Clyde stabling and maintenance facility construction site. Indirect impacts to this threatened ecological community are discussed in Section 22.6.

22.4.5 Groundwater dependent ecosystems

There are no mapped aquatic groundwater dependent ecosystems within the Stage 1 study area. However, the Atlas of Groundwater Dependant Ecosystems (Bureau of Meteorology, 2017) identifies portions of the locality as containing some areas of high potential terrestrial groundwater dependent ecosystems including areas of saltmarsh and mangrove forest.

Based on the results of the field surveys, there is high potential for terrestrial groundwater dependent ecosystems known to be present, including:

- Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion Plant Community Type (849)
- Forest Red Gum – Rough-barked Apple grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion Plant Community Type (835)
- Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter Valley Plant Community Type (1800)
- Turpentine – Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion Plant Community Type (1281).

These plant community types have a moderate to high likelihood to be terrestrial groundwater dependant ecosystems but are not entirely dependent on groundwater. These plant community types may depend on the subsurface presence of groundwater in some locations but not in others.

22.4.6 Threatened flora species

Based on the assessment of habitat in the Stage 1 construction footprints, and a review of databases and published information, the following species credit plant species were considered 'candidate species' for assessment (see Table 22-5). The full assessment for threatened plant species is provided in Technical Paper 10 (Biodiversity development assessment report).

Table 22-5: Candidate threatened flora species identified for assessment

Species name	Common name	Biodiversity *Conservation Act 2016* status	*Environment Protection and Biodiversity Conservation Act 1999* status
Acacia pubescens	Downy Wattle	Vulnerable	Vulnerable
Cynanchum elegans	White-flowered Wax Plant	Endangered	Endangered
Dillwynia tenuifolia	Dillwynia tenuifolia	Vulnerable	Not listed
Grevillea juniperina subsp. juniperina	Juniper-leaved Grevillea	Vulnerable	Not listed
Haloragis exalata* subsp. *exalata	Square Raspwort	Vulnerable	Vulnerable
***Marsdenia viridiflora* subsp. *viridiflora* – endangered population**	Marsdenia viridiflora R. Br. subsp. viridiflora population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas	Endangered Population	Not listed
Pultenaea pedunculata	Matted Bush-pea	Vulnerable	Not listed
Wilsonia backhousei	Narrow-leafed Wilsonia	Vulnerable	Not listed

Note: V = Vulnerable, E = Endangered, EP = Endangered population

No threatened flora species were recorded during field surveys. A small sub-population of *Wilsonia backhousei* (listed as Vulnerable under the *Biodiversity Conservation Act 2016*) was recorded about 1.2 kilometres downstream of the Clyde stabling and maintenance facility construction site.

22.4.7 Threatened fauna species

Targeted surveys for threatened fauna were not undertaken during the surveys. The assessment of threatened fauna species was based on suitable habitat present and the findings of previous surveys.

One species credit fauna species, the Southern Myotis (listed as vulnerable under the *Biodiversity Conservation Act 2016*) is considered likely to occur based on the presence of suitable habitat. Foraging habitat is present but no potential roosting or breeding habitat is present. The Southern Myotis is known to occur around the Port Jackson estuary and its tributaries.

Based on the assessment of habitat in the Stage 1 construction footprints, and a review of databases and published information, the ecosystem credit fauna species in Table 22-6 were assumed to be present based on the presence of suitable habitat. The full assessment for threatened fauna species is provided in Technical Paper 10 (Biodiversity development assessment report).

The Stage 1 construction footprint also provides some limited foraging habitat for the *Environment Biodiversity Conservation Act 1999* listed species Grey-headed Flying-fox and Swift Parrot.

A number of threatened and migratory shorebirds and other estuarine birds listed under the *Biodiversity Conservation Act 2016* and/or the *Environment Protection and Biodiversity Conservation Act 1999* have the potential to occur downstream of the Stage 1 construction footprint. This is discussed in the following section.

Table 22-6: Threatened ecosystem credit fauna species assumed to be present

Common name	Scientific name	*Biodiversity Conservation Act 2016* status	*Environment Biodiversity Conservation Act 1999* status	Commentary
Within the Stage 1 construction site footprint (does not include landscape buffer)				
Dusky Woodswallow	*Artamus cyanopterus cyanopterus*	Vulnerable	Not listed	Commonly seen near the Parramatta River and may forage in or over the mangroves in and adjacent to the Stage 1 construction footprint.
Little Bent-winged Bat	*Miniopterus australis*	Vulnerable	Not listed	May forage in and around the mangrove vegetation.
Large Bent-winged Bat	*Miniopterus orianae oceanensis*	Vulnerable	Not listed	May forage in and around the mangrove vegetation.
Eastern Coastal Free-tailed Bat	*Micronomus norfolkensis*	Vulnerable	Not listed	Foraging habitat is present and potential roosting habitat is present in the mangrove vegetation.
Grey-headed Flying-fox	*Pteropus poliocephalus*	Vulnerable	Vulnerable	Known to occur in the Sydney urban area. Some foraging habitat may be impacted (street trees, garden plantings and mangroves).
Little Lorikeet	*Glossopsitta pusilla*	Vulnerable	Not listed	May forage in street trees within the construction footprint on occasion.
Swift Parrot	*Lathamus discolor*	Endangered	Critically Endangered	Vagrant birds are known to occasionally visit the street trees around the Sydney urban area but the likelihood of birds using the trees within the footprint as a continual source of habitat is low.
Above the tunnel alignment (does not include the Stage 1 construction site surface footprint and does not include the landscape buffer)				
Australasian Bittern	*Botaurus poiciloptilus*	Endangered	Endangered	Habitat present in saltmarsh downstream of the Clyde stabling and maintenance facility construction site and in Mason Park wetlands located above the tunnels.
Green and Golden Bell Frog	*Litorea aurea*	Endangered	Vulnerable	Habitat present in wetlands of Haslams Creek that are located above the tunnels.

22.4.8 Migratory species

Based on the desktop assessment, the following species are considered moderately likely to occur within the study area in habitats which include mangrove, wetlands and saltmarsh:

- Migratory marine birds – Fork-tailed Swift
- Migratory terrestrial species – White-throated Needletail
- Migratory wetland species – Common Sandpiper, Ruddy Turnstone, Sharp-tailed Sandpiper, Curlew Sandpiper, Pectoral Sandpiper, Red-necked Stint, Great Knot, Double-banded Plover, Greater Sand Plover, Lesser Sand Plover, Latham's Snipe, Bar-tailed Godwit, Black-tailed Godwit, Eastern Curlew, Whimbrel, Osprey, Ruff, Pacific Golden Plover, Grey-tailed Tattler, Common Greenshank and Marsh Sandpiper.

These birds are also listed as marine species under the *Environment Protection and Biodiversity Conservation Act 1999*. Other listed marine species including the Great Egret, Cattle Egret, Red-capped Plover, White-bellied Sea-Eagle, Black-winged Stilt, Swift Parrot, and Red-necked Avocet may occur in the mangrove, wetlands and saltmarsh habitats on occasion.

While some migratory bird species are likely to use the study area, the Stage 1 construction footprint would not be classed as an 'important habitat' according to the guidance provided in the *Environment Protection and Biodiversity Conservation Act 1999* Policy Statement 3.21 — Industry guidelines for avoiding, assessing and mitigating impacts on *Environment Protection and Biodiversity Conservation Act 1999* listed migratory shorebird species (Department of the Environment, 2015).

22.4.9 Aquatic ecology

Key watercourses

The Stage 1 construction footprint is located entirely within the Sydney Metro catchment (Parramatta River/ Port Jackson subcatchment). The tunnel alignment would pass at depth under a number of waterways. Duck Creek and A'Becketts Creek would be traversed with culverts over the creeks as part of works at the Clyde stabling and maintenance facility construction site. A description of each of the key watercourses in the study area (which includes the 1,500 metre landscape buffer) is provided in Table 22-7

Table 22-7: Key watercourses within the study area (including the 1,500 metre landscape buffer)

Watercourse	Description	Mapped as key fish habitat?[1]	Waterway class[2]	Habitat for threatened fish species?[3]	SEPP (Coastal Management) wetland?[4]
Coopers Creek	• Heavily urbanised, first order stream • Approximately 1.5 km north-west of the Westmead metro station construction site • Unlikely to be impacted by Stage 1.	No	Class 2 (moderate key fish habitat)	No	No
Toongabbie Creek	• Third order stream • Major tributary of Parramatta River • Approximately 1.2 km north-west of Westmead metro station construction site • Unlikely to be impacted by Stage 1.	Yes	Class 1 (major key fish habitat)	No	No
Finlaysons Creek	• A freshwater, first order creek • Located approximately 1 km west of the Westmead metro station construction site • Majority of the creek is a modified concrete lined channel with no instream aquatic habitat • Unlikely to be impacted by Stage 1.	No	Class 4 (unlikely key fish habitat)	No	No
Darling Mills Creek	• A freshwater, forth order creek • Located approximately 1.5 metres north-east of Westmead metro station construction site. • Unlikely to be impacted by Stage 1.	Yes	Class 2 (moderate key fish habitat)	No	No
Domain Creek	• A freshwater, first order creek • The tunnels pass about 25 m beneath the creek and are located about 300 m east of the Westmead metro station construction site • Within the vicinity of the tunnels, the creek is a modified waterway with sections of naturalised channel, and sections that are concrete-lined • The instream habitat includes aquatic macrophytes and limited overhanging riparian vegetation.	No	Class 1 (major key fish habitat)	No	No
Parramatta River	• Main tributary of Sydney Harbour (a large fourth order waterway) • The Parramatta metro station construction site is located about 300 m south of the river • The tunnels would not pass beneath Parramatta River • The river is freshwater upstream of Charles Street weir, downstream it is saline	Yes	Class 1 (major key fish habitat)	No	Yes. Large sections of the Parramatta River estuary are mapped.
Clay Cliff Creek	• Highly modified second order creek • The tunnels pass about 35 m beneath the creek and about 820 m upstream of the confluence with the Parramatta River • The creek is a concrete lined channel, with underground sections, and contains no instream habitat.	No	Class 4 (unlikely key fish habitat)	No	Yes Located downstream along the banks of the Parramatta River at the confluence with Clay Cliff Creek.
Vineyard Creek	• Freshwater, second order watercourse • Located around 1.4 km north of the Clyde stabling and maintenance facility • Unlikely to be impacted by Stage 1.	No	Class 2 (moderate key fish habitat)	No	No
Subiaco Creek	• Freshwater, second order watercourse • Located around 1.4 km north of the Clyde stabling and maintenance facility • Unlikely to be impacted by Stage 1.	Yes	Class 2 (moderate key fish habitat)	No	No
Duck River	• Within the study area, the river is a third order estuarine stream • The tunnels pass about 30 m beneath the Duck River at about 1.7 km upstream of the confluence with the Parramatta River, and east of the Clyde stabling and maintenance facility construction site • The banks of the channel are densely vegetated by mangroves.	Yes	Class 1 (major key fish habitat) as it is a permanently flowing river.	No	Yes The banks of the channel are mapped.

Watercourse	Description	Mapped as key fish habitat?[1]	Waterway class[2]	Habitat for threatened fish species?[3]	SEPP (Coastal Management) wetland?[4]
Duck Creek	• Highly modified second order stream • The creek is located within and adjacent to the Clyde stabling and maintenance facility construction site • Within the study area, the creek is estuarine but becomes less saline and eventually freshwater in its upper reaches • The creek contains mangrove vegetation, but the banks are dominated by exotic species with occasional planted native trees.	Yes	Class 1 (major key fish habitat)	No	Yes Area mapped along Duck Creek in the footprint of the Clyde stabling and maintenance facility construction site.
A'Becketts Creek	• Highly modified first order stream • The creek is located upstream and within the Clyde stabling and maintenance facility construction site • Within the study area, the creek is estuarine but becomes less saline and eventually freshwater in its upper reaches • The creek contains mangrove vegetation, but the banks are dominated by exotic species with occasional planted native trees.	No	Class 1 (major key fish habitat)	No	Yes Area mapped along A'Becketts Creek in the footprint of the Clyde stabling and maintenance facility construction site
Haslams Creek	• Highly modified second order stream • Within the study area, the creek is estuarine • The tunnels pass about 30 m beneath the creek at about 2 km upstream of the confluence with Homebush Bay	Yes	Class 1 (major key fish habitat)	No	Yes Present along the creek
Saleyards Creek	• Highly modified first order stream • The tunnels pass about 25 m beneath the creek at about 130 m upstream of the confluence with Powells Creek • The creek is a concrete lined channel and contains minimal instream habitat.	Yes However following inspection, it is not considered key fish habitat in accordance with relevant guidelines	Class 3 (minimal key fish habitat)	No	Yes Mason Park Wetlands are in close proximity to the creek.
Powells Creek	• A semi-naturalised concrete lined first order drainage channel • Within the study area, the creek is estuarine • The tunnels pass about 25 m beneath the creek at about 1.4 km upstream of the confluence with Homebush Bay, • located about 320 m west of North Strathfield metro station construction site • Dense mangroves occur in areas along the banks	Yes	Class 1 (major key fish habitat)	No	Yes Mason Park wetland and Homebush Bay wetlands are in close proximity to the creek.
St Lukes Park Canal	• Highly modified first order channel • The channel is predominantly concrete lined and contains no instream aquatic habitat • Within the study area, the canal is estuarine but is also influenced by stormwater runoff from its predominantly urban catchment • The tunnels pass about 20 metres underground immediately to the south of the canal, at about 90 m east of the Burwood North station construction site	No	Class 4 (unlikely key fish habitat)	No	No

Note 1: Mapped as key fish habitat (NSW Department of Primary Industries, 2013)

Note 2: Waterway classification (Fairfull and Witheridge, 2003)

Note 3: Habitat for threatened aquatic species listed under the Fisheries Management Act 1994 and Environment Protection and Biodiversity Conservation Act 1999

Note 4: Proximity to coastal wetlands listed in the State Environment Planning Policy (Coastal Management) 2018

Other watercourses

There are a number of other watercourses located near Stage 1, including:

- Saltwater Creek, a concrete lined canal located approximately 1.7 kilometres north of the Burwood North Station construction site that discharges to Exile Bay at Concord
- Barnwell Park Canal, which discharges in Hen and Chicken Bay. The tunnels pass about 30 metres beneath the upstream extents of canal
- Iron Cove Creek (also known as Dobroyd Canal), which discharges into Iron Cove. The tunnels pass around 130 metres to the north of the creek at about 35 metres below ground, and Five Dock Station construction site is located about 600 metres to the north
- Hawthorne Canal, which discharges into Iron Cove. The tunnels pass around 180 metres to the north of the creek at around 40 metres below ground
- Whites Creek, a concrete lined canal that discharges to Rozelle Bay at Annandale approximately 600 metres south-west of The Bays Station construction site
- Johnstons Creek, a concrete lined canal that discharges to Rozelle Bay at Glebe approximately 1.3 kilometres south of The Bays Station construction site.

These waterways are concrete lined and contain no instream aquatic habitat. While some are mapped as key fish habitat, these waterways are not considered to be key fish habitat in accordance with the Policy and Guidelines for Fish Habitat Conservation and Management ((NSW Department of Primary Industries, 2013) and are classified as Class 4 (unlikely key fish habitat).

No threatened species listed under the *Fisheries Management Act 1994* have potential habitat within these watercourses. Coastal wetlands as defined by the Coastal Management SEPP are greater than 500 metres downstream.

Sydney Harbour

The tunnels are located south of Sydney Harbour and pass about 35 to 45 metres beneath Iron Cove which is mapped as key fish habitat. The Bays Station construction site is located on the foreshore of White Bay.

The entire Sydney Harbour and all major tributaries linked to the harbour are mapped as key fish habitat (Type 1 key fish habitat) and Class 1 (major key fish habitat). However, White Bay has been heavily modified for port purposes and is unlikely to contain significant aquatic habitat and is therefore not considered key fish habitat in accordance with the Policy and Guidelines for Fish Habitat Conservation and Management (NSW Department of Primary Industries, 2013).

No threatened species listed under the *Fisheries Management Act 1994* have potential habitat within White Bay. Coastal wetlands as defined by the Coastal Management SEPP are present greater than 500 metres away.

Sensitive receiving environments

Parramatta River/Sydney Harbour, Duck River, Duck Creek, Haslams Creek, Powells Creek, Iron Cove Creek/Dobroyd Canal and Hawthorne Canal have been identified as high sensitive receiving environments predominantly due to the key fish habitat classifications and/or proximity to SEPP Coastal Wetlands. Table 22-8 summarises the sensitive receiving environments that may be impacted by Stage 1:

Table 22-8: Sensitive receiving environments

Stage 1 component	Watercourse / waterbody name	Conditions	Sensitivity
• **Westmead metro station construction site** • **Parramatta metro station construction site** • **The Bays Station construction site** • **Tunnels**	Parramatta River / Sydney Harbour	Moderately disturbed	High
• **Westmead metro station construction site** • **Tunnels**	Domain Creek	Highly disturbed	Low
• **Westmead metro station construction site**	Toongabbie Creek	Moderately disturbed	Moderate
• **Tunnels**	Clay Cliff Creek	Highly disturbed	Moderate
• **Clyde stabling and maintenance facility construction site** • **Tunnels**	Duck River	Moderately disturbed	High
	Duck Creek	Moderately disturbed	High
	A'Becketts Creek	Highly disturbed	Moderate
• **Sydney Olympic Park metro station construction site** • **Tunnels**	Haslams Creek	Moderately disturbed	High
• **North Strathfield metro station construction site** • **Tunnels**	Saleyards Creek	Highly disturbed	Moderate
	Powells Creek	Moderately disturbed	High
	Mason Park Wetland	Moderately disturbed	High
• **Burwood North Station construction site** • **Tunnels**	St Lukes Park Canal	Highly disturbed	Moderate
	Barnwell Park Canal	Highly disturbed	Moderate
• **Five Dock Station construction site**	Iron Cove Creek / Dobroyd Canal	Moderately disturbed	High
• **Tunnels**	Iron Cove	Moderately disturbed	High
• **The Bays Station construction site**	White Bay	Highly disturbed	Low

Marine vegetation

Mangroves are present within and adjacent to the Clyde stabling and maintenance facility construction site along Duck River and A'Becketts Creek.

Expansive seagrass meadows are not known within the study area, however small isolated and fragmented patches of seagrass (*Zostera capricorni* and *Halophila ovalis*) have been identified within Iron Cove.

Aquatic fauna

Previous fish surveys within the Parramatta River at Charles Street Weir, Homebush Bay and Kendall Bay have not recorded threatened aquatic fauna species.

The desktop searches identified sixteen threatened aquatic fauna species that have the potential to occur within the locality. Of these, three are regarded as having a moderate to high likelihood of occurrence (Table 22-9).

Table 22-9: Aquatic species with moderate to high likelihood to occur within the locality

Common name	Scientific name	*Biodiversity Conservation Act 2016* status	*Environment Biodiversity Conservation Act 1999* status	Commentary
Black Rockcod	*Epinephelus daemelii*	Vulnerable	Vulnerable	Inhabit caves, gutters, beneath bommies in near shore environments to depths of 50 metres. Potential occurrence around near shore environments, particularly in the vicinity of The Bays station construction sites.
White Shark	*Carcharadon carcharias*	Vulnerable	Vulnerable	If in the unlikely event White Sharks were within the waterways at Pyrmont and Iron Cove, it is not expected that any sharks would remain long enough to be vulnerable to any potential impacts. Parramatta River and Duck River are considered marginal habitat for the Grey Nurse Shark.
Grey Nurse Shark	*Carcharias taurus*	Critically Endangered	Critically Endangered	

Stage 1 is not expected to directly impact suitable habitat for the Black Rockcod, and the nearshore environments, particularly within the vicinity of The Bays station construction site as this is considered unsuitable for this species. The Black Rockcod has a low likelihood of occurrence in any habitats that may be impacted by Stage 1.

The threatened shark species (White Shark, Grey Nurse Shark) are large and conspicuous. While desktop assessment indicated that the habitat in the lower Parramatta River Estuary is suitable or potentially suitable for these species to occupy, they have not been recorded in the study area. If in the unlikely event White Sharks were within the waterways at Pyrmont and Iron Cove, it is unlikely that any sharks would remain long enough to be vulnerable to any potential impacts. Parramatta River and Duck River are considered marginal habitat for the White Shark. Given the distance from known aggregation areas, the proposed works within the study area would not directly affect Grey Nurse Shark habitat. Parramatta River and Duck River are considered marginal habitat for the Grey Nurse Shark.

22.5 Avoidance and minimisation of impacts

The design development of Stage 1 focussed on avoiding or minimising potential biodiversity impacts. Stage 1 is largely within a highly urbanised area that does not possess large expanses of intact native vegetation with high biodiversity value. As the majority of Stage 1 would be underground or in pre-existing developed areas, direct impacts to terrestrial biodiversity has been largely avoided and/or minimised.

22.6 Potential impacts

The Stage 1 construction footprint is predominantly set in areas with existing development. The limited amount of native vegetation to be disturbed by Stage 1 is of poor to moderate quality and threatened species habitats are very limited. Biodiversity impacts that would occur are described below.

22.6.1 Loss of native vegetation

No areas of land that the Minister for Energy and Environment has declared as an area of outstanding biodiversity value in accordance with Section 3.1 of the *Biodiversity Conservation Act 2016* would be impacted.

No threatened flora species would be directly impacted as a result of Stage 1.

Stage 1 would involve the direct removal of 0.18 hectares of native vegetation that corresponds with the following Plant Community Types:

- Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (Plant Community Type 849) – 0.03 hectares located within the Westmead metro station construction site
- Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion (Plant Community Type 920) – 0.15 hectares located within the Clyde stabling and maintenance facility construction site.

22.6.2 Loss of fauna habitat

The following seven threatened fauna species may use other vegetation, including both native and exotic planted trees and shrubs, and are found within the Stage 1 construction footprint:

- Large Bent-winged Bat (*Miniopterus orianea oceanensis*)
- Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*)
- Grey-headed Flying-fox (*Pteropus poliocephalus*)
- Little Bent-winged Bat (*Miniopterus australis*)
- Little Lorikeet (*Glossopsitta pusilla*)
- Southern Myotis (*Myotis macropus*)
- Swift Parrot (*Lathamus discolor*).

The Grey-headed Flying-fox, Swift Parrot and Little Lorikeet are considered likely to forage on the flowers and/or fruit of both planted and exotic trees within the Stage 1 construction footprint. The Large Bent-winged Bat, Eastern Coastal Free-tailed Bat and Little Bent-winged Bat may forage in the air spaces around areas of non-native vegetation, feeding on the insects attracted to the vegetation. Potential roosting habitat in the form of small tree hollows may also be present in some of the larger trees for the Eastern Coastal Free-tailed Bat and Southern Myotis. In the case of the Southern Myotis, only tree hollows within 200 metres of water bodies are likely to be used.

Due to the marginal, unnatural structure of the vegetation present, it is unlikely that vegetation within the Stage 1 footprint would be used as breeding habitat by any threatened species. Therefore, it is unlikely that Stage 1 would detrimentally affect these species if they were present.

22.6.3 Assessments of significance

No threatened species are likely to be significantly impacted by Stage 1. The findings of *Environment Protection and Biodiversity Conservation Act 1999* assessments of significance are summarised in Table 22-10 and further details are provided in Appendix D of Technical Paper 10 – Biodiversity development assessment report.

Table 22-10: Assessment of significance – *Environment Protection and Biodiversity Conservation Act 1999*

Threatened species	Impacts on important population?	Likely significant impact?
Grey-headed Flying-fox (*Pteropus poliocephalus*)	No	No
Swift Parrot (*Lathamus discolour*)	No	No

22.6.4 Impacts to habitat connectivity

The Stage 1 construction footprint is located within a highly disturbed landscape where the majority of habitats have been cleared. The habitats that do remain are fragmented and highly isolated.

The vegetated riparian zones of Duck Creek and A'Becketts Creek potentially provide movement corridors that would be temporarily impacted by the Stage 1 construction footprint, but these corridors are only likely used by flying species or local common mammals, reptiles and amphibians. There is a low chance that the threatened Green and Golden Bell Frog would utilise the riparian zones of Duck Creek and A'Becketts Creek as these two waterways are tidal (not still water), have permanent water, are polluted, lack emergent aquatic plant species (i.e. no Typha, Phragmites, etc.), and contain predatory fish including Gambusia and Carp. Additionally, the planted urban vegetation within the construction footprint also plays a small role in facilitating the movement of threatened species across the landscape.

Many mobile species, particularly birds and bats, and to a more limited extent amphibians, mammals and reptiles may potentially use these vegetated riparian corridors. Flying animals such as birds and bats use the airspace to move between natural habitats and the planted vegetation potentially within the construction sites and are could be used as a foraging or perching resource as part of daily movements.

22.6.5 Impacts on aquatic habitats and groundwater dependent ecosystems

Potential Stage 1 activities that could impact aquatic habitats and water quality include:

- Direct removal of 0.15 hectares of mangrove habitat
- Realignment of short sections of A'Becketts Creek and Duck Creek
- New crossings of A'Becketts Creek and Duck Creek
- Discharge of treated groundwater from water treatment plants (collected from tunnelling activities)
- General construction activities.

The above construction activities would have the following potential impacts:

- Disruption to fish passage
- Direct loss of mangrove habitat
- Reduced water quality due to increased turbidity associated with instream earthworks.

Indirect impacts such as those from groundwater drawdown are not expected to impact the habitat of threatened species based on groundwater modelling as detailed in Chapter 18 (Groundwater and ground movement – Stage 1). Impacts to threatened ecological communities are expected to be minimal as the threatened ecological communities are likely to be opportunistic facultative groundwater dependent ecosystems that depend on the subsurface presence of groundwater in some locations but not in others, particularly where an alternative source of water (i.e. rainfall) cannot be accessed to maintain ecological function.

Impacts of groundwater drawdown relating to soils, water quality and hydrology are discussed in Chapter 19 (Soils and surface water quality – Stage 1) and Chapter 21 (Hydrology and flooding – Stage 1) respectively.

22.6.6 Marine fauna species

As discussed in Section 22.4.9 and Table 22-9, three aquatic fauna species have a moderate to high likelihood to occur within the locality.

Suitable habitat for the Black Rockcod, particularly within the vicinity of The Bays Station construction sites would not be directly impacted however it may be impacted by changes to water quality during construction.

In the unlikely event White Sharks were within the waterways at Pyrmont and Iron Cove, it is unlikely that any sharks would remain long enough to be vulnerable to any potential impacts. Similarly, no aggregation sites for Grey Nurse Sharks are located within Sydney Harbour, therefore Stage 1 would not directly affect suitable habitat.

22.6.7 Fauna injury or mortality

There is a chance of fauna mortality during construction through vehicle collision (i.e. roadkill). Mammals, reptiles, amphibians and birds are all at risk of vehicle strike, particularly those common species (e.g. birds) that are tolerant of disturbance and would remain within the construction footprint. The risk of increased vehicle strike due to Stage 1 is low and would generally be limited to movement of vehicles to and from sites. Vehicle strike associated with Stage 1 is unlikely to affect any threatened species of animals.

22.6.8 Assessment against the Biodiversity Assessment Method

An offset is required for the impacts to plant community types and threatened (species credit) species. The biodiversity credit obligation has been calculated using the Biodiversity Assessment Method Calculator. Only areas of the Stage 1 construction footprint that contain plant community types were assessed and the offset credits that are required were determined.

A summary of the biodiversity credit requirements for Stage 1 is:

- Ecosystem credits required:
  - Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion (Plant Community Type 920) – three credits
- Species credits required:
  - Southern Myotis (*Myotis macropus*) – three credits.

An offset is not required for impacts on native vegetation where the vegetation integrity score is below 15. The vegetation integrity score for the Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion Plant Community Type (849) is 11.4 and therefore an offset is not required for impacts to this Plant Community Type.

For marine vegetation such as mangroves, the offsetting rules of the NSW Department of Primary Industries Policy and Guidelines for Fish Habitat Conservation and Management (NSW Department of Primary Industries, 2013) are applicable as the guidelines are intended to feed into the assessment of State Significant Infrastructure projects to ensure the sustainable management, and 'no net loss', of key fish habitats in NSW.

Offsets for impacts to marine vegetation would need to be made at a 10:1 ratio due to impacts on a mapped coastal wetland area and the mangrove community (refer to Table 22-11).

An alternative to the provision of offsets is the making of a payment to the Biodiversity Conservation Trust Fund.

Table 22-11: Impact to marine vegetation and likely offset ratio

Plant community type	Area in Stage 1 footprint	Offset ration	Likely offset required
Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion	0.15 ha	10:1	1.5 ha

22.6.9 Key threatening process

A key threatening process is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Stage 1 may directly or indirectly contribute to the following key threatening processes as outlined in Table 22-12.

Table 22-12: Summary of key threatening processes that Stage 1 may directly or indirectly contribute to

Key threatening process	Act designated under[1]	Likelihood of Stage 1 directly or indirectly contributing to the key threatening process
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	BC Act	High – some sections of Duck Creek and A'Becketts Creek would be modified.
Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams	FM Act	High – permanent instream structures would be built in A'Becketts Creek and Duck Creek but they would be designed where practicable to allow for fish passage.
Clearing of native vegetation	BC Act	High – clearing of native vegetation will would occur. However, the magnitude of clearing is small (0.18 hectares).
Land clearance	EPBC Act	High – clearing of native vegetation will would occur. However, the magnitude of clearing is small (0.18 hectares).
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	BC Act	Low – mitigation measures would be implemented to prevent the spread or introduction of amphibian chytrid fungus.
Infection of amphibians with chytrid fungus resulting in chytridiomycosis	EPBC Act	Low – mitigation measures would be implemented to prevent the spread or introduction of amphibian chytrid fungus.
Infection of native plants by *Phytophthora cinnamomi*	BC Act	Low – mitigation measures would be implemented to prevent the spread or introduction of *Phytophthora cinnamomi*.
Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)	EPBC Act	Low – mitigation measures would be implemented to prevent the spread or introduction of *Phytophthora cinnamomi*.
Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	BC Act	Low – mitigation measures would be implemented to prevent the spread or introduction of Exotic Rust Fungi.
Invasion and establishment of exotic vines and scrambler	BC Act	Low – mitigation measures would be implemented to prevent the spread of weeds.
Invasion of native plant communities by African Olive *Olea europaea* subsp. *cuspidata* (Wall. ex G. Don) Cif.	BC Act	Low – mitigation measures would be implemented to prevent the spread of weeds.
Invasion of native plant communities by *Chrysanthemoides monilifera*	BC Act	Low – mitigation measures would be implemented to prevent the spread of weeds.
Invasion of native plant communities by exotic perennial grasses	BC Act	Low – mitigation measures would be implemented to prevent the spread of weeds.
Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat)	BC Act	Low – mitigation measures would be implemented to prevent the spread of weeds.
Degradation of native riparian vegetation along New South Wales water courses	FM Act	High – sections of Duck Creek and A'Becketts Creek and associated native riparian vegetation would be modified and cleared.

Note 1: BC Act: NSW Biodiversity Conservation Act 2016, FM Act: Fisheries Management Act 1994, EPBC Act: Environmental Protection and Biodiversity Conservation Act 1999

22.6.10 Cumulative impacts

Potential cumulative impacts were considered for assessment based on the likely interactions of Stage 1 with other projects and plans that met the adopted screening criteria. The approach to assessment and the other projects considered are described further in Appendix G (Cumulative impacts assessment methodology – Stage 1).

The cumulative impacts of historic vegetation clearing for agriculture, urban development, and development and maintenance of infrastructure would likely include continued loss of biodiversity on the Cumberland Plain. The Cumberland Plain is an over cleared landscape and due to the expansion of western Sydney and creation of housing and associated infrastructure, further impacts to biodiversity are likely to result in this region.

Available information on recent projects with biodiversity impacts is as follows:

- Parramatta Light Rail (Stage 1): Direct impact to 0.62 hectares of native vegetation. Removal of approximately 300 individual trees that are mostly horticultural plantings
- Clyde Terminal Conversion Project: No impacts to native vegetation. Impact to tank farm habitat for the Green and Golden Bell Frog
- WestConnex M4 Widening: Direct impact on up to 8.86 hectares of planted and remnant vegetation.

When the impacts of Stage 1 are considered together with the impacts of the above projects the contribution of Stage 1 to cumulative biodiversity impacts in the Cumberland Plain region is low. While there would be some limited biodiversity impacts from Stage 1, no significant increase to cumulative impacts would occur.

All potential biodiversity impacts during construction would be managed to acceptable levels through the implementation of the mitigation measures in Section 22.7.2.

22.7 Mitigation and management

22.7.1 Management approach

Stage 1 biodiversity impacts would be managed in accordance with the Construction Environmental Management Framework. Of relevance, the Construction Environmental Management Framework (Appendix D) includes biodiversity management objectives to maximise workers' awareness of biodiversity values and avoid or minimise potential impacts to biodiversity.

The Construction Environmental Management Framework also requires the preparation and implementation of a Flora and Fauna Management Plan, including as a minimum:

- Procedures for the demarcation and protection of retained vegetation, including all vegetation outside and adjacent to the construction footprint
- Measures to reduce disturbance to sensitive fauna
- Procedures for the clearing of vegetation and the relocation of flora and fauna
- Procedures for dealing with unexpected Endangered Ecological Communities or threatened species identified during construction
- Weed management measures in accordance with the *Biosecurity Act 2015*
- Pathogen management measures to prevent introduction and spread of amphibian chytrid fungus *Phytopthera cinnamomi* and exotic rust fungi
- Inspection and monitoring requirements.

22.7.2 Mitigation measures

The mitigation measures in Table 22-13 would be implemented to further reduce the potential biodiversity impacts of Stage 1.

Table 22-13: Mitigation measures – Biodiversity Stage 1

Reference	Impact/issue	Mitigation measure	Applicable location(s)[1]
B1	Impacts to fish passage	During construction, sufficient flow and fish passage would be maintained similar to current conditions during in-stream works where feasible and reasonable.	CSMF
B2	Impacts of proposed creek crossings	The A'Becketts Creek and Duck Creek crossings would be designed to: • Provide sufficient fish passage is accordance with Policy and guidelines for fish habitat conservation and management Update 2013 (DPI (Fisheries NSW) 2013) • Incorporate suitable scour protection • Avoid worsening existing flow velocities downstream from the crossing locations • Incorporate a vegetated riparian zone within the realigned open channel sections where feasible and reasonable.	CSMF
B3	Impacts to groundwater dependent ecosystems	Additional investigations and assessment would be completed to confirm the potential for impacts to groundwater dependant ecosystems due to groundwater drawdown, and to identify any required mitigation through design.	WMS, CMSF, NSMS, BNS, FDS.

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (e.g. tunnel boring machine works); PSR: Power supply routes.

22.7.3 Interactions between mitigation measures

Mitigation measures in other chapters that are relevant to the management of biodiversity include:

- Chapter 18 (Groundwater and ground movement – Stage 1), specifically measures which address modelling changes to groundwater levels and measures requiring further investigations to confirm the existing groundwater baseflow contribution to the streamflow.
- Chapter 19 (Soil and surface water – Stage 1), specifically measures which address water quality impacts.

There are no mitigation measures identified in the assessment of other environmental aspects that are likely to affect the assessment of biodiversity.

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23 Air quality – Stage 1

23 Air quality – Stage 1

This chapter assesses the potential impacts of Stage 1 on air quality and identifies mitigation measures to address these impacts.

23.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relevant to air quality, and reference to where they are addressed in the Environmental Impact Statement are provided in Table 23-1.

Table 23-1: Secretary's Environmental Assessment Requirements – Air quality Stage 1

Reference	Secretary's Environmental Assessment Requirements	Where addressed
13. Other Issues		
13.1	Air quality, greenhouse gas and energy, climate change adaptation, waste management and resource use, hazard and risk assessments should be undertaken in accordance with the commitments in Section 9 of the Scoping Report.	This chapter Chapter 24 (Spoil, waste management and resource use) Chapter 25 (Hazards) Chapter 26 (Sustainability and climate change) Refer to Table 2 of Appendix A for Scoping Report requirements

23.2 Legislative and policy context

23.2.1 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* provides the statutory framework for managing pollution in NSW. It includes procedures to regulate the potential for pollution, including the issue of environment protection licences for activities identified in Schedule 1 of the Act. Air quality requirements (including criteria) are typically included in environment protection licences. An environment protection licence(s) would be obtained as necessary for Stage 1.

The Protection of the Environment Operations (Clean Air) Regulation 2010 regulates emissions from motor vehicles, fuels, and industry. The Regulation does not apply to railway vehicles or special purpose motor vehicles such as construction vehicles (e.g. earthworks vehicles, mobile cranes and lifting equipment). As such, while Stage 1 would be constructed so that it complies with the Clean Air Regulation, the provisions of the Clean Air Regulation would have no direct application.

Air quality impact assessment is guided by the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (Environment Protection Authority, 2016). The Approved Methods generally apply to stationary sources of air pollution, but include air quality impact assessment criteria that are used for the qualitative assessment described in this chapter.

23.2.2 National Environment Protection (Ambient Air Quality) Measure

The National Environment Protection (Ambient Air Quality) Measure sets national air quality standards for particulate matter with an aerodynamic diameter of less than 10 microns (PM_{10}), and for particulate matter with an aerodynamic diameter of less than 2.5 microns ($PM_{2.5}$). The relevant standards under the National Environment Protection (Ambient Air Quality) Measure are reproduced in the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (Environment Protection Authority, 2016).

23.3 Assessment approach

23.3.1 General methodology

The general methodology applied to assess potential air quality impacts during Stage 1 was designed to address the primary risks to air quality, and involved:

- Identifying the key air quality related risks from Stage 1
- Establishing prevailing climate and meteorological conditions around Stage 1 using publicly available data from the Bureau of Meteorology monitoring station at Parramatta North
- Establishing prevailing ambient air quality conditions around Stage 1 using publicly available data from Department of Planning, Industry and Environment air quality monitoring stations at Prospect, Parramatta North, Rozelle and Randwick (the closest monitoring stations to Stage 1)
- A desktop review of Commonwealth Department of the Environment and Energy National Pollutant Inventory data to identify any projects or facilities that may be contributing to local air quality conditions
- Identifying air quality sensitive receivers with the potential to be adversely affected by Stage 1
- Assessing potential air quality impacts during construction of Stage 1
- Identifying mitigation measures to address or manage potential air quality impacts.

23.3.2 Methodology for assessing dust impacts

Consistent with other recent large-scale Australian transport infrastructure projects, the potential for dust related impacts during Stage 1 was evaluated using the risk-based assessment approach developed by the UK Institute of Air Quality Management (UK IAQM). The UK IAQM assessment approach is an evaluation of the risk of dust impacts during Stage 1 construction, which involves:

- Estimating the magnitude (i.e. large, medium or small) of potential dust emissions associated with each of the relevant Stage 1 construction activities, including:
  - Demolition (with reference to the volume and height of buildings to be demolished, and the materials with which they are built)
  - Earthworks (with reference to the area of earthworks, soil type, the number of heavy vehicles, and the total amount of materials to be moved)
  - Construction of acoustic sheds and other temporary buildings and structures (with reference to size of buildings being constructed, and whether construction activities include on-site concrete batching or sandblasting)
  - 'Track-out' or transport related handling of construction materials on-site (with reference to the number of heavy vehicles per day and the extent of unsealed roads)
- Classifying the sensitivity of the surrounding human and ecological environment, taking into account the proximity and density of human receivers within 350 metres of each Stage 1 construction site, and sensitive ecological receivers within 50 metres. The sensitivity of the surrounding receiver area is identified for both:
  - Nuisance impacts (such as dust soiling), which is based on the number of sensitive receivers in close proximity to the site
  - Human health impacts, including eye irritation, which has a lower threshold for significance in terms of the number of sensitive receivers and their proximity to the site.

The area around a construction site is assessed as having a high sensitivity to nuisance impacts under the IAQM where more than 10 sensitive receivers are located within 20 metres of the construction site, or where more than 100 sensitive receivers are located within 50 metres of the construction site. The surrounding area is assessed as having a lower sensitivity to nuisance impacts where there are fewer sensitive receivers in close proximity to the construction site, or where surrounding receivers are of a less sensitive nature. Receivers that have a higher sensitivity to nuisance impacts include residential properties, museums and other culturally important collections, medium and long-term car parks, and car show rooms.

Receivers that have a higher sensitivity to human health impacts are locations where members of the public are exposed over longer periods of time, and include residential properties, hospitals, schools and residential care homes. For human health impacts, the sensitivity of the surrounding receiver area also depends on the degree that sensitive receivers are currently subjected to elevated dust concentrations in addition to the number of receivers in proximity to the construction site. A background PM_{10} level of 22 micrograms per cubic metre was applied for construction sites closest to Parramatta North, whereas a background PM_{10} level of 18 micrograms per cubic metre was applied at construction sites closer to the Rozelle air quality monitoring station. The higher background concentration for construction sites closest to Parramatta North indicates a higher level of sensitivity of the surrounding receiver areas to human health impacts. The calculation of background levels of PM_{10} are discussed in Section 23.4.3.

The UK IAQM method results in a risk rating for each type of construction activity without mitigation. The risk ratings for each of the four construction activities are based on different combinations of magnitude and sensitivity, to reflect the potential impacts associated with the different types of construction activity. In particular, receivers are considered to be more sensitive to demolition activities, which can lead to higher risk rating levels for the demolition phase of works compared to other construction activities. This risk rating is then used to determine what mitigation and management measures are required to effectively manage these risks.

23.4 Existing environment

23.4.1 Climate and meteorology

Meteorological conditions are important for determining the direction and rate at which air pollution would disperse. Dust generation is the main air quality risk during construction, and long-term climate data is useful for identifying periods throughout the year when conditions conducive to dust generation are most likely (such as warm and/or dry periods).

Long-term records from the Bureau of Meteorology monitoring station at Parramatta North (the nearest weather station with long-term records) were reviewed to understand meteorological conditions most common during peak day time construction periods.

The data indicates the Sydney metropolitan area experiences warm, wet summers, with average maximum temperatures of around 28 degrees Celsius. Months through winter are the coldest with average mean daily maximum temperatures of around 18 degrees Celsius. Months through winter were also measured to be the driest, with the lowest average monthly rainfall recorded in July (45 millimetres).

Conditions most likely to be associated with dust generation were measured in spring, with above average temperature conditions and average or below average rainfall.

23.4.2 Ambient air quality

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

The NSW Office of Environment and Heritage uses a standardised measurement known as the air quality index to characterise air quality and the acceptability of air quality at a location and compare it in relative terms with other locations throughout NSW. Average daily air quality index values for the four monitored locations between 2014 and 2018 were:

- Prospect – ranging from 48 to 55
- Parramatta North – 56 (only measured in 2018)
- Rozelle – ranging from 42 to 47
- Randwick – ranging from 43 to 49.

These values correspond with an air quality index outcome of 'good', indicating that air quality around Parramatta and Central Sydney is generally of an acceptable quality. Worse air quality index values can occur as a result of a combination of natural and human phenomena including dust storms and bushfires. The recent bushfire events in 2019/2020 resulted in the air quality index exceeding 200 (being the hazardous level), indicating the effect that bushfires can have on air quality.

23.4.3 Background air quality

Air quality data sourced from monitoring stations at Prospect, Parramatta North, Rozelle and Randwick are summarised in Table 23-2, which also provides the air quality impact assessment criterion for each pollutant specified in the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (Environment Protection Authority, 2016). The data shows the existing concentrations of air pollutants were generally below the applicable air quality impact assessment criteria during the 2014 to 2018 reporting periods for sulfur dioxide, nitrogen dioxide and carbon monoxide. The exception is that on occasional days the 24-hour average concentration levels of:

- PM_{10} exceeded the 24-hour impact assessment criterion of 50 micrograms per cubic metre
- $PM_{2.5}$ exceeded the 24-hour impact assessment criterion of 25 micrograms per cubic metre.

These occurrences are generally the result of natural events including dust storms, bushfires and sea spray arising from on-shore winds. Annually averaged PM_{10} concentrations generally complied with the 25 micrograms per cubic metre criterion, whereas annually averaged $PM_{2.5}$ concentrations exceeded the eight micrograms per cubic metre criterion at the Prospect and Parramatta North monitoring stations.

To calculate background PM_{10} levels for the IAQM dust impact assessment, the PM_{10} concentration has been averaged across the years that the data is available at a specific monitoring location.

Table 23-2: Background air quality data

Pollutant	Averaging period	Air quality impact assessment criteria	Prospect					Parramatta North					Rozelle					Randwick				
			2014	2015	2016	2017	2018	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018
PM_{10} (µg/m³)	Maximum 24-hour	50	44	**69**	**110**	**61**	**113**	-	-	-	-	**107**	44	**60**	**59**	**54**	**88**	46	**77**	44	**56**	**96**
	95th percentile 24-hour	50	30	30	34	32	37	-	-	-	-	39	30	29	20	31	31	32	32	32	32	36
	Annual	25	18	18	19	19	22	-	-	-	-	22	18	17	17	18	-	18	19	18	19	21
$PM_{2.5}$ (µg/m³)	Maximum 24-hour	25	-	**30**	**85**	**30**	**48**	-	-	-	-	**42**	-	-	**49**	**36**	19	-	-	-	-	**31**
	95th percentile 24-hour	25	-	16	18	15	16	-	-	-	-	17	-	-	14	13	14	-	-	-	-	14
	Annual	8	-	**8.2**	**8.7**	7.7	**8.5**	-	-	-	-	**9.2**	-	-	7.4	7.2	-	-	-	-	-	7.6
Carbon monoxide (mg/m³)	Maximum 1-hour	30	2	2	2	2	2	-	-	-	-	2	2	2	2	1	1	-	-	-	-	-
Nitrogen dioxide (µg/m³)	Maximum 1-hour	246	88	100	100	113	96	-	-	-	-	120	103	113	94	115	107	88	81	89	77	75
	Annual	62	19	18	19	19	17	-	-	-	-	-	21	17	21	21	21	11	15	15	13	13
Sulfur dioxide (µg/m³)	Maximum 1-hour	570	50	71	55	60	66	-	-	-	-	55	-	73	52	63	79	68	81	89	76	55
	Annual	60	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3	3	3	3	3	3

Note: Exceedances of the relevant air quality impact assessment criteria are shown in bold.

23.4.4 Local emissions sources

Air quality in Sydney is influenced by a variety of different anthropogenic and natural sources. The Environment Protection Authority has investigated the relative contribution to the levels of relevant pollutants in the Sydney region from different anthropogenic sources (Environment Protection Authority, 2012), including:

- Domestic activities (such as wood-fired home heaters and lawn mowing) are major contributors to the total emissions of PM_{10}, $PM_{2.5}$, carbon monoxide and volatile organic compounds
- Road traffic and off-road mobile equipment (such as construction plant and boats) are major contributors to the total emissions of carbon monoxide and nitrogen dioxide, while making a smaller but still significant contribution to total emissions of PM_{10}, $PM_{2.5}$ and volatile organic compounds
- Industrial and commercial activities are major contributors to the total emissions of PM_{10}, while making a smaller but still significant contribution to total emissions of $PM_{2.5}$, nitrogen dioxide, and volatile organic compounds.

A search of the Commonwealth Department of the Environment and Energy National Pollutant Inventory (for 2015) and a desktop review of land uses surrounding Stage 1 identified several air pollution sources close to Stage 1 which are likely to influence local air quality. These sources include industrial facilities within several industrial areas:

- Petroleum and hydrocarbon distribution facilities at Rosehill/Camellia, Silverwater and Homebush West
- Waste treatment facilities at Camellia, Silverwater, Clyde and Homebush Bay
- Manufacturing of construction materials at Rosehill and Camellia
- Food and beverage manufacturing at Lidcombe, Northmead, Camellia, Ermington and Camperdown
- Other manufacturing or processing facilities at Rydalmere, Silverwater and Enfield
- Railway maintenance activities at Auburn.

23.4.5 Sensitive receivers

Stage 1 would traverse a well-established urban environment that contains a wide range of sensitive receivers including residential properties, community facilities (such as schools, childcare centres, places of worship and medical facilities), recreational areas and commercial and retail premises. A number of these receivers are located immediately adjacent to Stage 1 construction sites.

A detailed description of the existing land use patterns and sensitive receivers surrounding Stage 1 is provided in Chapter 11 (Noise and vibration – Stage 1), Chapter 14 (Property and land use – Stage 1) and Chapter 17 (Social impacts – Stage 1), and summarised for each construction site in Section 23.6.1.

23.5 Avoidance and minimisation of impacts

The design development of Stage 1 has aimed to avoid or minimise potential air quality impacts. This included:

- Most spoil handling activities would be carried out within enclosed structures
- Positioning the Westmead metro station construction site south of the existing rail corridor to minimise construction air quality impacts to sensitive medical receivers around Westmead Hospital
- Locating the stabling and maintenance facility at Clyde within an industrial area to minimise potential construction air quality impacts on sensitive receivers
- Retrieval of tunnel boring machines at Sydney Olympic Park to minimise air quality impacts to residential areas relative to alternative options considered.

23.6 Potential impacts

23.6.1 Dust

Potential dust emissions would be temporary in nature and comparable to other similar infrastructure projects. Best-practice management measures (as identified in Section 23.7) would be implemented during all construction works to adequately manage potential dust impacts. This would include regularly wetting down exposed and disturbed area and adjusting construction activities based on observed dust levels and weather forecasts.

Construction activities would involve clearing and demolition, excavation, materials handling, stockpiling and compaction activities. Dust potentially generated from these activities is expected to be the main potential air quality impact during Stage 1.

Dust is a general term used to describe particulate matter in the form of total suspended particulates or particulate matter with a specified aerodynamic diameter (PM_{10} and $PM_{2.5}$), or particulate matter that has deposited onto surfaces over prescribed periods of time. When not properly managed, elevated airborne dust levels have the potential to cause health or nuisance impacts.

The volume of dust potentially generated during a typical work day would vary depending on the types of activities occurring at each construction site, the prevailing weather conditions (for example, dry windy conditions increase the potential for wind erosion) and the controls that are implemented to reduce these emissions.

The risk assessment for each Stage 1 construction site is provided below for each of the two types of potential impacts (nuisance impacts and human health impacts). The sensitivity of the receiver area to these two types of potential impacts has been determined in accordance with the methodology explained in Section 23.3.2 Methodology for assessing dust impacts. Where sensitive ecological receivers are identified within the 50 metre UK IAQM trigger distance of a construction site, the risk assessment includes an assessment on these ecological receivers.

Proposed measures to mitigate potential air quality impacts are discussed in Section 23.7.

Westmead metro station construction site

Potential sensitive receivers nearest to the Westmead metro station construction site include:

- Residential receivers located immediately to the west, south and east of the construction site
- Westmead Public School located less than 50 metres from the construction site, with the University of Western Sydney campus and Marist High School located about 70 metres and 210 metres respectively to the north-west of the construction site
- Patients and staff of medical facilities located about 130 metres to the north of the construction site, on the northern side of the existing rail corridor
- Ecological receivers within Parramatta Park, located about 350 metres to the east of the Westmead metro station construction site.

The risk assessment for unmitigated dust impacts is provided in Table 23-3. Potential dust impact would be temporary in nature and would be substantially reduced with the implementation of standard mitigation measures identified in Section 23.7. Westmead metro station construction site was given a 'high risk' rating (unmitigated) for earthworks for human health impacts due to the scale of earthworks and the close proximity of Westmead Public School and a large number of sensitive residential receivers to the construction site. Due to the distance of the construction site to Parramatta Park, potential ecological impacts are negligible and have not been assessed further.

Table 23-3: Risk of potential unmitigated dust impacts – Westmead metro station construction site

Construction activity	Magnitude of potential emissions	Potential nuisance impacts (high sensitivity)	Potential human health impacts (high sensitivity)
Demolition	Small	Medium risk	Medium risk
Earthworks	Large	High risk	High risk
Construction	Small	Low risk	Low risk
Track-out	Large	High risk	Medium risk

Parramatta metro station construction site

Potential sensitive receivers nearest to the Parramatta metro station construction site include:

- Educational facilities including the University of New England, University of Western Sydney, Richmond School of Business, and Lead College within 50 metres of the construction site, and Arthur Phillip High School and the Sydney Graduate School of Management over 100 metres to the east
- Civic places such as Centenary Square, Parramatta Town Hall and the future Parramatta Square, opposite the site, south of Macquarie Street
- Leigh Memorial Church and St John's Anglican Church which adjoins Parramatta Square
- Residents in the closest residential apartment building about 200 metres to the west at 31-39 Macquarie Street
- Ecological receivers associated with Parramatta River, located about 300 metres to the north of the construction site.

The risk assessment for unmitigated dust impacts is provided in Table 23-4. Potential dust impact would be temporary in nature and would be substantially reduced with the implementation of standard mitigation measures identified in Section 23.7. The Parramatta metro station construction site was assessed as having the highest risk of all construction sites, with an overall 'high risk' rating (unmitigated) in three of the four activities assessed for nuisance impacts and a 'high risk' rating (unmitigated) for human health impacts from demolition activities. These ratings are a result of the scale of the buildings to be demolished, the amount of excavation required and a large number of nearby receivers. While there are only a small number of residential receivers nearby, the construction site is surrounded by densely occupied commercial offices, restaurants and shops, as well as culturally significant buildings such as the Parramatta Town Hall. The density of receivers means that the receiver area is particularly sensitive to potential nuisance impacts from dust. Due to the distance of the construction site to the Parramatta River, potential ecological impacts are negligible and have not been assessed further.

Table 23-4: Risk of potential unmitigated dust impacts – Parramatta metro station construction site

Construction activity	Magnitude of potential emissions	Potential nuisance impacts (high sensitivity)	Potential human health impacts (medium sensitivity)
Demolition	Large	High risk	High risk
Earthworks	Large	High risk	Medium risk
Construction	Small	Low risk	Low risk
Track-out	Large	High risk	Medium risk

Clyde stabling and maintenance facility

Potential sensitive receivers nearest to the Clyde stabling and maintenance facility construction site include:

- Residential receivers in Rosehill about 50 metres to the west of the construction site, separated by James Ruse Drive a major arterial road
- Attendees at a Fun2Learn Early Learning Centre (within the Rosehill residential area) about 100 metres to the west of the construction site, separated by James Ruse Drive, a major arterial road
- Attendees at Rosehill Gardens racecourse immediately adjacent to the northern boundary of the construction site. This also includes horses stabled at the racecourse
- Duck Creek, the nearest ecological receiver, located adjacent to the site.

The risk assessment for unmitigated dust impacts is provided in Table 23-5. Potential dust impact would be temporary in nature and would be substantially reduced with the implementation of standard mitigation measures identified in Section 23.7. The Clyde stabling and maintenance facility construction site was identified as having a large scale of potential emissions for all Stage 1 construction activities, as it would include major earthworks and excavation for the dive structure within the construction site. The ratings for demolition for both potential nuisance impacts and potential human health impacts are a result of the large number of buildings to be demolished. Risk assessment for sensitive ecological receivers has also been carried out due to the close proximity of Duck Creek.

Table 23-5: Risk of potential unmitigated dust impacts – Clyde stabling and maintenance facility construction site

Construction activity	Magnitude of potential emissions	Potential nuisance impacts (high sensitivity)	Potential human health impacts (medium sensitivity)	Potential ecological impacts (medium sensitivity)
Demolition	Large	High risk	High risk	High risk
Earthworks	Large	High risk	Medium risk	Medium risk
Construction	Large	High risk	Medium risk	Medium risk
Track-out	Large	High risk	Medium risk	Medium risk

Silverwater services facility construction site

Potential sensitive receivers nearest to the Silverwater services facility construction site include:

- Employees at commercial or industrial premises in all directions from the site
- Residential receivers about 200 metres to the south of the construction site, along Carnarvon Street.

There are no nearby ecologically sensitive areas.

The risk assessment for unmitigated dust impacts is provided in Table 23-6. Potential dust impact would be temporary in nature and would be substantially reduced with the implementation of standard mitigation measures identified in Section 23.7. The Silverwater services facility construction site was assessed as a relatively low risk rating due to the surrounding receivers being of a commercial and industrial nature, and low-rise in intensity, as well as the significantly smaller site extent and smaller scale of activities associated with the construction of services facilities compared to a station excavation.

Table 23-6: Risk of potential unmitigated dust impacts – Silverwater services facility construction site

Construction activity	Magnitude of potential emissions	Potential nuisance impacts (medium sensitivity)	Potential human health impacts (low sensitivity)
Demolition	Small	Low risk	Negligible risk
Earthworks	Medium	Medium risk	Low risk
Construction	Small	Low risk	Negligible risk
Track-out	Large	Medium risk	Low risk

Sydney Olympic Park metro station construction site

Potential sensitive receivers nearest to the Sydney Olympic Park metro station construction site include:

- Residential receivers in medium and high-density residential dwellings about 200 metres to the east
- Educational buildings including the Kirana College and the New South Wales Institute of Sport less than 50 metres to the south
- Attendees at several open-air sporting venues that may be sensitive to dust impacts
- Customers at three hotels within 100 metres of the construction site
- Ecologically sensitive receivers associated with Lake Belvedere, Bicentennial Park and Powells Creek are about 350 metres to the east.

The risk assessment for unmitigated dust impacts is provided in Table 23-7. Potential dust impact would be temporary in nature and would be substantially reduced with the implementation of standard mitigation measures identified in Section 23.7. While the immediately surrounding area is mainly commercial, a number of large buildings require demolition leading to a 'high risk' rating (unmitigated) during demolition. Similarly, the mixed-use nature of Sydney Olympic Park and large extent of excavation would result in a 'medium risk' rating (unmitigated) during earthworks activities. Due to the distance of the construction site to sensitive ecological receivers, potential ecological impacts are negligible and have not been assessed further.

Table 23-7: Risk of potential unmitigated dust impacts – Sydney Olympic Park metro station construction site

Construction activity	Magnitude of potential emissions	Potential nuisance impacts (medium sensitivity)	Potential human health impacts (medium sensitivity)
Demolition	Large	High risk	High risk
Earthworks	Large	Medium risk	Medium risk
Construction	Small	Low risk	Low risk
Track-out	Large	Medium risk	Medium risk

North Strathfield metro station construction site

Potential sensitive receivers nearest to the North Strathfield metro station construction sites include:

- Residential receivers immediately to the east, south and north of the construction sites
- Schools immediately to the west of the rail corridor, including the McDonald College and Our Lady of the Assumption Catholic Primary School
- Ecologically sensitive receivers associated with Powells Creek, located about 350 metres to the west.

The risk assessment for unmitigated dust impacts is provided in Table 23-8. Potential dust impact would be temporary in nature and would be substantially reduced with the implementation of standard mitigation measures identified in Section 23.7. The large extent of excavation and earthworks combined with the close proximity of sensitive receivers results in North Strathfield metro station construction site being assessed as having a 'high risk' rating (unmitigated) for earthworks and track-out activities. Due to the distance of the construction site to Powells Creek, potential ecological impacts are negligible and have not been assessed further.

Table 23-8: Risk of potential unmitigated dust impacts – North Strathfield metro station construction site

Construction activity	Magnitude of potential emissions	Potential nuisance impacts (high sensitivity)	Potential human health impacts (medium sensitivity)
Demolition	Small	Medium risk	Low risk
Earthworks	Large	High risk	Medium risk
Construction	Small	Low risk	Low risk
Track-out	Large	High risk	Medium risk

Burwood North Station construction site

Potential sensitive receivers nearest to the Burwood North Station construction sites include:

- Residential areas mostly to the north and west of the construction sites
- Schools including MLC Junior School (about 250 metres south-west of the construction site), St Marys Catholic Primary School (about 250 metres west of the construction site)
- Attendees at St Luke's Anglican Church located opposite the northern construction site on Burton Street, and St Marys Catholic Parish Church which is about 300 metres to the west
- Attendees at Concord Oval immediately to the east of Loftus Street, as well as Cintra Park (about 250 metres to the north) and Goddard Park (about 280 metres to the north-west)
- A number of medical facilities along Burwood Road to the south, and Concord Private Hospital on Burwood Road about 300 metres to the north of the construction site.

There are no nearby ecologically sensitive areas.

The risk assessment for unmitigated dust impacts is provided in Table 23-9. Potential dust impact would be temporary in nature and would be substantially reduced with the implementation of standard mitigation measures identified in Section 23.7. The large extent of excavation and earthworks combined with the close proximity of sensitive receivers results in Burwood North Station construction site being assessed as having a 'high risk' rating (unmitigated) for earthworks and track-out activities.

Table 23-9: Risk of potential unmitigated dust impacts – Burwood North Station construction site

Construction activity	Magnitude of potential emissions	Potential nuisance impacts (high sensitivity)	Potential human health impacts (medium sensitivity)
Demolition	Medium	Medium risk	Medium risk
Earthworks	Large	High risk	Medium risk
Construction	Small	Low risk	Low risk
Track-out	Large	High risk	Medium risk

Five Dock Station construction site

Potential sensitive receivers nearest to the Five Dock Station construction sites include:

- Residential receivers at both the eastern and western Five Dock Station construction sites, including nursing homes in surrounding residential areas
- Medical facilities located within the town centre immediately adjacent to both construction sites, as well as in the surrounding residential areas
- Key civic places such as Fred Kelly Place, adjacent to the south of the western construction site
- Customers at a number of cafes and restaurants fronting Great North Road and surrounding lanes and streets, in close proximity to both construction sites
- Attendees at places of worship including St Albans Anglican Church and GGC Life Church, immediately to the north of the western construction site, as well as the Five Dock-Drummoyne Uniting Church off Garfield Street about 100 metres to the south-west
- Five Dock Public School, about 120 metres to the west of the western construction site off West Street
- Five Dock Park located about 250 metres to the east of the eastern construction site.

There are no nearby ecologically sensitive areas.

The risk assessment for unmitigated dust impacts is provided in Table 23-10. Potential dust impact would be temporary in nature and would be substantially reduced with the implementation of standard mitigation measures identified in Section 23.7. The large extent of excavation and earthworks combined with the close proximity of sensitive receivers results in the Five Dock Station construction site being assessed as having a 'high risk' rating (unmitigated) for earthworks and track-out activities.

Table 23-10: Risk of potential unmitigated dust impacts – Five Dock Station construction site

Construction activity	Magnitude of potential emissions	Potential nuisance impacts (high sensitivity)	Potential human health impacts (medium sensitivity)
Demolition	Medium	Medium risk	Medium risk
Earthworks	Large	High risk	Medium risk
Construction	Small	Low risk	Low risk
Track-out	Large	High risk	Medium risk

The Bays Station construction site

Potential sensitive receivers nearest to The Bays Station construction site include:

- Residential receivers to the north at Mansfield Street (about 80 metres away), and to the west of Quirk Street, Hornsey Street and Lilyfield Road (over 150 metres away)
- Users of several parks (the closest on Robert Street about 100 metres to the north-east), as well as several educational facilities (more than 250 metres from the construction site), and places of worship, including C3 Church (immediately north of the construction site)
- Ecologically sensitive receivers associated with White Bay are located immediately adjacent to the construction site.

The risk assessment for unmitigated dust impacts is provided in Table 23-11. Potential dust impact would be temporary in nature and would be substantially reduced with the implementation of standard mitigation measures identified in Section 23.7. While The Bays Station construction site would include large excavation and earthworks activities, and associated track-out activities, the receiver sensitivity is lower than at other sites due to the distance and density of sensitive receivers. As such, The Bays Station construction site does not exceed an overall risk rating of 'medium' (unmitigated) for any of the Stage 1 activities. Risk assessment for sensitive ecological receivers has also been carried out due to the close proximity of ecological receivers in White Bay.

Table 23-11: Risk of potential unmitigated dust impacts – The Bays Station construction site

Construction activity	Magnitude of potential emissions	Potential nuisance impacts (medium sensitivity)	Potential human health impacts (low sensitivity)	Potential ecological impacts (high sensitivity)
Demolition	Medium	Medium risk	Low risk	Medium risk
Earthworks	Large	Medium risk	Low risk	High risk
Construction	Small	Low risk	Negligible risk	Low risk
Track-out	Large	Medium risk	Low risk	High risk

23.6.2 Other emissions to air

Exhaust emissions generated during construction would be temporary and would not significantly contribute to emissions in the local area, given the high existing levels of vehicle use in urban areas surrounding the construction sites. These emissions would be adequately managed by the implementation of standard construction mitigation measures, described in Section 23.7. No long-term adverse impacts to air quality are anticipated.

The main source of air emissions would be from the combustion of diesel fuel and petrol from heavy vehicles, mobile excavation machinery, and stationary combustion equipment as well as from the handling and/or on-site storage of fuel and other chemicals. The volume of emissions from construction vehicles and machinery would depend on the type of fuel used, the power output and condition of the engine, and duration of use.

The tunnel boring machines and roadheaders used to excavate the tunnels and caverns would use electric power and therefore would not create local exhaust emissions. However, at some of the station construction sites, this equipment may be powered by generators for a short period of time prior to the mains power supply becoming available. This would result in local exhaust emissions.

Exhaust emissions would involve periodic localised emissions of carbon monoxide, particulate matter (PM_{10} and $PM_{2.5}$), oxides of nitrogen (including nitrogen dioxide), sulphur dioxide, volatile organic compounds, and polycyclic aromatic hydrocarbons associated with the combustion of diesel fuel and petrol.

The risk of mobilising airborne hazardous materials, odours or vapours could occur as a result of uncovering contaminated soils or hazardous materials (including asbestos). As identified in Chapter 20 (Contamination – Stage 1) all potential contamination impacts can be managed to acceptable levels with the implementation of appropriate management measures and/or remediation. In addition, the presence of hazardous materials in building stock to be demolished would be determined prior to demolition and managed to meet legislative requirements.

23.6.3 Construction site power supply routes

Air quality mitigation measures detailed in Section 23.7 would be applied as required to manage potential dust generated during power supply works. The main potential air quality risk associated with these works would be dust temporarily generated from the excavation, handling, placement and compaction of soils, and from exposed surfaces and stockpiled materials. The small footprint of the active work area and linear nature of the construction activity means potential impacts would be limited in extent and temporary in nature.

23.6.4 Regional impacts

Stage 1 would not result in any substantial regional air quality impacts as any emissions would be highly dispersed in the local area and would not impact on any areas away from Stage 1.

23.6.5 Cumulative impacts

The adoption of mitigation and management measures set out in Section 23.7 are expected to result in the adequate management of dust and other emissions for Stage 1. Potential cumulative air quality impacts would be temporary and managed through consultation with the relevant stakeholders and coordinating construction programs with other nearby projects.

Cumulative air quality impacts may result from increased dust generation and emissions if other major projects nearby to the Stage 1 sites are being constructed concurrently with Stage 1. The potential for cumulative air quality impacts are highest at the following construction sites as a result of the number, proximity and/or scale of other nearby major projects:

- Parramatta
- Clyde
- Sydney Olympic Park
- The Bays.

23.7 Management and mitigation measures

23.7.1 Approach to management and mitigation

Potential impacts to air quality would be managed in accordance with the Construction Environmental Management Framework, as described in Chapter 27 (Synthesis of the Environmental Impact Statement).

The Construction Environmental Management Framework requires the preparation of an Air Quality Management Plan and includes the following air quality management objectives:

- Minimise gaseous and particulate pollutant emissions from construction activities as far as feasible and reasonable
- Identify and control potential dust and air pollutant sources.

23.7.2 Mitigation measures

The mitigation measures that would be implemented to address potential air quality impacts are described in Table 23-12.

Table 23-12: Mitigation measures – Air quality Stage 1

Reference	Impact/issue	Mitigation measures	Applicable location(s)[1]
AQ1	Dust impacts during all construction phases	The following best-practice dust management measures would be implemented during all construction works: • Regularly wet-down exposed and disturbed areas including stockpiles, especially during dry weather • Adjust the intensity of activities based on measured and observed dust levels and weather forecasts • Minimise the amount of materials stockpiled and position stockpiles away from surrounding receivers • Regularly inspect dust emissions and apply additional controls as required • Implement all relevant measures listed in the UK IAQM corresponding to the highest level of risk determined around each Stage 1 construction site.	All
AQ2	Exhaust emissions from the combustion of fossil fuels during construction	Plant and equipment would be maintained in a proper and efficient manner. Visual inspections of emissions from plant would be carried out as part of pre-acceptance checks.	All
AQ3	Odour emissions during construction	The following best-practice odour management measures would be implemented during relevant construction works: • The extent of opened and disturbed contaminated soil at any given time would be minimised • Temporary coverings or odour supressing agents would be applied to excavated areas where appropriate • Regular monitoring would be conducted during excavation to verify that no offensive odours are being generated.	All

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (e.g. tunnel boring machine works); PSR: Power supply routes.

23.7.3 Interactions between mitigation measures

Mitigation measures in other chapters that are relevant to the management of air quality impacts include:

- Chapter 20 (Contamination – Stage 1), specifically measures which address the management of contaminated soils and groundwater during construction, which would include the assessment and management of vapours and gas
- Chapter 24 (Spoil, waste management and resource use – Stage 1), specifically measures which address appropriate handling and management of hazardous materials or asbestos
- Chapter 27 (Synthesis of the Environmental Impact Statement), specifically measures which address consultation with relevant stakeholders to manage the interface of nearby projects under construction at the same time.

Together, these measures would minimise the potential air quality impacts of Stage 1.

There are no mitigation measures identified in the assessment of other environmental aspects that are likely to affect the assessment of air quality impacts.

24 Spoil, waste management and resource use – Stage 1

24 Spoil, waste management and resource use – Stage 1

This chapter provides an assessment of spoil and waste generation and resource use during Stage 1 and includes a description of how spoil, waste and resources would be managed.

24.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to spoil, waste management and resource use, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 24-1.

Table 24-1: Secretary's Environmental Assessment Requirements – Spoil, waste management and resource use Stage 1

Reference	Requirement	Where addressed
2. Spoil		
2.1	Relevant commitments made in Section 9.17.2 of the Scoping Report	Sections 24.5.1 to 24.5.4 Refer to Table 2 of Appendix A for Scoping Report requirements
2.2	Spoil generation and reuse, including: a. type and quantity;	Section 24.5.1
	b. onsite storage (including capacity to minimise amenity impacts);	
	c. reuse potential and disposal sites;	
	d. transport and handling options (including traffic, distance, road safety and related amenity and environmental impacts); and	
	e. illegal dumping.	
13. Other Issues		
13.1	Air quality, greenhouse gas and energy, climate change adaptation, waste management and resource use, hazard and risk assessments should be undertaken in accordance with the commitments in Section 9 of the Scoping Report.	Chapter 23 Chapter 24 Chapter 25 Chapter 26 Section 24.5.3 Section 24.5.2

24.2 Legislative and policy context

The legislative and policy context for spoil, waste management and resource use is described in Chapter 8 (Concept environmental assessment).

The following additional guidelines inform or respond to the regulatory framework and have been applied to the assessment of Stage 1:

- Waste Classification Guidelines (NSW Environment Protection Authority, 2014)
- NSW Sustainable Design Guidelines, Version 4.0 (Transport for NSW, 2019)
- Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004).

Sydney Metro's commitment to managing waste during construction of Stage 1 is outlined in Section 24.4 and in Chapter 26 (Sustainability and climate change – Stage 1).

24.3 Assessment approach

A desktop assessment was carried out and comprised:

- Review of spoil generation (quantity and type) and reuse opportunities
- Review of the likely resources required for construction of Stage 1, including construction materials, water and power
- Identification of likely waste generating activities
- Review of the likely waste types
- Identification of possible waste streams in accordance with relevant legislation and guidelines
- Identification of the environmental impacts associated with the generation of waste materials and subsequent disposal, with consideration of:
  - Waste minimisation and reuse potential
  - The capacity of disposal facilities to receive the volumes of waste for key waste streams generated by Stage 1
- Development of a spoil management strategy to identify how spoil would be managed during construction, including likely spoil volumes, likely nature and classification of excavated material, opportunities for recycling, potential disposal sites, stockpile management, and method(s) and route of transportation
- Development of management strategies to adequately address waste during construction, including:
  - Managing construction waste through the waste hierarchy established under the *Waste Avoidance and Resource Recovery Act 2001*
  - Procedures for the assessment, handling, stockpiling and disposal of potentially contaminated materials and wastewater, in accordance with the NSW Environment Protection Authority publication Waste Classification Guidelines (NSW Environment Protection Authority, 2014)
  - Targets for the beneficial reuse of solid wastes, wastewater and other construction wastes in accordance with the Sydney Metro West sustainability plan. Refer to Chapter 26 (Sustainability and climate change – Stage 1)
- Consideration of the cumulative effects of spoil haulage, waste management and resource use with other major infrastructure projects within Sydney.

24.4 Avoidance and minimisation of impacts

The design development process for Stage 1 aimed to avoid or minimise potential spoil and waste management and resource use impacts. This included the selection of tunnelling equipment (tunnel boring machines) to excavate the mainline tunnels which would minimise spoil generation by cutting a circular profile ideal for a rail tunnel.

24.5 Potential impacts

24.5.1 Spoil generation and management

Spoil generation

As discussed in Chapter 9 (Stage 1 description), spoil from tunnel boring would be extracted from the Westmead metro station construction site and The Bays Station construction site (as reflected in Table 24-2), while spoil from other construction sites would generally be excavated from station sites and shafts.

Stage 1 would generate about 3.05 million cubic metres of in-situ spoil. Indicative volumes of spoil generated at each construction site during Stage 1 are outlined in Table 24-2.

Table 24-2: Indicative volumes of spoil generated during construction of Stage 1

Construction site	Volume of spoil (m^3)	Expected spoil composition
Westmead metro station (and crossover cavern)	245,000 675,000 (from tunnelling)	Fill Residual clay Ashfield Shale Mittagong formation
Parramatta metro station	125,000	Parramatta Sands Ashfield Shale Mittagong Formation Hawkesbury Sandstone
Clyde stabling and maintenance facility	20,000 (services facility shaft) 90,000 (dive structure) 85,000 (connecting tunnels)	Fill Residual clay Ashfield Shale Mittagong formation Hawkesbury Sandstone
Silverwater services facility	20,000	Fill Residual clay Ashfield Shale Mittagong formation Hawkesbury Sandstone
Sydney Olympic Park metro station	225,000	Fill Ashfield Shale
North Strathfield metro station	110,000	Fill Residual clay Ashfield Shale Mittagong formation Hawkesbury Sandstone
Burwood North Station	235,000	Fill Ashfield Shale Mittagong formation Hawkesbury Sandstone
Five Dock Station	165,000	Fill Residual clay Ashfield Shale Mittagong formation Hawkesbury Sandstone
Services facility between Five Dock and The Bays	35,000	Hawkesbury Sandstone
The Bays Station	155,000 860,000 (from tunnelling)	Alluvial/marine deposits Fill Residual clay Hawkesbury Sandstone
Total	**3,045,000**	

The largest volumes of spoil are anticipated to be generated during the excavation of the tunnels and stations, with smaller quantities of spoil generated from services facilities. Excavated material would predominantly include uncontaminated soil, crushed rock and wastewater (from water used during excavation, and groundwater inflows).

Spoil stockpiles

Spoil from tunnelling works of the mainline tunnels would be transported from the tunnel face to stockpiles within the Westmead metro station and The Bays Station construction site. Spoil generated by other earthworks, such as station and services facility excavation, would also be stored in stockpiles at each construction site. These stockpiles would be bunded and managed to avoid potential impacts associated with runoff, sedimentation and leachate. Stockpiling of spoil at construction sites would be managed to balance impacts associated with truck movements and impacts associated with dust, runoff and sedimentation.

Potential dust impacts would be further minimised through the implementation of the environmental mitigation measures described in Chapter 23 (Air quality – Stage 1). Potential impacts from runoff and sedimentation would be further minimised through the implementation of the environmental mitigation measures described in Chapter 19 (Soils and surface water quality – Stage 1).

Spoil management

The design of Stage 1 tunnels and station excavations and the preferred construction methodology has taken into consideration the waste hierarchy by aiming to reduce the volume spoil generated, as far as practical. Opportunities to further reduce the generation of spoil through tunnel and station optimisation would be considered during future design.

Spoil would be classified in accordance with Waste Classification Guidelines (NSW Environment Protection Authority, 2014). Spoil that is classified as virgin excavated natural material, or excavated natural material, subject to a resource recovery order/resource recovery exemption under the Protection of the Environment Operations (Waste) Regulation 2014 or is otherwise reusable would be reused following a set of criteria for reuse, recycling and disposal of material as provided in Table 24-3. Following the criteria, a hierarchy of management options for spoil reuse is presented in Table 24-4.

Table 24-3: Reuse, recycling and disposal criteria

Option	Criteria
Reuse on Sydney Metro West sites	• The material is suitable for the final land use at the placement location in accordance with guidelines made or approved under the *Contaminated Land Management Act 1997* and would not cause pollution under the *Protection of the Environment Operations Act 1997* • The material meets engineering requirements for the placement location.
Reuse off-site	• The material meets Virgin Excavated Natural Material (VENM) or Excavated Natural Material (ENM) definition • Suitable off-site reuse locations have been identified and have necessary approvals to receive the material.
	• The material does not meet VENM or ENM definition but has potential for reuse and a Resource Recovery Exemption/Resource Recovery Order has been granted • Suitable off-site reuse locations have been identified and have necessary approvals to receive the material.
Recycling off-site	• The material has value for recycling • Suitable off-site reuse locations have been identified and have necessary approvals to receive the material.
Disposal off-site	• The material is classified as General Solid Waste, Restricted Solid Waste, Special Waste or Hazardous Waste • Suitable off-site reuse locations have been identified and have necessary approvals to receive the material.

Table 24-4: Spoil management hierarchy for Stage 1

Priority	Reuse options	Possible reuse options
1	Within the Stage 1 footprint	• Reuse spoil for landscaping, structural fill, general fill, fill embankments and mounds within a short haulage distance of the source • Reuse spoil to restore any pre-existing contaminated sites within the Stage 1 construction footprint • Reuse spoil as a feed product in construction materials.
2	Environmental projects (outside of the Stage 1 footprint)	• Reuse spoil for coastal protection, such as beach nourishment and land raising • Reuse spoil in flood mitigation projects.
3	Other development projects (including other Sydney Metro projects)	• Reuse spoil for landscaping, structural fill, general fill, fill embankments and mounds on projects within a financially feasible transport distance of the site • Reuse spoil for land reclamation or remediation projects • Reuse sand for manufacturing concrete and shale for manufacturing bricks and tiles.
4	Land restoration	• Reuse spoil to fill disused facilities (for example mines and quarries) to enable either future development or site rehabilitation.
5	Landfill management	• Reuse spoil to cap completed landfill cells • Reuse spoil in daily covering of landfill waste.

Spoil reuse opportunities for Stage 1 and other projects

Sydney Metro would target beneficial reuse of 100 per cent of the usable spoil generated during construction. The geology of the spoil material as well as its consistency and quality would determine the reuse options. It is envisaged the spoil produced by Stage 1 would have the characteristics and potential reuse opportunities suitable for priority 1, 2 and 3 spoil management options outlined in Table 24-5.

Table 24-5: Spoil characteristics and potential reuse opportunities for Stage 1

Spoil characteristic	Potential reuse opportunities for priority 1, 2 and/or 3 spoil management options
Clean granular fill	Structural fill
Excavated moist clay and clayey sand material	General fill (following moisture conditioning)
Excavated weathered shale and sandstone	Structural fill (following moisture conditioning to reduce reactivity for shale)
Medium strength or better-quality shale	Non-reactive fill
Medium to high strength sandstone	Structural fill
Wet clay and wet shale spoil	Unlikely to be suitable for reuse without substantial moisture conditioning
Contaminated soils	General fill for priority 1 (in accordance with guidelines made or approved under the *Contaminated Land Management Act* and would not cause pollution under the *Protection of the Environment Operations Act 1997*) General fill for priority 2 (subject to a resource recovery order and/or exemption under the Protection of the Environment Operations (Waste) Regulation 2014)

The Stage 1 civil works for the Clyde stabling and maintenance facility would present a key opportunity for spoil reuse. About one million cubic metres of fill would be required to protect the facility from flooding impacts – refer to Chapter 9 (Stage 1 description) and Chapter 21 (Hydrology and flooding – Stage 1). The suitability of the spoil generated by Stage 1 for this use would be assessed during construction.

It is expected there may be limited opportunities for additional spoil reuse at other Stage 1 construction sites. The quantities and locations of any additional reuse opportunities would be determined during further design of Stage 1. The reuse of spoil for Stage 1 construction works would be maximised to the extent possible before alternative off-site opportunities for spoil reuse are pursued.

Where spoil cannot be reused for Stage 1, opportunities to reuse this material in future stages or on other projects (preferably within the Sydney region to reduce transport distances) would be identified. Potential options for spoil reuse/disposal sites are included in Table 24-6.

Table 24-6: Potential spoil reuse/disposal opportunities

Potential re-use location	Haulage distance from Stage 1 construction footprint
Moorebank Intermodal Terminal and Freight Precinct	16 kilometres
Western Sydney Airport	25 kilometres
Port Kembla Outer Harbour land reclamation works	70 kilometres
Development and infrastructure projects in the Sydney metropolitan region	Various
Brick making businesses in the Sydney metropolitan region	Various

These sites have a need for spoil or fill material and represent viable reuse locations. Other reuse or disposal sites may be used depending on need at the time the spoil is generated.

Spoil reuse opportunities for land restoration and landfill management

Spoil could be used for filling former quarries in the Sydney region and beyond. Former quarries and other sites that are potentially available for large-scale reuse of virgin excavated natural material, excavated natural material and material subject to resource recovery orders/exemptions are listed in Table 24-3. Spoil could also be used to cap completed landfill cells and to cover waste at active landfill sites. Potential opportunities for spoil reuse in land restoration and landfill management applications would be determined during further construction planning for Stage 1.

Table 24-7: Possible large-scale spoil reuse opportunities in the Sydney region and beyond

Potential reuse location	Haulage distance from Stage 1 construction footprint
Kurnell Landfill	20 kilometres
Castlereagh Landfill	30 kilometres
Penrith Lakes Scheme	30 kilometres
Bombo Quarry	120 kilometres

Contaminated soil

There is potential to encounter contaminated soil or rock during Stage 1 during spoil-generating construction works at all Stage 1 construction sites (refer to Chapter 20 (Contamination – Stage 1)).

Contamination is defined in the *Contaminated Land Management Act 1997* as the presence of a substance in, on or under the land at a concentration above which the substance is normally present and that presents a risk of harm to human health or any other aspect of the environment.

Sampling and testing of soils in areas of potential contamination concern would be conducted to characterise the soils and determine the appropriate waste classification (which may include hazardous wastes or special wastes). Characterisation would be carried out in accordance with guidelines made or approved under the *Contaminated Land Management Act 1997*. Waste classification would be carried out in accordance with the Waste Classification Guidelines Part 1: Classifying Waste (NSW Environment Protection Authority, 2014).

The suitability for beneficial reuse of tested soils would also be determined in accordance with the National Environment Protection (Assessment of Site Contamination) Measure (National Environment Protection Council, 1999) and the Environment Protection Authority NSW resource recovery framework. Soils would be considered for reuse within the spoil management hierarchy for Stage 1 (refer to Table 24-4) if they would not cause harm to human health or the environment. Reuse of these soils for projects and opportunities outside of the Stage 1 construction footprint would require a resource recovery order and/or exemption under the Protection of the Environment Operations (Waste) Regulation 2014.

Soils that cannot be beneficially reused would be disposed off-site and be managed and transported in accordance with the waste classification and the Protection of the Environment Operations (Waste) Regulation 2014 and disposed of to an appropriately licensed waste management facility. There are several solid waste landfills in Sydney that are licensed to accept contaminated soils. It is anticipated the volumes of contaminated spoil generated during Stage 1 could be readily accommodated at these facilities. Alternatively, materials may be transported to appropriately licenced facilities in NSW. If materials are required to be transported interstate, this would be carried out in consultation with the NSW Environment Protection Authority and relevant interstate regulatory bodies and in accordance with regulatory requirements. Further discussion of contamination, including asbestos and other hazardous materials, is provided in Chapter 20 (Contamination – Stage 1).

Acid sulfate soils

As discussed in Chapter 19 (Soils and surface water quality – Stage 1), there is potential to encounter acid sulfate soils during excavation and other ground disturbance at the following Stage 1 construction sites:

- Parramatta metro station
- Clyde stabling and maintenance facility
- The Bays Station.

Impacts associated with the disturbance of acid sulfate soils are described in Chapter 19 (Soils and surface water quality – Stage 1), as are measures to mitigate potential impacts. Acid sulfate soils would be disposed of in accordance with the Waste Classification Guidelines Part 4: Acid Sulfate Soils (Environment Protection Authority, 2014).

24.5.2 Resource use

A variety of resources would be needed to construct Stage 1. The resource requirements for Stage 1 shown in Table 24-5 are typical for an infrastructure project of this scale. While the resource requirements of Stage 1 have the potential to temporarily impact resource availability within the Sydney metropolitan region over the construction period, the recent concurrent construction of other major infrastructure projects including NorthConnex, WestConnex, Sydney Metro Northwest and Sydney Metro City & Southwest (Chatswood to Sydenham) from 2015 to the present demonstrates the market is able to manage the concurrent construction of major infrastructure projects given sufficient opportunity to forward plan. The period between the approval of Stage 1 and the start of major construction would be sufficient to allow the market to prepare for the resource needs of Stage 1 in conjunction with the concurrent infrastructure projects listed in Appendix G (Cumulative impacts assessment methodology – Stage 1).

Indicative quantities of the major resources to complete the construction of Stage 1 are provided in Table 24-8.

Table 24-8: Indicative quantities of resources required for construction

Material	Indicative quantity required
Electricity	140 gigawatt hours
Fuel	40,000 kilolitres
Concrete	870,000 tonnes
Shotcrete	12,000 tonnes
Steel	30,000 tonnes
Water	370 mega litres

The development of Stage 1 has included careful consideration of the construction methodology and selection of materials and resources to ensure fitness for purpose and minimise resource consumption. Consistent with the resource management hierarchy of the *Waste Avoidance and Resource Recovery Act 2001*, resource consumption would be further minimised during construction through reuse of materials, where possible.

24.5.3 Waste generation and management

Waste generation

The volumes of construction wastes are expected to be comparable to other similar infrastructure projects including Sydney Metro Northwest (which opened in May 2019) and the Chatswood to Sydenham component of Sydney Metro City & Southwest (currently under construction). These construction wastes would be manageable through the application of waste management strategies outlined in the following section.

The likely main construction waste streams for Stage 1 are outlined in Table 24-9 along with the likely waste classification under the Waste Classification Guidelines (NSW Environment Protection Authority, 2014). About 317,050 tonnes of demolition materials and about 2,850 megalitres of wastewater would be produced during Stage 1. The types and quantities of construction waste generated during Stage 1 would be site specific and would vary throughout the construction period. The quantities and classification of waste streams would be confirmed following further design work.

Table 24-9: Indicative types of waste generated during construction

Activity	Waste stream	Examples of wastes	Likely waste classification
Demolition of buildings and other structures	General demolition wastes	• Concrete • Bricks • Tile • Timber • Metals • Plasterboard • Carpets • Electrical and plumbing fittings • Furnishings	• General solid waste (non-putrescible)
	Hazardous wastes	• Heavy metals	• Hazardous waste
	Special waste	• Asbestos	• Special waste
Clearing and grubbing of vegetation, landscaped and/or turfed areas	Vegetation wastes	• Trees • Shrubs • Ground cover • Soil	• General solid waste (non-putrescible)
Tunnelling, excavation and general earthworks	Spoil	• Virgin excavated natural material (uncontaminated soil and crushed rock) • Acid sulfate soils • Soils and materials containing asbestos, heavy metals, hydrocarbons, pesticides and/or other industrial residues	• General solid waste (non-putrescible) • General solid waste (putrescible) • Special waste • Restricted solid waste • Hazardous waste
	Tunnel boring machine wastes	• Cutter heads • Associated equipment replacement (conveyor belts etc.)	• General solid waste (non-putrescible)
	Wastewater	• Groundwater inflows to tunnels and station excavations	• Liquid waste
Dust suppression, wash down of plant and equipment, and staff amenities at construction sites (such as toilets)	Wastewater	• Sediment-laden wastewater • Sewage • Grey water	• Liquid waste

Activity	Waste stream	Examples of wastes	Likely waste classification
General construction works and resource use	General construction wastes	• Timber formwork • Scrap metal • Steel • Concrete • Plasterboards • Soil • Packaging materials	• General solid waste (non-putrescible)
Maintenance of construction plant, vehicles and equipment	Mechanical wastes	• Adhesives • Lubricants • Waste fuels • Oils • Engine coolant • Batteries • Hoses • Tyres	• Hazardous waste and/or special waste • Liquid waste
Works at site offices and crib rooms	General wastes	• Putrescibles • Paper • Cardboard • Plastics • Glass • Printer cartridges	• General solid waste (non-putrescible) • General solid waste (putrescible)

Waste management

Based on the construction performance of Sydney Metro Northwest and Sydney Metro City & Southwest, Sydney Metro West would adopt a construction waste recycling target of 95 per cent.

Potential waste management issues are manageable through standard mitigation measures. These measures would be developed in accordance with the Sydney Metro Construction Environmental Management Framework which requires the Principal Contractor to develop a waste management plan (refer to Appendix D) and the Sydney Metro West sustainability plan (refer to Chapter 26 (Sustainability and climate change – Stage 1)) and would address the following:

- Classification of waste in accordance with the current guidelines
- Handling of waste including measures to facilitate segregation of waste into stockpiles of concrete, steel, timber, paper and cardboard and vegetation to make it easier to recycle components and prevent cross contamination
- Management of waste
- Waste minimisation and reuse
- Lawful disposal or recycling locations for each type of waste using a hierarchy which prioritises higher value end use
- Contingencies for the above, including managing unexpected waste volumes.

Potential waste management issues during construction would be temporary and include:

- Waste potentially being unnecessarily directed to landfill due to the inadequate collection and/or incorrect classification which would increase the demand for landfill capacity within the Sydney region
- Potential contamination of soil, surface and/or groundwater from the inappropriate storage, transport and disposal of liquid and solid wastes
- Potential increase in vermin from the incorrect storage, handling and disposal of putrescible waste from construction sites
- Potential incorrect classification and/or disposal of waste, including the incorrect storage, handling and disposal of hazardous materials (for example, asbestos from building demolition)
- Potentially excessive amounts of materials being ordered, resulting in a large amount of left-over, unused resources
- Lack of identification of feasible options for recycling or reuse of resources.

Existing metropolitan waste management facilities would have capacity to receive the anticipated waste streams generated by Stage 1. General construction and demolition wastes and wastes from site offices would be collected for off-site recycling wherever practicable. Wastes that contain hazardous, special or otherwise contaminated materials would be treated and disposed of off-site at a licensed facility in accordance with the relevant guidelines (refer to Section 24.2). Waste facilities in Sydney licensed to accept general solid waste and vegetation waste include (but are not limited to):

- Clyde Transfer Terminal
- Eastern Creek Resource Recovery Park
- Kemps Creek Advanced Resource Recovery Park
- Lucas Heights Resource Recovery Park.

A number of waste facilities in Sydney are licenced to accept special and/or hazardous waste, including:

- Chullora Resource Recovery Facility
- Elizabeth Drive Landfill, Kemps Creek
- Eastern Creek Resource Recovery Park
- Genesis Xero Waste – Landfill and Recycling
- Horsley Park Waste Management Facility
- Jacks Gully Waste and Recycling Centre
- Kimbriki Recycling and Waste Disposal Centre
- Lucas Heights Resource Recovery Park
- Wetherill Park Resource Recovery Facility.

Recyclables such as containers (plastics, glass, cans, etc), paper and cardboard would be collected by an authorised contractor for off-site recycling. There are a number of materials recovery facilities in Sydney. The recycling facility would be determined by the contractor engaged to collect the material.

Management strategies that would be developed to address specific construction wastes are discussed further below.

Spoil

The spoil management hierarchy and strategy are discussed in detail in Section 24.5.1.

Demolition wastes

As outlined in Chapter 9 (Stage 1 description), it is anticipated that construction of Stage 1 would require the demolition of about 114 buildings. Demolition waste would be managed through the waste hierarchy established under the *Waste Avoidance and Resource Recovery Act 2001* (refer to Section 24.2).

Demolition waste would be segregated and stockpiled on site, with materials such as bricks and tiles, timber, plastic and metals being separated where practicable. All demolition waste would be classified in accordance with the Waste Classification Guidelines (Environment Protection Authority, 2014) and sent to a waste facility with recycling capabilities, where appropriate, or directed to a waste management facility that is lawfully permitted to accept that type of waste.

Hazardous materials

There is the potential for materials to be present within demolished buildings/structures that meet the hazardous waste criteria within the Waste Classification Guidelines (NSW Environment Protection Authority, 2014). The presence of potentially hazardous wastes would be identified through a hazardous material survey which would be completed for those buildings and structures suspected of containing hazardous materials prior to their demolition – refer to Chapter 25 (Hazards – Stage 1). If materials that meet the hazardous waste criteria are encountered, they would be handled and managed in accordance with relevant legislation, codes of practice and Australian standards.

The management of contaminated spoil and acid sulfate soils, which may be classified as hazardous wastes, are discussed further in Section 24.5.1.

Special wastes

There is the potential for asbestos containing materials to be present within demolished buildings/structures. Under the Waste Classification Guidelines (NSW Environment Protection Authority, 2014), asbestos is defined as a 'special waste'. The disturbance, movement and disposal of asbestos containing materials would be carried out in strict accordance with the Protection of the Environment Operations (Waste) Regulation 2014, Work Health and Safety Regulation 2017 and applicable guidelines.

The management of contaminated spoil, which may be classified as special wastes, are discussed further in Section 24.5.1.

Wastewater

As discussed in Chapter 18 (Groundwater and ground movement – Stage 1), the excavation of the tunnels, stations and shafts are likely to intercept groundwater aquifers resulting in the need to capture, treat and discharge water. Construction water treatment plants would be required at the tunnelling support sites and each construction site which would treat all intercepted groundwater to meet the requirements of any environmental protection licence issued for Stage 1 and/or the relevant requirements of the *Protection of the Environment Operations Act 1997.* Treatment of construction water is discussed further in Chapter 19 (Soils and surface water quality – Stage 1).

The reuse of treated water would be maximised during the construction works by re-circulating water to the tunnel cutting face (where it is of suitable quality) and for surface dust suppression, however there would be a surplus of treated water requiring discharge from the sites. Considering the prevailing drought conditions in Sydney and across NSW, Sydney Metro is further investigating options to minimise potable water use and maximise wastewater reuse. Additionally, opportunities to treat wastewater to a higher standard to enable additional end uses onsite or offsite would be considered, to further reduce reliance on potable water supply. Once potential onsite water uses are exhausted, water would be discharged to the local stormwater system or directly to a local surface watercourse, although options such as disposal via Sydney Water trade waste agreements would be investigated during detailed construction planning. The water balance for Stage 1 is discussed further in Chapter 19 (Soils and surface water quality – Stage 1).

Wastewater would also be generated by the use of staff amenities at construction sites (such as toilets). Sewage and grey water from these amenities would be disposed to sewer or transported to an appropriately licenced liquid waste treatment facility.

24.5.4 Cumulative impacts

Potential cumulative impacts associated with spoil and waste management and resource use during Stage 1 would be limited to temporary increases in resource demand and availability, waste and spoil generation, and temporary impacts to reuse and disposal opportunities within the Sydney metropolitan region. Cumulative spoil and waste management and resource use impacts would be managed through the mitigation measures in Table 24-10 and in Chapter 27 (Synthesis of the Environmental Impact Statement).

24.6 Management and mitigation measures

24.6.1 Approach to management and mitigation

Spoil and waste would be managed in accordance with Sydney Metro's Construction Environmental Management Framework which is described in Chapter 27 (Synthesis of the Environmental Impact Statement). The Construction Environmental Management Framework includes requirements in relation to:

- Management of spoil
- Preparation of a Waste Management Plan
- Waste monitoring, reporting and compliance tracking.

24.6.2 Mitigation measures

Specific mitigation measures that would be implemented, to address potential impacts associated with spoil, waste management and resource use are listed in Table 24-10.

Table 24-10: Mitigation measures – Spoil, waste management and resource use Stage 1

Reference	Impact/issue	Mitigation measure	Applicable location(s)[1]
WR1	Compliance with legislative and policy requirements	All waste would be assessed, classified, managed, transported and disposed of in accordance with the Waste Classification Guidelines.	All
WR2	Disposal of hazardous materials	A hazardous material survey would be completed for those buildings and structures suspected of containing hazardous or special waste materials (particularly asbestos) prior to their demolition. If hazardous waste or special waste (e.g. asbestos) is encountered, it would be handled and managed in accordance with relevant legislation, codes of practice and Australian standards.	All
WR3	Waste minimisation	Construction waste would be minimised by accurately calculating materials brought to the site and limiting materials packaging.	All
WR4	Reuse and recycling	Waste streams would be segregated to avoid cross-contamination of materials and maximise reuse and recycling opportunities.	All
WR5	Reuse on Sydney Metro West sites	A materials tracking system would be implemented for material transferred between Sydney Metro West sites and to offsite locations such as licensed waste management facilities.	All

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (e.g. tunnel boring machine works); PSR: Power supply routes.

24.6.3 Interactions between mitigation measures

Mitigation measures in other chapters that are relevant to the management of waste include:

- Chapter 19 (Soils and surface water quality – Stage 1), specifically measures which address potential acid sulfate soils and the and potential interaction with contaminated soils
- Chapter 20 (Contamination – Stage 1), specifically measures which address the disturbance of contaminated land during construction
- Chapter 26 (Sustainability and climate change – Stage 1), specifically measures which address the implementation of sustainability initiatives and sustainable procurement.

These measures would work collectively to minimise the potential spoil, waste management and resource use impacts of Stage 1.

There are no mitigation measures identified in the assessment of other environmental aspects that are likely to affect the assessment of spoil, waste management and resource use.

25 Hazards – Stage 1

25 Hazards – Stage 1

This chapter provides an assessment of the potential hazards that could arise from Stage 1. It also includes mitigation measures to address these potential hazards.

25.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to hazards, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 25-1.

Table 25-1: Secretary's Environmental Assessment Requirements – Hazards Stage 1

Reference	Requirement	Where addressed
13. Other Issues		
13.1	Air quality, greenhouse gas and energy, climate change adaptation, waste management and resource use, hazard and risk assessments should be undertaken in accordance with the commitments in Section 9 of the Scoping Report.	Chapter 23 Chapter 24 This chapter Chapter 26 Refer to Table 2 of Appendix A for Scoping Report requirements

25.2 Legislative and policy context

The following guidelines inform or respond to the regulatory framework and have been applied to the assessment of Stage 1:

- Hazardous and Offensive Development Application Guidelines: Applying SEPP 33 (Department of Planning, 2011a)
- International Standard (ISO/IEC 31010: 2009) Risk Management – Risk Assessment Techniques
- *Work Health and Safety Act 2011 (NSW)* and Work Health and Safety Regulation 2017 (NSW)
- Australian Code for the Transport of Dangerous Goods by Road and Rail (edition 7.6) (National Transport Commission, 2018)
- Code of Practice: How to manage and control asbestos in the workplace (Safework Australia, 2019)
- Code of Practice: How to Safely Remove Asbestos (Safework NSW, 2016)
- Storage and Handling of Dangerous Goods Code of Practice (WorkCover, 2005) (noting this Code is a guide for processes and controls to manage risks and is not to be relied upon to ascertain requirements under the Work Health and Safety Regulation 2017)
- Hazardous Industry Planning Advisory Paper No. 6 – Guidelines for Hazard Analysis (Department of Planning, 2011b)
- Australian Standard AS2885 Pipelines – Gas and liquid petroleum
- Multi-Level Risk Assessment (Department of Planning and Infrastructure, 2011)
- Bushfire prone land mapping developed and published by the relevant local councils.

25.2.1 Dangerous goods and hazardous materials

Dangerous goods are substances or objects that pose acute risks to people, property and the environment due to their chemical or physical characteristics, while hazardous substances are chemicals or materials that can pose a significant risk to health and safety if not managed correctly.

Dangerous goods are classified according to their physical or chemical effects, such as fire, explosion, corrosion and poisoning, affecting property, the environment, or people. Dangerous goods are substances that, because of their physical, chemical (physico-chemical) or acute toxicity properties, present a risk to people, property, or the environment. Types of substances classified as dangerous goods include explosives, flammable liquids and gases, corrosives, and chemically reactive or acutely (highly) toxic substances. Dangerous goods are defined by the Australian Dangerous Goods Code. Many dangerous goods are also classed as hazardous substances.

Hazardous materials are those that meet the classification criteria specified by the Work Health and Safety Regulation 2017 and the Globally Harmonised System of Classification and Labelling of Chemicals (an internationally agreed system of chemical classification). The thresholds in 'Applying SEPP 33' represent the maximum quantities of hazardous materials that can be stored or transported without causing a significant off-site risk. Although SEPP 33 is not applicable to State significant infrastructure projects, the guidelines have been applied to inventories of dangerous goods likely to be stored at construction sites to assess the potential risk of Stage 1 to the environment and to public safety.

25.3 Assessment approach

A desktop assessment was carried out to identify environmental hazards that could arise during Stage 1. The assessment focused on hazards with the potential to adversely affect the quality of the surrounding environment, land uses and communities and included:

- Consideration of the relevant regulatory framework and guidelines
- Identification of the types of activities included in Stage 1 that may generate potential hazards
- Identification of the potential environmental impacts associated with the potential hazards
- Identification of mitigation measures to address potential hazards.

Other work, health and safety hazards are not specifically considered in this Environmental Impact Statement. These issues would be addressed by the relevant construction contractor in accordance with relevant guidelines and legislative requirements.

25.4 Avoidance and minimisation of impacts

The design development process for Stage 1 aimed to avoid or minimise potential hazards. This included selecting construction sites at Clyde and Silverwater which avoid potential interaction with major hazard facilities including Viva Energy's Clyde Terminal and associated high pressure fuel pipelines in the locality.

25.5 Potential impacts

25.5.1 Potential hazards

Potential hazards during Stage 1 would be temporary and associated with:

- The on-site storage, use and transport of dangerous goods and hazardous substances
- The on-site handling and transport of contaminated soil and hazardous wastes
- Potential impacts to utilities
- Potential interaction with major hazard facilities
- Potential risk of damage to existing building basements and ground support structures due to potential ground movement
- Potential bushfire risks.

These hazards are described further in the following sections.

25.5.2 On-site storage, use, handling and transport of dangerous goods and hazardous substances

Construction sites would be planned so that hazardous materials are stored appropriately and at a suitable distance from sensitive receivers, in accordance with the thresholds established under Applying SEPP 33 guidelines. If minimum buffers cannot be maintained, either due to space constraints, the close proximity of sensitive receivers, or a requirement to store volumes of hazardous materials in excess of storage thresholds, a risk management strategy would be developed on a case-by-case basis.

Environmental hazards associated with the on-site storage, use and transport of chemicals, fuels and materials would be managed through standard mitigation measures to be developed as part of the construction environmental management documentation. These measures would include the storage and management of all dangerous goods and hazardous substances in accordance with the *Work Health and Safety Act 2011*, the Work Health and Safety Regulation 2017, the Storage and Handling of Dangerous Goods Code of Practice (WorkCover NSW, 2005) and Applying SEPP 33 (Department of Planning, 2011a).

An indicative list of the types of dangerous goods and potentially hazardous materials anticipated to be used, stored and transported during construction of Stage 1 is provided in Table 25-2, along with the relevant storage and transport thresholds established under the Hazardous and Offensive Development Application Guidelines: Applying SEPP 33 (Department of Planning, 2011a).

Typically, low volumes of potentially hazardous materials would be stored on site, except for the tunnel support sites at Westmead and The Bays, where larger volumes of materials would be required to support tunnel construction. The volume required to be stored on site would largely depend on the anticipated rates of consumption, with deliveries of dangerous goods coordinated to match consumption rates. This could be about one delivery per day if needed to minimise volumes stored on-site to reduce the potential for SEPP 33 storage thresholds being exceeded.

Table 25-2: Indicative list of hazardous materials potentially required during construction and applicable storage/transport thresholds

Material	Australian Dangerous Good Code Class	Storage locations	Storage method	Applying SEPP 33 thresholds		
				Storage volume	Minimum storage distance from sensitive receivers	Transport (weekly)
Diesel	C1[1]; 3 PG III[2]	All sites	5,000 litre drums	Greater than 5 tonnes, if stored with other Class 3 flammable liquids	5 metres	Not applicable if not transported with Class 3 dangerous goods
Petrol	C1[1]; 3 PG III[2]	All sites	500 litre drums	Greater than 5 tonnes, if stored with other Class 3 flammable liquids	5 metres	Not applicable if not transported with Class 3 dangerous goods
Lubricating and hydraulic oils and greases	C2	All sites	45 gallon drums	N/A	N/A	Not applicable, if not transported with Class 3 dangerous goods
Explosives	1.1	No on-site storage	Delivery of explosives would be timed to avoid the need for on-site storage	N/A	N/A	Subject to consultation with the Department of Planning, Industry and Environment
Industrial grade oxygen	2.2	All sites	Cylinders (up to 55 kilograms) in rack	N/A	N/A	Not subject to Applying SEPP 33 transport thresholds
Acetylene	2.1	All sites	Cylinders (up to 55 kilograms) in rack	Greater than 0.1 tonnes (100kg)	15 metres	2 tonnes; 30 times per week
Cement	N/A	All sites	Bags/pallets (in container)	N/A	N/A	Not subject to Applying SEPP 33 transport thresholds
Premix concrete	N/A	All sites	Bags/pallets (in container)	N/A	N/A	Not subject to Applying SEPP 33 transport thresholds
Concrete curing compounds	N/A	All sites	20 litre drums	N/A	N/A	Not subject to Applying SEPP 33 transport thresholds
Concrete retardant	3 PG III	All sites	205 litre drums	Greater than 5 tonnes	5 metres	10 tonnes; 60 times per week
Shotcrete accelerator	3 PG II	All sites	1,000 litre intermediate bulk containers	Greater than 5 tonnes	5 metres	3 tonnes; 45 times per week
Epoxy glue	3 PG III	All sites	Small containers	Greater than 5 tonnes	5 metres	10 tonnes; 60 times per week
Coagulants	N/A	All sites	1,000 litre intermediate bulk containers	N/A	N/A	Not subject to Applying SEPP 33 transport thresholds
Acids	8 PG II	All sites	1,000 litre intermediate bulk containers	Greater than 25 tonnes	N/A	2 tonnes; 30 times per week
Bases	8 PG II	All sites	1,000 litre intermediate bulk containers	Greater than 25 tonnes	N/A	2 tonnes; 30 times per week
Disinfectant	8 PG III	All sites	500 litre intermediate bulk containers	Greater than 50 tonnes	N/A	2 tonnes; 30 times per week
Anti-scalent	N/A	All sites	100 litre drums	N/A	N/A	Not subject to Applying SEPP 33 transport thresholds
Membrane preservative	8 PG III	All sites	10 litre drums	Greater than 50 tonnes	N/A	2 tonnes; 30 times per week
De-bonding agents	N/A	All sites	Drums/containers	N/A	N/A	Not applicable
Paint	N/A	All sites	20 litre drums	N/A	N/A	Not subject to Applying SEPP 33 transport thresholds

Note 1: Classified as C1 if not stored with other Class 3 flammable liquids.
Note 2: Classified as 3PGIII if stored with other Class 3 flammable liquids.

Dangerous goods would be transported to and from construction sites using the routes identified in Chapter 10 (Transport and traffic – Stage 1). Transport of dangerous goods would be in accordance with the *Dangerous Goods (Road and Rail Transport) Act 2008* and Dangerous Goods (Road and Rail Transport) Regulation 2014, and extended routes would avoid areas (such as road tunnels) prohibited by NSW Road Rule 300-2 (carriage of dangerous goods in prohibited areas).

25.5.3 On-site handling and transport of contaminated soil and hazardous wastes

In addition to the materials listed in Table 25-2, Stage 1 may require the handling and transport of contaminated soil, hazardous waste and asbestos waste. The handling and transport of contaminated soils, hazardous waste and asbestos waste would be adequately managed by the measures identified in the following chapters:

- Chapter 18 (Groundwater and ground movement – Stage 1)
- Chapter 19 (Soils and surface water quality – Stage 1)
- Chapter 20 (Contamination – Stage 1)
- Chapter 24 (Spoil, waste management and resource use – Stage 1).

25.5.4 Impacts to utilities

The potential risk associated with utility related hazards would be minimised by carrying out utility checks (such as dial before you dig searches and non-destructive digging) and consulting with the relevant utility providers. Construction methodologies for construction works near high pressure gas or petroleum pipelines would be developed to comply with relevant standards in consultation with utility providers to minimise environmental hazards.

A program of ongoing consultation has been established and implemented to further assess requirements for utilities as outlined in Chapter 9 (Stage 1 description).

Damage, rupture and/or failure to shut down, isolate or otherwise appropriately manage underground utilities during construction activities has the potential to result in the following environmental hazards:

- Release of untreated sewage and/or gas from a sewer main
- Release of natural gas from a gas main
- Release of large electrical currents through the ground surface from an underground electricity cable (known as earth potential rise)
- Release of high pressure petroleum or gas products from petroleum, gas or oil pipelines.

Key utilities which would present a potential hazard or risk where located close to construction sites include:

- High voltage power lines (both aboveground and underground) located throughout the Stage 1 footprint
- High pressure gas mains, including secondary mains near the Clyde stabling and maintenance facility construction site
- Gas distribution lines near all construction sites.

The following high pressure petroleum pipelines are near Stage 1 but would not be affected as there is either a sufficient horizontal offset distance from the tunnels and construction sites, or the tunnels pass beneath these pipelines at depth:

- Hunter Gas Pipeline near the Clyde stabling and maintenance facility construction site
- Viva Energy Gore Bay – Clyde pipeline near the Clyde stabling and maintenance facility construction site
- Clyde – Sydney Airport pipeline near the Clyde stabling and maintenance facility construction site
- Kurnell – Banksmeadow pipeline near the Clyde stabling and maintenance facility, Sydney Olympic Park metro station, and North Strathfield metro station construction sites.

25.5.5 Interaction with major hazard facilities

The construction of Stage 1 would not interact with any major hazard facilities.

The closest major hazard facility is Viva Energy's Clyde Terminal (classified and regulated as a major hazard facility under the *NSW Work Health and Safety Act 2011* and NSW Work Health and Safety Regulation 2017) which is located about 350 metres to the south-west of the Clyde stabling and maintenance facility construction site.

25.5.6 Ground movement risks

An assessment of potential ground movement associated with Stage 1 and identification of management and mitigation measures is provided in Chapter 18 (Groundwater and ground movement – Stage 1). In summary, Stage 1 is considered to have a negligible ground movement risk, with superficial damage to buildings unlikely to occur. Small areas around station sites and the dive structure within the Clyde stabling and maintenance facility may require future assessment. The use of survey data would inform the understanding of potential risks associated with basements and ground support structures and inform the future design process.

The uncertainty about ground conditions may also present potential risks for the construction process. For example, if rock is found to be harder or softer than assumed during the design process, this could lead to a reassessment of tunnelling design. This uncertainty would be addressed through further geotechnical investigation to improve understanding of ground conditions and through the development of an appropriate construction methodology.

Chapter 11 (Noise and vibration – Stage 1) considers potential temporary impacts from vibration and includes measures to address these potential impacts. Detailed assessment of the buildings predicted to be above the cosmetic damage screening criteria would be carried out prior to construction. Attended vibration monitoring would be carried out during construction to ensure vibration levels remain below appropriate limits for the structure.

25.5.7 Bushfire risks

Stage 1 would be in a highly developed urban environment that generally lacks substantial areas of bushland. A review of bushfire prone land mapping developed and published by relevant local councils indicated that none of the proposed construction sites would be located on or near bushfire prone land. Therefore, bushfire risks would be negligible.

25.5.8 Cumulative impacts

No cumulative impacts in relation to hazards are likely during Stage 1. All potential hazards during construction would be managed to acceptable levels through the implementation of the mitigation measures in Section 25.6.

25.6 Management and mitigation measures

25.6.1 Approach to management and mitigation

Hazards would be managed in accordance with Sydney Metro's Construction Environmental Management Framework which is described in Chapter 27 (Synthesis of the Environmental Impact Statement).

The Construction Environmental Management Framework includes requirements for the development and implementation of emergency and incident response plans and procedures.

25.6.2 Mitigation measures

Specific mitigation measures that would be implemented to address potential hazards are listed in Table 25-3.

Table 25-3: Mitigation measures – Hazards

Reference	Impact/issue	Mitigation measure	Applicable location(s)[1]
HA1	Risks to people, property and the environment associated with transport and storage of explosives	The method for delivery of explosives would be developed prior to the commencement of blasting (if proposed) in consultation with the Department of Planning, Industry and Environment and be timed to avoid the need for on-site storage.	All
HA2	Impacts on underground utilities	Dial before you dig searches and non-destructive digging would be carried out to identify the presence of underground utilities.	All
HA3	Impacts on underground utilities	Ongoing consultation would be carried out with utility providers for high pressure gas or petroleum pipelines to identify appropriate construction methodologies to be implemented. Any interaction with high pressure gas or petroleum pipelines would comply with the relevant standards, including AS 2885 Pipelines – Gas and Liquid Petroleum.	All

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (e.g. tunnel boring machine works); PSR: Power supply routes.

25.6.3 Interactions between mitigation measures

Mitigation measures in other chapters that are relevant to the management of potential hazards include:

- Chapter 11 (Noise and vibration – Stage 1), specifically measures which address construction vibration impacts and building condition surveys respectively
- Chapter 18 (Groundwater and ground movement – Stage 1), specifically measures which address ground movement and settlement impacts
- Chapter 24 (Spoil, waste management and resource use – Stage 1), specifically measures which address the identification and disposal of hazardous materials.

Together, these measures would minimise the potential hazards of Stage 1.

There are no mitigation measures identified in the assessment of other environmental aspects that are likely to affect the assessment of hazards.

26 Sustainability and climate change – Stage 1

26 Sustainability and climate change – Stage 1

This chapter describes the overall approach to sustainability for Stage 1, as well as an assessment of the potential impact of climate change and the greenhouse gas emissions that would be generated during Stage 1 construction.

26.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to sustainability and climate change for Stage 1, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 26-1.

Table 26-1: Secretary's Environmental Assessment Requirements – Sustainability and climate change Stage 1

Reference	Secretary's Environmental Assessment Requirements	Where addressed
12. Sustainability		
12.1	The sustainability of the Proposal in accordance with (as relevant) Green Star or the Infrastructure Sustainability Council of Australia (ISCA) Infrastructure Sustainability Rating Tool (or equivalent) and commit to an appropriate target rating.	This chapter Chapter 8
13. Other issues		
13.1	Air quality, greenhouse gas and energy, climate change adaptation, waste management and resource use, hazard and risk assessments should be undertaken in accordance with the commitments in Section 9 of the Scoping Report.	Chapter 23 This chapter Chapter 24 Chapter 25 Refer to Table 2 of Appendix A for Scoping Report requirements

26.2 Overview

Chapter 8 (Concept environmental assessment), Section 8.20 outlines initiatives and targets for the Sydney Metro West Concept that have been developed to align with relevant government resource efficiency policies. These initiatives and targets would also apply to Stage 1. These initiatives would be further refined as part of the design process, committed to in an update to the Sydney Metro West Sustainability Plan and included in the contract documents for Stage 1 works.

Sydney Metro West (including Stage 1) would also achieve an equivalent or improved level of sustainability performance compared to previous metro projects. This would include achieving a minimum Infrastructure Sustainability Council of Australia (ISCA) IS rating of 75 – Version 1.2 (or equivalent) and a 5-Star Green Star rating.

This chapter assesses the following elements of sustainability for Stage 1:

- Climate change risk and adaptation
- Greenhouse gas and energy.

Chapter 17 (Social impacts – Stage 1) considers the social sustainability elements.

26.3 Climate change risk and adaptation

26.3.1 Climate change risk assessment methodology

The climate change risk assessment and adaptation planning process methodology for Stage 1 is based on the Australian Standard AS 5334-2013 Climate change adaptation for settlements and infrastructure – A risk based approach. This standard follows the International Standard ISO 31000, Risk Management – Principles and guidelines.

The main steps in the process are:

- Establishing the climate change context of Stage 1
- Carrying out a climate change risk assessment
- Treating key climate risks.

The climate change risk assessment was carried out using the Transport for NSW risk framework. The severity or consequence of risks was assessed with reference to the following:

- Health and safety impact
- Environmental impact
- Customer experience and operational reliability impact
- Government, stakeholder and community trust
- Regulatory impact
- Managerial and organisational impact
- Impact on the benefit realisation
- Financial impact.

Risk likelihood was assessed cumulatively over the applicable asset life, rather than the chance of occurrence of the hazard-consequence combination in any given year.

Climate change risks were assessed by considering the implications of climate change projection scenarios, allowing for a business-as-usual risk control for natural hazards that would still apply in the absence of any consideration of climate change.

A climate change workshop was undertaken as part of the definition design process. Participants considered climate change projections for the region and the potential impact these would have on a range of aspects related to Stage 1.

26.3.2 Climate change risks

To effectively manage potential climate change risks, each stage in the design and delivery of Stage 1 would consider the most up to date climate change projections and design guidelines and would be subject to ongoing review and response by designers and constructors. Refer to Section 26.5 for mitigation measures to manage climate change risks for Stage 1.

Climate change projections relevant to Sydney Metro West (including Stage 1) are detailed in Chapter 8 (Concept environmental assessment), Section 8.20, and include:

- Potential increases in absolute maximum temperature
- Potential increases in average temperatures and the frequency of heatwaves
- Potentially lower annual average rainfall, increased rainfall intensity during storm events and resultant surface water flooding
- Potential sea level rise in the order of 0.19 metres by 2030 and 0.88 metres by 2090
- Potential increased carbon dioxide concentrations in the atmosphere, together with increased temperature and periods of heavy rainfall could lead to increases in the carbonation of concrete.

As a consequence of these projections (especially increased temperatures and reduced annual rainfall) there could be potential increases in the number of days where the Forest Fire Danger Index will be greater than 50 (severe).

Climate change is anticipated to have potential direct and indirect impacts on Stage 1. The climate change risk assessment process for Stage 1 identified the following potential risks after the implementation of climate change adaption measures (residual risks):

- Six medium (tolerable) risks
- Three low (acceptable) risks. For these risks, no risk treatment is proposed at this stage – although some of the risks would be followed up during detailed design.

No extreme (unacceptable) risks or high (undesirable) risks were identified.

Table 26-2 outlines the 'medium' risks for Stage 1 and the proposed risk treatments (in addition to 'business as usual' measures).

Table 26-2: Climate change risks identified as 'medium'

Potential risk	Pre-treatment risk rating	Risk treatment	Post-treatment risk rating
Stabling and maintenance facility and other infrastructure located in low-lying areas may be at increased risk of flooding causing damage and disruption to services.	High	• Consider sea level rise and increased rainfall projections in flood modelling to determine any additional impact from climate change on local flood behaviour.	Medium
Potential increases in the number of flood events impacting on the tunnel drainage systems.	Medium	• Consider sea level rise and rainfall projections in design of tunnel portals and tunnel drainage systems • Space proof for additional drainage system capacity	Medium
Potential indirect flooding risks to local and regional communities.	Medium	• Risks to be re-evaluated following detailed survey	Medium
Potential changes to groundwater levels impacting on the integrity of embankments and cuttings, potentially leading to their collapse. Collapse could lead to damage or burying of rail lines. Embankments and cuttings are limited to the tunnel portal and dive structure and the stabling and maintenance facility.	Medium	• Ensure design takes into account climate change projections, research into embankments and cuttings used in regions where landslides and mass movement is likely.	Medium
Potential inundation of rail infrastructure near marine water including wave and tide damage.	Medium	• Consider sea level rise projections in flood protection design.	Medium
Potential increased carbonation of concrete resulting in such structures not lasting their required lifespan. Potential requirement for additional maintenance to deal with carbonation of concrete and exposure of concrete reinforcement.	Medium	• Consider revising the exposure classification for concrete structures to provide additional protection against concrete carbonation and chloride ion attack.	Medium

26.4 Greenhouse gas and energy

26.4.1 Greenhouse gas assessment methodology

Greenhouse gas emissions are reported as tonnes of carbon dioxide equivalent (tCO2-e) and categorised into three different scopes (either scope 1, 2 or 3) in accordance with the Greenhouse Gas Protocol (World Resources Institute, 2014), Intergovernmental Panel on Climate Change and Australian Government greenhouse gas accounting/classification systems.

The three emission categories (known as 'scopes') help differentiate between direct emissions from sources that are owned or controlled by a project, and upstream indirect emissions that are a consequence of project activities, but which occur at sources owned or controlled by another entity. The three greenhouse gas scopes are:

- Scope 1 emissions, also referred to direct emissions
- Scope 2 emissions, also referred to as indirect emissions
- Scope 3 emissions, includes all indirect emissions (not included in scope 2) due to upstream or downstream activities.

The objectives of the greenhouse gas assessment were to:

- Identify the likely sources of greenhouse gas emissions associated with construction of Stage 1
- Quantify the greenhouse gas emissions associated with each greenhouse gas source
- Identify opportunities (mitigation measures) to reduce greenhouse gas emissions.

Transport for NSW's online Carbon Estimate and Reporting Tool was used for the greenhouse gas emissions assessment. The tool was developed to provide consistency in greenhouse gas emissions assessment and reporting for the construction stage of Transport for NSW projects.

The greenhouse gas assessment is a preliminary estimate based on current design information and construction methods.

26.4.2 Estimated greenhouse gas emissions

Greenhouse gas emissions were estimated for the range of construction emission sources (noting that Stage 1 does not include metro operation). The estimated scope 1, 2 and 3 emissions are summarised in Table 26-3.

In 2016/17, NSW's annual greenhouse gas emissions were about 131.5 million tCO_2-e (Department of Planning, Industry and Environment, 2019d), with the transport industry sector accounting for about 21 per cent of the total at 28 million tCO_2-e.

Construction of Stage 1 would equate to about 1.4 per cent of the transport industry's 2016/17 annual greenhouse gas emissions and about 0.3 per cent of total NSW emissions. While these percentage contributions are small within the NSW and national contexts, the management and mitigation measures outlined in Section 26.5 would further minimise and offset greenhouse emissions during construction.

Table 26-3: Estimated greenhouse gas emissions – Stage 1

Resource	Source	Greenhouse gas emissions (tCO_2e)$_1$
Scope 1	Fuel consumption	38,165
	Vegetation clearing	56
Scope 2	Electricity consumption	111,685
Scope 3	Fuel consumption	1,957
	Electricity consumption	12,410
	Construction materials	217,104
	Haulage	7,290
TOTAL		**388,667**

Note 1: tCO_2e = tonnes of CO_2 equivalent.

26.5 Management and mitigation measures

26.5.1 Approach to management and mitigation

Stage 1 would be constructed in accordance with the Sydney Metro West Sustainability Plan (discussed in Section 8.20). Contractors for Sydney Metro would be required to develop an environmental and sustainability management system which would be linked to the Sydney Metro sustainability system.

The relationship between key documents within the Sydney Metro and contractor environment and sustainability management systems is shown in Figure 26-1. Notably:

- The Contractor's Construction Environment Management Plan and sub plans would capture the construction environmental management requirements emerging from the Environmental Impact Statement and the Sydney Metro West Sustainability Plan
- The Contractor's Sustainability Management Plan would capture governance and design requirements, social sustainability initiatives required by the Sydney Metro West Sustainability Plan and contract requirements. This plan would vary in scope across different delivery packages
- Progress against sustainability objectives and targets would be tracked through regular sustainability reporting over the delivery period.

Sub-contractors engaged by the contractor would be required to work under the contractor's environmental and sustainability management system.

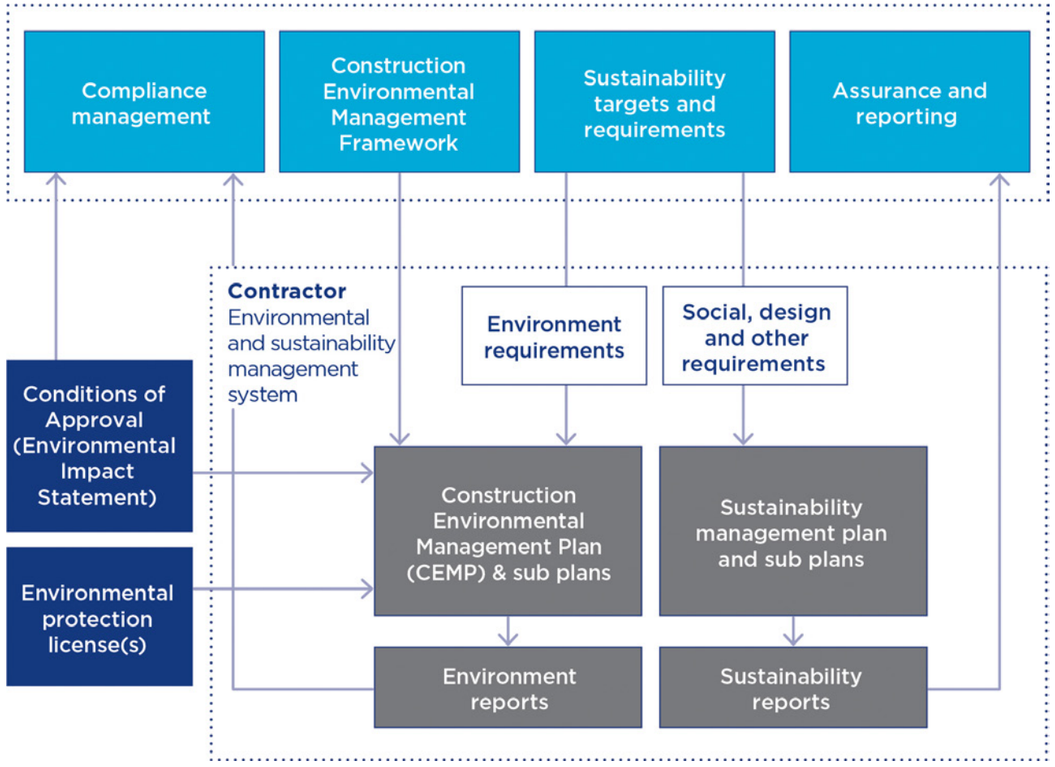

Figure 26-1: Environmental and sustainability management system

The Construction Environmental Management Framework provides the basis for the development and implementation of a design and/or construction sustainability management plan. The framework provides minimum requirements for the plan which includes carbon and energy management, and waste management and recycling.

The Contractor's Sustainability Management Plan would also incorporate the specific mitigation measures listed in Table 26-4 as relevant to the scope of works.

26.5.2 Mitigation measures

The mitigation measures that would be implemented to address sustainability and climate change for Stage 1 are listed in Table 26-4.

Table 26-4: Mitigation measures - Sustainability and climate change Stage 1

Reference	Impact/issue	Mitigation measure	Applicable location(s)[1]
SCC1	Sustainability implementation	Sustainability initiatives would be incorporated into the detailed design and construction to support the achievement of the Sydney Metro West sustainability objectives.	All
SCC2	Sustainability implementation	Best practice level of performance would be achieved using market leading sustainability rating tools during design and construction.	All
SCC3	Climate change risks	Climate change risk treatments would be confirmed and incorporated into the detailed design.	All
SCC4	Greenhouse gas emissions	An iterative process of greenhouse gas assessments and design refinements would be carried out during detailed design and construction to identify opportunities to minimise greenhouse gas emissions. Performance would be measured in terms of a percentage reduction in greenhouse gas emissions from a baseline inventory calculated at the detailed design stage.	All
SCC5	Greenhouse gas emissions	25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction would be offset.	All

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (e.g. tunnel boring machine works); PSR: Power supply routes.

26.5.3 Interactions between mitigation measures

Mitigation measures in other chapters that are relevant to sustainability and management of potential climate change risk impacts include:

- Chapter 21 (Hydrology and flooding – Stage 1), specifically measures which address detailed construction planning to consider flood risk at construction sites.

Together, these measures would minimise the potential sustainability and climate change impacts of Stage 1.

There are no mitigation measures identified in the assessment of other environmental aspects that are likely to affect the assessment of sustainability and climate change.

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Part D | Synthesis, risk analysis and conclusion

27 Synthesis of the Environmental Impact Statement

27 Synthesis of the Environmental Impact Statement

This chapter provides a synthesis of the findings of the Environmental Impact Statement.

27.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relevant to the synthesis of the Environmental Impact Statement, and reference to where they are addressed in this chapter and in the Environmental Impact Statement, are provided in Table 27-1.

Table 27-1: Secretary's Environmental Assessment Requirements – Synthesis

Reference	Secretary's Environmental Assessment Requirements	Where addressed
2. Environmental Impact Statement		
2.1	(q) a chapter that synthesises the environmental impact assessment and provides: • A succinct but full description of the project for which approval is sought;	Section 27.2 to 27.5
	• A description of uncertainties that still exist around footprint, construction methodologies for Stage 1 and how these will be resolved in subsequent approval stages;	Section 27.6
	• A compilation of the impacts that have not been avoided;	Section 27.7
	• For Stage 1, a compilation of the proposed measures associated with each impact to avoid or minimise (through design refinements or ongoing management during construction or during latter stages) or offset these impacts;	Section 27.8
	• A compilation of the performance outcome(s) and criteria the Proponent target and how these will be monitored; and	Section 27.9
	• The reason justifying carrying out Stage 1 as proposed, having regard to the biophysical, economic and social considerations, including ecologically sustainable development and cumulative impacts	Section 27.10

27.2 Overview

Sydney Metro West would involve a new metro line around 24 kilometres long between Westmead and the Sydney CBD. This infrastructure investment would double the rail capacity of the Parramatta to Sydney CBD corridor with a travel time target between the two centres of about 20 minutes.

The planning approvals and environmental impact assessment for Sydney Metro West will be broken down into a number of stages recognising the size of the project. This includes:

- Sydney Metro West at a Concept level
- Stage 1 – All major civil construction works between Westmead and The Bays including station excavation and tunnelling
- Stage 2 – All stations, depots and rail systems between Westmead and The Bays.
- Stage 3 - All major civil construction works including station excavation, tunnels, stations, depots and rail systems between The Bays and the Sydney CBD Station, and operation of the line.

Whilst the content of these stages may be varied, this Environmental Impact Statement covers the Concept and Stage 1 comprising all major civil construction works between Westmead and The Bays including station excavation and tunnelling.

This Environmental Impact Statement assesses the potential impacts of the Sydney Metro West Concept and Stage 1 only. Future stages, including the operation of Sydney Metro West would be assessed in future applications.

27.3 The Concept

The design and construction approach presented in this Environmental Impact Statement is based on a concept design and is indicative only. Changes may be made to the design and the construction methodology following community and stakeholder feedback provided during the Environmental Impact Statement exhibition.

The design and detailed construction methodologies may also change during the detailed design process which would progress if planning approval is obtained.

27.3.1 Key features of the Concept

The Concept is shown in Figure 27-1. The key features of the Sydney Metro West Concept are:

- About 24 kilometres of twin tunnels between Westmead and the Sydney CBD
- New metro stations at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock, The Bays and Sydney CBD. The location of the Sydney CBD station will be determined following further investigations and community and stakeholder engagement. Strategic station locations at Rydalmere and Pyrmont are also under investigation
- A turn-up-and-go metro service operating early morning to late at night, between Westmead and Sydney CBD
- Pedestrian links and connections to other modes of transport (such as the existing suburban rail network and other parts of the metro network) and surrounding land uses
- Modifications to existing suburban stations and associated rail infrastructure (such as overhead wiring, signalling, access tracks/paths and rail corridor fencing) at Westmead and North Strathfield
- Services within each of the metro stations, including mechanical and fresh air ventilation equipment and electrical power substations to supply power for operation
- A stabling and maintenance facility at Clyde, including associated aboveground and belowground tracks to connect to the mainline tunnels and other operational ancillary infrastructure
- Services facilities at Rosehill (within the Clyde stabling and maintenance facility construction site), Silverwater and between Five Dock and The Bays for fresh air ventilation and emergency evacuation
- Alterations to pedestrian and traffic arrangements, and cycling and public transport (e.g. bus) infrastructure around the new stations
- Subdivision of station sites to support integrated station and precinct development and ancillary facilities
- Ancillary facilities to support construction.

The Concept is further described in Chapter 6 (Concept description).

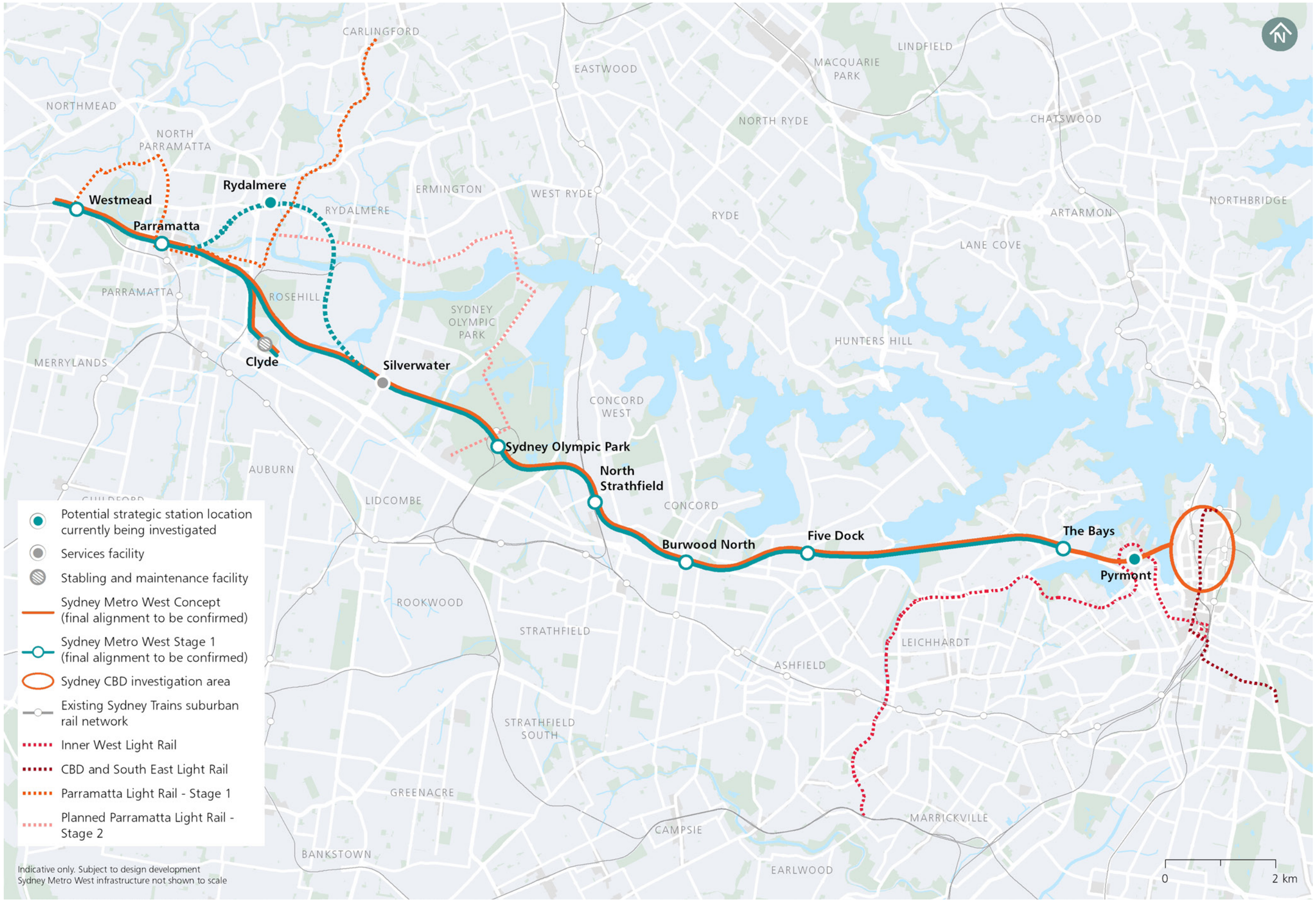

Figure 27-1: Sydney Metro West Concept

27.3.2 Concept construction elements

Key construction elements of the Concept would include:

- Enabling works
- Tunnel excavation and associated tunnelling support activities such as segment production, segment storage and spoil management
- Station construction including excavation, fit-out and aboveground building construction
- Rail interchange support works at Westmead and North Strathfield stations
- Operational ancillary infrastructure construction including excavation of shafts, fit-out and aboveground building construction
- Construction of a stabling and maintenance facility, including the dive structure and tunnel portal
- Tunnel and rail systems fit-out.

27.3.3 Key operational aspects

As indicated above, operational aspects of Sydney Metro West would be described in detail in subsequent development applications. The following summary is provided for the purposes of the assessment of the Concept. Further details are provided in Chapter 6 (Sydney Metro West concept description). Stage 1 would not include any operational elements.

Network interface, servicing and capacity

The Concept would operate as a rail line separate from the existing suburban and intercity rail network and separate from the Metro North West Line and City & Southwest line.

Demand for the service would be managed through increased service frequency. The ultimate operational capacity of the Concept is expected to be 30 trains per hour in each direction – a train every two minutes each way.

Hours of operation

Sydney Metro West would operate from early morning to late at night. Operating hours can be extended to accommodate planned special events.

Train types

All trains would be new, single-deck metro trains. They would deliver a fast, safe and reliable journey for customers with high performance standards and good customer amenities.

Design considerations

The considerations to guide the design of stations forming part of the Concept are provided in Table 27-2.

Table 27-2: Preliminary station design considerations

Station aspect	Design considerations
Customer experience	• Escalators, platforms, passageways, mezzanines and concourses would be designed to accommodate peak customer flows and ensure stations are easy to navigate • The station and public access areas would be designed as attractive spaces and include public art and landscaping (where appropriate) and would also maximise the use of natural daylight. The design would also protect customers from weather (covered access paths, waiting shelters etc.) at stations and also at interchange areas • Furniture on station platforms would be provided to cater for a range of customers including seating and standing spaces.
Customer information and wayfinding	• Real-time information would be delivered to customers through multiple media • An easy, intuitive and consistent wayfinding system would be developed that facilitates efficient customer movements to, from and through stations.
Operations and system requirements	Stations would be designed in accordance with the operations and system requirements, including: • Maintaining customer flows at an acceptable and safe level of service standard • Securing platforms and critical infrastructure spaces from public access when services are not operating.
Safety and security	• The safety of customers, staff and areas surrounding stations would be considered in station design in accordance with crime prevention through environmental design principles • Well-designed and efficiently controlled lighting systems, visible closed circuit television surveillance and appropriate staffing during operational hours would contribute to safe station environments. Passive station design elements that promote safety would include clear visibility lines in and around stations and the use of natural daylight and adequately wide paths to avoid blind spots.
Accessibility and functionality	• Efficient transfer between metro and other types of transport (such as suburban network trains, walking, cycling, light rail and buses) is important to station design and supporting integrated transport network approach • The Sydney Metro network would be integrated into the Opal ticketing system • Station design would be guided by an 'access for all' philosophy using 'priority of access' principles, with pedestrians and cyclists first, followed by buses, point to point services and kiss and ride customers • Station design includes emergency exit and access facilities, such as fire stairs to allow for customer evacuation and emergency services access.
Sustainability and climate change	• Sustainability measures at stations would include (where feasible) natural light, solar panels, reuse of rainwater, passive ventilation and shading, use of durable and low maintenance materials, and energy-efficient lighting.
Placemaking and activation	• Sydney Metro West stations would provide a new public domain as well as integrate with the existing public realm and adjoining lands to develop and promote vibrant retail, community and other spaces as appropriate to the context and locality • Each station location would include space for retail outlets that meet customer needs (e.g. café, newsagents, etc.), as well as providing spaces for temporary activation and public art where appropriate. Station entries would be designed to make a positive contribution to the local area.

Other operational features

Other key operational features of the Concept would include:

- Pedestrian links and connections to other modes of transport (such as the existing suburban rail network and other parts of the metro network) and surrounding land uses
- Operation of a services facility at Rosehill, Silverwater and between Five Dock and The Bays for fresh air ventilation and emergency evacuation
- Traction substations to provide traction power supply. These would generally be co-located with other infrastructure where possible at Clyde stabling and maintenance facility, Burwood North Station and The Bays Station
- Operation of a stabling and maintenance facility at Clyde.

27.4 Placemaking

The approach to design and placemaking for the Sydney Metro West Concept, as well as site-specific place and design principles for each metro station and facility, are provided in Chapter 7 (Placemaking).

The approach to placemaking at each locality would be contextual, taking into consideration that metro stations would:

- Function as 'places' in their own right, creating focal points in the communities each station serves. The stations would attract a range of benefits and land uses, including reducing dependence on private vehicles, providing public places for gathering and human interaction supported by commercial and retail, as well as encouraging exercise by promoting walking and cycling to and from the stations
- Have a role in contributing to their surrounding environment or 'place' in which they are located by supporting planned growth and renewal, and acting as a catalyst for transit-oriented development within their catchments.

27.5 Stage 1

27.5.1 Key features of Stage 1

Stage 1 is shown on Figure 27-2 and would involve the major civil construction work between Westmead and The Bays, including:

- Enabling works such as demolition, utility supply to construction sites, utility adjustments and modifications to the existing transport network
- Tunnel excavation including tunnel support activities
- Station excavation for new metro stations at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock and The Bays
- Shaft excavation for services facilities at Rosehill (within the Clyde stabling and maintenance facility construction site), a location between Five Dock Station and The Bays Station construction sites (to be determined), and Silverwater
- Civil work for the stabling and maintenance facility at Clyde including earthworks and structures for crossings at A'Becketts Creek and Duck Creek
- A concrete segment facility for use during construction located at the Clyde stabling and maintenance facility construction site
- Excavation of a tunnel dive structure and associated tunnels at Rosehill to support a connection between the Clyde stabling and maintenance facility and the mainline metro tunnels.

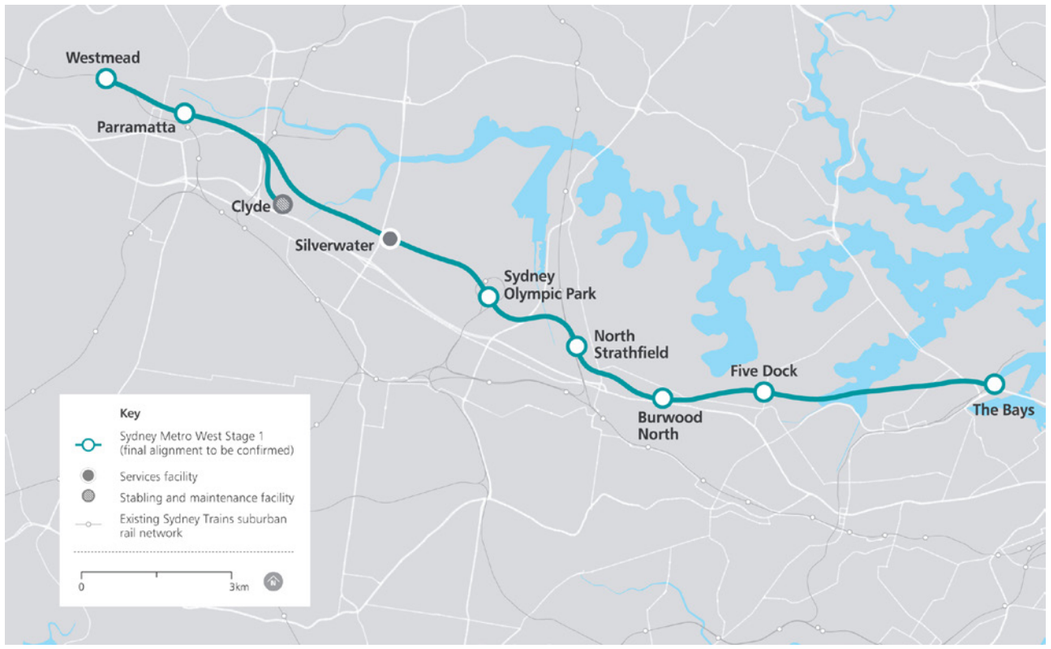

Figure 27-2: Overview of Stage 1

Tunnel location

The Stage 1 tunnel alignment (refer Figure 27-2) is indicative at this stage and has been used for the purposes of the environmental impact assessment, including all specialist investigations. During detailed design the alignment may change. Any changes to the alignment would be reviewed for consistency with the assessment contained in this Environmental Impact Statement including any relevant mitigation measures, performance outcomes and any future conditions of approval.

Construction sites and associated activities

A number of construction sites would be required for:

- Tunnel boring machine launch, support and retrieval
- Roadheader support
- Station excavation
- Services facility shaft excavation
- Civil works for the stabling and maintenance facility.

Table 27-3 shows the proposed construction sites and their uses. All construction sites would provide staff facilities such as offices, lunch rooms and amenities.

Table 27-3: Construction site activities – Stage 1

Construction site	Tunnel boring machine launch and support	Tunnel boring machine retrieval	Roadheader works and support	Spoil removal	Station excavation	Services facilities excavation	Construction staff facilities	Stabling and maintenance facility civil works	Creek crossings	Tunnel dive structure
Westmead metro station	●		●	●	●		●			
Parramatta metro station				●	●		●			
Clyde stabling and maintenance facility				●		●	●	●	●	●
Silverwater services facility				●		●	●			
Sydney Olympic Park metro station		●		●	●		●			
North Strathfield metro station				●	●		●			
Burwood North Station			●	●	●		●			
Five Dock Station			●	●	●		●			
The Bays Station	●			●	●		●			

27.5.2 Stage 1 construction methods

Table 27-4 provides an overview of the key construction methods for Stage 1.

Table 27-4: Construction methods – Stage 1

Construction activity	Construction methods
Enabling works	Enabling works activities that would typically be carried out before the start of substantial construction in order to make ready key construction sites and to provide protection to the public. Enabling works are expected to include: • Construction site establishment • Demolition of buildings and structures within the proposed construction footprint • Utility adjustments and protection • Utility supply to the construction sites including power and water • Transport network modifications to roads, public transport, and pedestrian and cyclist facilities • Heritage investigations, protection and archival recordings • Additional geotechnical and contamination investigations and remediation where required.

Construction activity	Construction methods
Tunnels	Tunnel boring machines would be used to excavate twin tunnels about 21 kilometres long. The two bored tunnels would have a circular cross-section with an internal lined diameter of about six metres and an excavated diameter of about seven metres. Roadheaders would be used to excavate caverns, stub tunnels and connection tunnels from the stabling and maintenance facility to the mainline tunnels. It is anticipated that tunnelling would occur from two tunnel boring machine launch and support sites: • Westmead metro station construction site • The Bays Station construction site. These construction sites would provide the necessary support for the tunnelling operation including spoil storage and removal, power supply to the tunnel boring machines, fresh air ventilation, grout batching, water treatment and disposal, material storage as well as office facilities, worker amenities and parking. Retrieval and dismantling of the tunnel boring machines would be carried at the Sydney Olympic Park metro station construction site. A temporary pre-cast concrete segment production facility would be at the Clyde stabling and maintenance facility construction site to provide concrete segments for the tunnel lining.
Station construction	Excavation of stations would generally be carried out in the following sequence: • Enabling works including protection or diversion of utilities and establishment of site access points • Demolition of structures on the site and clearance of landscaped vegetation • Excavation and structural works for station boxes and underground pedestrian passages including piled walls. This may be carried out using excavators and rock hammers, however drill and controlled blasting or penetrating cone fracture techniques may also be used.
Services facilities	Vertical shafts would be constructed at Rosehill and Silverwater to house future services facilities. Stage 1 construction works for the services facilities would involve: • Enabling works including protection or diversion of utilities and establishment of site access points • Demolition of structures on the site and vegetation removal • Excavation of a vertical shaft to the tunnels below. This may be carried out using excavators and rock hammers, however drill and blast or penetrating cone fracture techniques may also be used • Temporary lining and reinforcement of the shaft.
Stabling and maintenance facility	Civil works for the stabling and maintenance facility would involve: • Enabling works including protection or diversion of utilities and establishment of site access points • Demolition of structures on the site and clearance of vegetation (if present) • Import and placement of fill material. The stabling and maintenance facility would be designed and constructed to be protected from the one per cent Annual Exceedance Probability flood event. In some areas, this may also involve the construction of retaining walls • Structures for crossings of A'Becketts Creek and Duck Creek. A temporary pre-cast concrete segment construction production facility to support tunnelling would also be located at the Clyde stabling and maintenance facility construction site.
Dive structures and tunnel portals	A dive structure and tunnel portal would be constructed at Rosehill (within the Clyde stabling and maintenance construction site) to facilitate a surface connection to the Clyde stabling and maintenance facility. The construction of the dive structure and tunnel portal would generally involve: • Piling work along the walls of the dive structure • Excavation of existing material to below future track level • Placement of precast concrete for the cut-and-cover section and to form the tunnel portal. The dive structures would be designed and constructed to be protected from the probable maximum flood level.

27.5.3 Construction program

The total period for Stage 1 construction works would be around four years. An indicative construction program is shown in Figure 27-3.

The actual program and commencement of works at each construction site is subject to the final delivery strategy being confirmed.

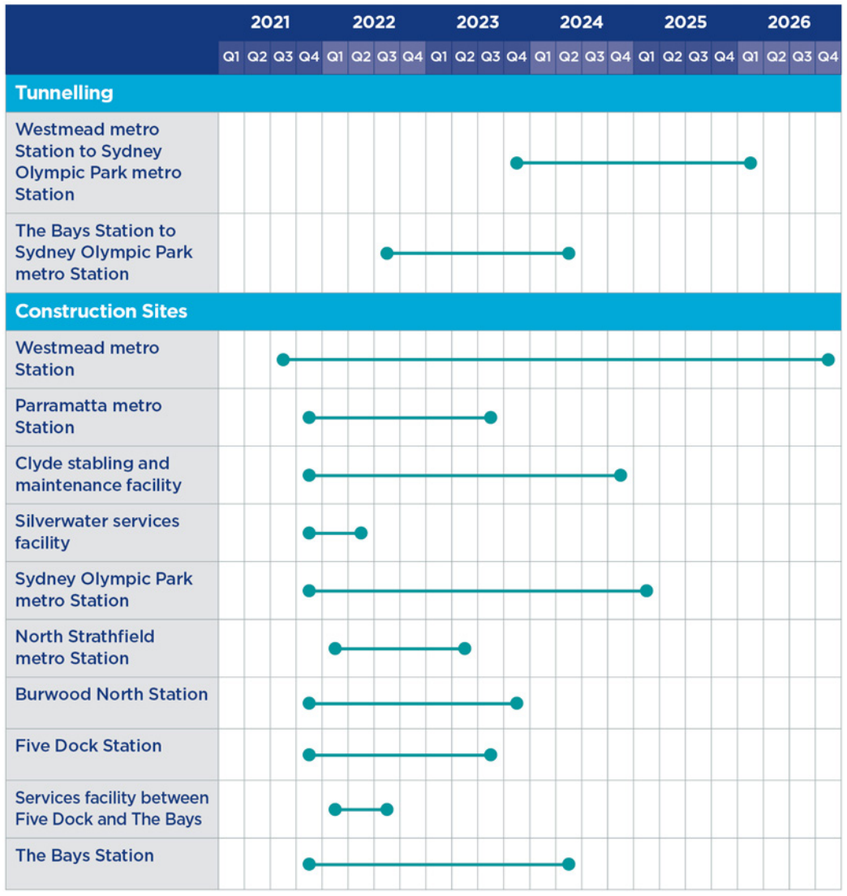

Figure 27-3: Indicative construction program

Note: This program only shows major civil works (Stage 1) indicative duration and not the total works.

27.6 Uncertainties and resolution

The design presented in this Environmental Impact Statement is conceptual and subject to further detailed design. The design as presented serves to:

- Confirm that the proposed performance and technical requirements can be achieved
- Validate the feasibility and methodology of the required construction
- Identify key risks/constraints and environmental assessment issues.

27.6.1 Concept

The following items will be resolved as part of ongoing design and assessments for future staged approvals:

- Future staging of construction of the Concept (i.e. beyond Stage 1)
- The preferred location of the metro station in the Sydney CBD
- The potential inclusion of strategic station options at Rydalmere and Pyrmont
- Station design, access, fit-out, finishes etc
- Placemaking and the integration of stations into the surrounding environment
- Tunnel and tunnel rail systems fit-out works
- Track form (and associated operational noise and vibration characteristics)
- Permanent adjustments/alterations to the transport network to facilitate transport interchange
- Long-term groundwater treatment
- Tunnel alignment (horizontal and vertical) between The Bays and the Sydney CBD
- The extent of residual land following construction of the Concept
- Provisions within the station design to allow for integrated station development.

27.6.2 Stage 1

Construction footprints for Stage 1 stations, services facilities and the stabling and maintenance facility have been developed taking into account expected future requirements for the stations, as well as considering the key construction requirements. This process is described further in Chapter 3 (Sydney Metro West development and alternatives). There is a high level of certainty regarding the location and extent of construction sites.

The construction methodology for Stage 1 has been developed to a level where environmental impacts can be appropriately identified. Aspects of the construction methodology that may be subject to further refinement (but which would be unlikely to substantially alter the predicted environmental impacts) include:

- Specific location of facilities within construction sites (including the design and siting of acoustic sheds or other acoustic measures)
- Alternative haulage routes, construction site access and/or traffic management arrangements at North Strathfield, Burwood North and Five Dock to provide improved traffic safety and reduce potential impacts in these locations
- Spoil transport by barge from The Bays Station construction site for reuse at the Clyde Stabling and maintenance facility construction site or to locations such as Port Kembla or Port of Newcastle for regional re-use opportunities
- Alternative approaches to the construction of the B-double route around the Clyde stabling and maintenance facility construction site, including potential use of an underpass instead of bridging structures to minimise flooding and visual impacts
- Sequence of construction activities
- Temporary road diversions
- Specific location of a services facility to be located between Five Dock and The Bays.

All aspects of the construction methodology would be confirmed during the detailed design and construction planning processes.

27.7 Summary of impacts that have not been avoided

27.7.1 Outline of strategies to avoid impacts

Many potential impacts have been avoided through the project development process which included input from key stakeholders and the community. In particular, locating Sydney Metro West almost completely underground would substantially reduce most major environmental impacts, including:

- Noise
- Traffic
- Property and land use
- Social impacts
- Biodiversity.

Residual environmental and social impacts have been minimised through the specific design and the construction methods chosen, as well as application of comprehensive mitigation and management measures that have been shown to be proven and effective on previous construction projects. Design development and refinements would continue to further minimise any residual impacts.

Despite this, it is not unexpected that a project of this scale and nature being constructed in a highly urbanised environment would still have potential residual impacts that are unavoidable.

This section provides a summary of these unavoidable impacts for Stage 1. The potential impacts identified for the Concept are still at a conceptual level and therefore the specific nature and extent of unavoidable impacts would be premature to identify at this stage. All impacts associated with the Concept, and not assessed in Stage 1, would be subject to further consideration and assessment.

27.7.2 Impacts that have not been avoided – Stage 1

Chapters 10 to 26 provide an assessment of the potential impacts of Stage 1. The key potential impacts requiring mitigation and management are summarised in Table 27-5.

Potential impacts would be mitigated by implementing comprehensive environmental management procedures and plans. These are described in Section 27.8.

Table 27-5: Summary of potential impacts – Stage 1

Issue	Potential impact
Transport and traffic	• Temporary increase in construction traffic on the local and regional road network, resulting in potentially temporary increased congestion and delays. Construction site traffic would be managed to minimise movements during peak periods and avoid school zones during pick up and drop off times • Potential temporary local traffic disruptions and short-term access restrictions and detours for road users. Directional signage and line marking would be used to direct and guide drivers and pedestrians past construction sites and on the surrounding network. This would be supplemented by variable message signs to advise drivers of potential delays, traffic diversions, speed restrictions, or alternate routes • Potential temporary decrease in road network performance resulting in delays and increased queue lengths at some intersections in Westmead, North Strathfield and Five Dock • Potential temporary access restrictions for pedestrians and cyclists within and surrounding the construction sites such as Horwood Place in Parramatta. Access to existing properties and buildings would be maintained in consultation with property owners • Potential temporary impacts to the public transport network, particularly in Westmead, North Strathfield and Burwood North, associated with the temporary relocation of bus stops and changes to bus routes resulting in minor impacts to commuters • Potential temporary pedestrian and cyclists safety impacts near construction site access and egress points where construction vehicles would interact with the public. Vehicle access to and from construction sites would be managed to maintain pedestrian, cyclist and motorist safety. Depending on the location, this may require manual supervision, physical barriers, temporary traffic signals and modifications to existing signals or, on occasions, police presence • Several on and off-street parking spaces would be temporarily unavailable to the general public for the duration of construction, with the main potential impacts at Westmead and Parramatta. The Parramatta metro station construction site would result in the loss of 850 on and off-street parking spaces particularly due to the demolition of the City Centre car park. The demolition of the City Centre multi-level car park is identified in the Draft Parramatta CBD Public Car Parking Strategy (City of Parramatta, 2017). The strategy identifies potential measures to offset this loss of car parking.
Noise and vibration	• Given the nature and duration of works and the close proximity of receivers, airborne noise during construction is expected to temporarily exceed noise management levels at all sites – and at some sites by possibly more than 20 dBA. Noise intensive works within the construction sites at night would generally only be completed inside acoustic sheds (or once other acoustic measures have been established). Regardless, 'moderate' worst-case temporary impacts are expected at some receivers • Potentially temporary highly noise affected receivers (subject to noise levels of 75 dBA or greater) at Westmead metro station, Clyde stabling and maintenance facility, North Strathfield metro station, Burwood North Station and Five Dock Station construction sites • Potentially temporary high sleep disturbance impacts at Westmead metro station and Five Dock Station construction sites. Moderate sleep disturbance impacts at Sydney Olympic Park metro station and Burwood North Station construction sites • Potential temporary ground-borne noise impacts at nearby receivers associated with tunnelling and excavation works at construction sites. Less ground-borne noise and vibration intensive alternative construction methodologies may be adopted where deemed feasible and reasonable • Potential temporary exceedances of vibration criteria including cosmetic damage screening criteria, and human comfort criteria at several buildings closest to construction sites. Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure and attended vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure • Potential minor construction and operational traffic noise impacts to receivers near Westmead metro station construction site particularly along Grand Avenue and Alexandra Avenue. Further assessment of construction traffic would be completed during detailed design and measures would be implemented to minimise temporary traffic noise impacts.
Non-Aboriginal heritage	• Potential moderate direct impact on one item considered to be of State heritage significance (State Abattoirs at Sydney Olympic Park). Sydney Metro is investigating the feasibility of design and construction options to avoid direct impacts to this heritage item. Archival recording would be carried out prior to the commencement of construction works that impact the item • Potential moderate indirect visual impacts on two items listed on the State Heritage Register (Roxy Theatre at Parramatta and White Bay Power Station at The Bays) and one item considered to be of State heritage significance (State Abattoirs at Sydney Olympic Park). The policies of the White Bay Power Station Conservation Management Plan would be considered in regard to visual impacts of the Stage 1 works • Potential moderate indirect visual impacts on four items of local heritage significance. Archival recording would be carried out prior to the commencement of construction works • Potential direct impact on potential archaeological resources at Parramatta and The Bays. An archaeological research design(s) would be prepared and implemented to identify the need for archaeological testing or monitoring. Mitigation measures would be recommended in accordance with Heritage Council guidelines.
Aboriginal heritage	• Potential disturbance of a potential Aboriginal archaeological deposit of moderate to high significance and moderate to high potential for intact archaeological deposits, located within the Parramatta metro station construction site. This includes a site recorded on the AHIMS register as 45-6-3582. Archaeological test excavation (and salvage when required) would be carried out where intact natural profiles with the potential to contain significant archaeological deposits are encountered • Potential disturbance of Aboriginal archaeological deposit of moderate significance and low to moderate potential for intact archaeological deposits, located within the Parramatta metro station, Clyde Stabling and maintenance facility and The Bays Station construction sites.
Property and land use	• Acquisition of private land and publicly owned land for construction sites. The construction sites are located where permanent operational infrastructure would also be required, to minimise property impacts and residual land holdings at the completion of construction. All acquisitions would be carried out in consultation with landowners and in accordance with the requirements of the *Land Acquisition (Just Terms Compensation) Act 1991*. Sydney Metro has appointed Personal Managers to offer residents and small businesses assistance and support throughout the acquisition process • During construction, the use of land within the Stage 1 footprint would change from its existing use to use as a construction site. Except where required for subsequent construction activities associated with future stages of the Concept, temporary use areas for construction purposes would be stabilised and appropriately rehabilitated.
Landscape character and visual amenity	• Potential temporary visual impacts as a result of the introduction of new elements including acoustic sheds or other acoustic measures, machinery and equipment, site hoardings, partially complete structures, and other construction works. All structures (including acoustic sheds or other acoustic measures, site offices and workshop sheds) would be finished in a colour which aims to minimise their visual impact, if visible from areas external to the construction site • Removal of a portion of the Abattoir Heritage Precinct gardens which is considered a regionally sensitive landscape. Sydney Metro is investigating the feasibility of design and construction options to avoid direct impacts to this heritage item • Loss of mature street trees and vegetation providing screening and amenity and opening up views towards the construction sites such as at the Clyde stabling and maintenance facility construction site. Opportunities for the retention and protection of existing street trees and trees within the site would be identified during detailed construction planning.

Issue	Potential impact
Business impacts	• Broad economic benefits by way of job generation • Benefits to businesses from increased demand from construction workers requiring food and beverage services and other goods • Potential temporary reduction in passing trade for vehicular and pedestrian traffic due to detours and road and footpath closures or hoarding potentially restricting visibility of businesses that are reliant on passing trade (e.g. cafes). Clear pathways and signage would be implemented around construction sites to maximise visibility of retained businesses, including sufficient lighting along pedestrian footpaths during night-time where relevant • Potential temporary impacts on servicing and delivery access due to road closures and detours • Temporary changes to the road network, including temporary parking loss has the potential to affect deliveries and convenience for business employees and customers.
Social impacts	• Potential loss of and temporary disruption to existing social infrastructure, including open space, with associated impacts on community interactions and connectedness • The community's enjoyment of certain community facilities may potentially be temporarily reduced where they are located close to construction sites • Potential temporary changes to community character, such as changes to streetscape, access, businesses, increased numbers of workers and visitors in the area due to construction activity, resulting in changes to connections to the surrounding area • Potential temporary changes to sense of place due to impacts of construction, such as impacts to heritage items, loss of established businesses, changes to streetscape and urban fabric, resulting in potential loss of community connections to the surrounding area.
Groundwater and ground movement	• Potential minor impacts associated with localised ground movement and/or settlement due to excavation or groundwater drawdown causing damage to infrastructure. Condition surveys of buildings and structures in the vicinity of the tunnel and excavations would be carried out prior to the commencement of excavation at each site • Minor potential impacts on two registered groundwater users, one near Westmead metro station construction site and one near Burwood North Station construction site. Further investigations would be carried out and make good provision implemented as required • Potential migration of contaminated groundwater towards, and into, station excavations, posing a potential exposure risk to site users/workers, and potentially reducing the beneficial use of the aquifer. Monitoring would occur of groundwater levels and quality of the site area before, during and after construction for potential contaminants of concern. Water level data would be regularly reviewed by a qualified hydrogeologist • Groundwater collected within site excavations and within the tunnels during construction would be discharged to the local stormwater system at each construction site. Temporary water treatment plants would treat collected groundwater so that the discharged water quality meets the requirements of any relevant environment protection licence for Stage 1 or the requirements of the *Protection of the Environment Operations Act 1997*.
Hydrology and flooding	• Potential for inundation of construction areas during flood events particularly in areas where flooding currently occurs (such as high flood risk areas in Parramatta metro station, Clyde stabling and maintenance facility and The Bays Station construction sites). Detailed construction planning would consider flood risk at construction sites • Minor potential flooding impacts associated with the interruption of overland flow paths by installation of temporary construction site infrastructure (i.e. noise barriers, acoustic sheds (or other acoustic measures), retaining walls) and/or modifications to landforms (i.e. placement of fill materials, stockpiles). Key areas of potential flooding risk include the Parramatta metro station, Clyde stabling and maintenance facility, Silverwater services facility and The Bays Station construction sites • Minor potential increases in peak flooding levels, increases in the extent of floods and an increase in flood hazard during flooding events at Clyde stabling and maintenance facility. These potential increases are within acceptable limits. On-site stormwater detention would be provided for the Clyde stabling and maintenance facility construction site • Potential increases in flow velocity and scour potential may result where Stage 1 construction works alter flood flow patterns and significantly divert or concentrate flood flows. Flow velocities are expected to increase at the Clyde stabling and maintenance facility due to the proposed culvert crossings of A'Becketts Creek and Duck Creek and formalisation of sections of these creek channels. Further design refinement at the Clyde stabling and maintenance facility construction site would occur during detailed design to mitigate the identified potential impacts.
Biodiversity	• Direct removal of 0.18 hectares of native vegetation including 0.15 ha of Mangrove forest at Clyde, which would be offset in accordance with the *Biodiversity Conservation Act 2016* • Potential impacts to the habitat of seven threatened fauna species however these impacts are unlikely to detrimentally effect these species on a whole • Impacts to the vegetation riparian zones of Duck Creek and A'Becketts Creek that may limit the movement of threatened fauna species in that area.
Air quality	• Some unavoidable risks of temporary nuisance impacts from dust are expected at some locations. Best-practice dust management measures would be implemented during all construction works and additional measures would be implemented if required subject to outcomes of monitoring.
Spoil and waste management	• Moderate potential residual impacts would include generation of unusable spoil during tunnelling due to contamination or acid sulfate soils. All waste would be assessed, classified, managed, transported and disposed of in accordance with the Waste Classification Guidelines and the Protection of the Environment Operations (Waste) Regulation 2014.

Hazards	• Potential temporary impacts associated with the storage, use and transport of dangerous goods and hazardous substances. The method for delivery of explosives would be developed prior to the commencement of blasting (if proposed) in consultation with the Department of Planning, Industry and Environment and be timed to avoid the need for on-site storage
	• Potential risk of impacts to utilities (both above ground and underground) including:
	  • High voltage power lines located throughout the Stage 1 footprint
	  • High pressure gas mains near the Clyde stabling and maintenance facility construction site
	  • Gas distribution lines near all construction sites.
	Ongoing consultation would be carried out with utility providers for high pressure gas or petroleum pipelines to identify appropriate construction methodologies to be implemented.

27.7.3 Cumulative impacts

Potential temporary cumulative impacts during construction have been an important consideration given the potential overlap with a number of large infrastructure projects. Potential temporary cumulative impacts have been identified at the following locations:

- Westmead metro station construction site – potential concurrent construction of Parramatta Light Rail – Stage 1 (although the period of concurrent construction is anticipated to be minimal), major commercial and retail developments and future projects associated with strategic plans
- Parramatta metro station construction site – potential concurrent construction of Parramatta Light Rail – Stage 1 (although the period of concurrent construction is anticipated to be minimal), major commercial and retail developments and future projects associated with strategic plans
- Sydney Olympic Park metro station construction site – potential concurrent construction of the planned Parramatta Light Rail – Stage 2, major commercial and retail developments and future projects associated with strategic plans
- The Bays Station construction site – potential concurrent construction with WestConnex M4-M5 Link (although the period of concurrent construction is anticipated to be minimal), Western Harbour Tunnel and Warringah Freeway Upgrade, Sydney Metro City & Southwest (Chatswood to Sydenham).

Key potential construction stage cumulative issues are generally expected to be relatively minor and would include:

- Temporary local traffic impacts and accessibility
- Temporary noise and vibration (particularly night time works)
- Temporary visual impact and amenity effects of construction compounds and associated sites and activities
- Spoil disposal and disposal routes.

These impacts would be managed in accordance with the measures as outlined in Chapter 10 (Transport and traffic - Stage 1), Chapter 11 (Noise and vibration - Stage 1), Chapter 15 (Landscape character and visual amenity - Stage 1) and Chapter 24 (Spoil, waste management and resource use - Stage 1) respectively.

In addition, construction fatigue can potentially occur where nearby residents experience or have experienced extended periods of construction from concurrent or consecutive construction projects. This often includes where project construction activities overlap with other projects, or where there is little or no break between the activities of multiple adjacent projects. Coordination and engagement with other projects has been undertaken and would continue through construction to further manage fatigue impacts where possible.

Further opportunities to more effectively manage construction fatigue would also be considered during the design and construction. Any potential residual cumulative adverse impacts would be more than offset by the many and significant benefits of the Sydney Metro West.

As discussed in Chapter 5 (Stakeholder and community engagement), ongoing community consultation and stakeholder engagement would also be carried out so that potential cumulative impacts are better understood and reduced where possible.

A detailed assessment of cumulative impacts is provided for the Concept in Chapter 8 (Concept assessment) and for Stage 1 in Chapters 15 to 23.

27.8 Proposed measures to avoid or minimise impacts

At this stage measures to avoid or minimise impacts have been developed only for Stage 1 – which involves construction only. Measures applicable to the Concept including operation stage mitigation measures would be developed when planning approval applications are made for future stages.

27.8.1 Overall approach to environmental management

The overall approach to environmental management during construction is shown in Figure 27-4. This involves:

- Project design – measures incorporated in the design and construction planning to avoid and minimise impacts. Further information is provided in Chapter 8 (Concept environmental assessment) and Chapter 9 (Stage 1 description)
- Mitigation measures – identified as an outcome of the environmental impact assessment detailed in Chapters 10 to 27 and consolidated in Table 27-6
- Construction Environmental Management Framework – details the approach to environmental management and monitoring during construction. Further details are provided below
- Construction Noise and Vibration Standard – defines how construction noise and vibration will be managed for Sydney Metro West as a whole. Further details are provided below
- Construction Traffic Management Framework – provides the overall strategy and approach for construction traffic management for Sydney Metro West
- Design quality framework – being prepared in consultation with the Government Architect NSW to provide a high level process of how Sydney Metro ensures design quality throughout the project lifecycle, regardless of how the project is procured and delivered
- Environmental performance outcomes – future construction planning would be considered against the environmental performance outcomes provided in Section 27.9.

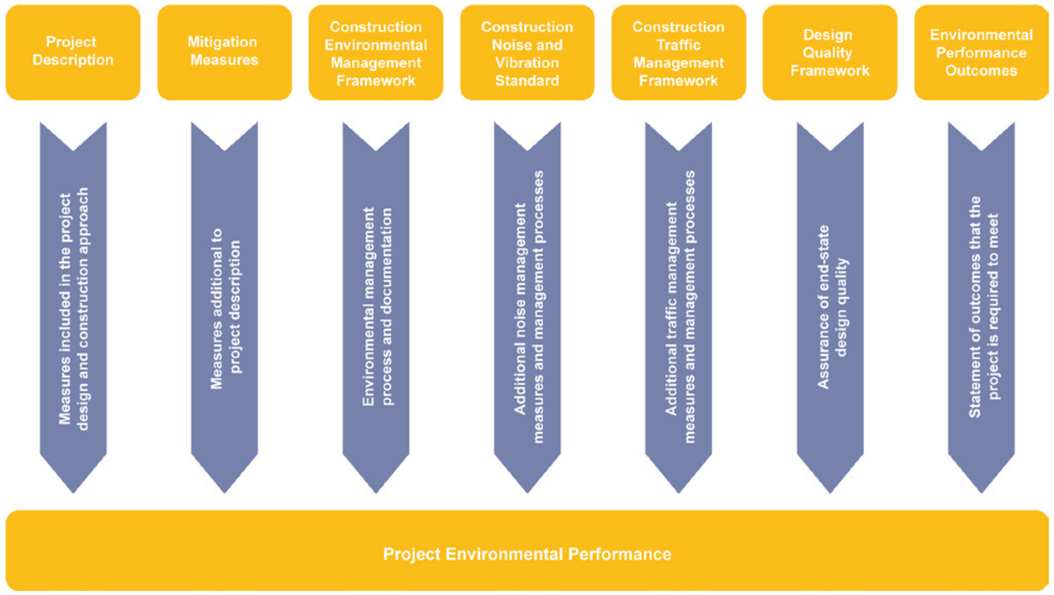

Figure 27-4 Approach to environmental mitigation and management

Construction Environmental Management Framework

The Sydney Metro Construction Environmental Management Framework (Appendix D) details the approach to environmental management and monitoring during construction. The framework is a linking document between planning approval documentation and construction environmental management documentation, which would be developed by the construction contractors.

The Construction Environmental Management Framework details the environmental, stakeholder and community management systems and processes for the construction of the project. Specifically, it details the requirements in relation to the Construction Environmental Management Plan, sub-plans and other supporting documentation for each specific environmental aspect.

Construction Noise and Vibration Standard

The Sydney Metro Construction Noise and Vibration Standard (Appendix E) defines how construction noise and vibration would be managed for Sydney Metro West as a whole. The Construction Noise and Vibration Standard provides guidance for managing construction noise and vibration impacts to provide a consistent approach to management and mitigation across all Sydney Metro projects.

The Construction Noise and Vibration Standard identifies the requirements and methodology to develop construction noise and vibration impact statements. These would be prepared prior to specific construction activities, based on a more detailed understanding of construction methods, including the size and type of construction equipment.

The Construction Noise and Vibration Standard also identifies standard mitigation measures that would be adopted during construction, and the framework and thresholds for the implementation of any additional mitigation measures during periods of noisy works.

Construction Traffic Management Framework

The Construction Traffic Management Framework provides the overall strategy and approach for construction traffic management for Sydney Metro West, and an outline of the traffic management requirements and processes that would be common to each of the proposed construction sites. It establishes the traffic management processes and acceptable criteria to be considered and followed in managing roads and footpaths adjacent to construction sites.

27.8.2 Environmental management measures

Table 27-6 provides a compilation of the measures to avoid, mitigate and/or manage the potential impacts of Stage 1 as identified in Chapters 10 to 26. The measures described in the chapters and compiled in this table were developed to take into account the findings of all the assessments carried out for the Environmental Impact Statement.

The mitigation measures compiled in Table 27-6, together with the approach to environmental management described in Section 27.8.1, provide Sydney Metro's commitments for Sydney Metro West. The mitigation measures may be revised in response to submissions raised during public exhibition and/or any design changes made following exhibition. A revised list of mitigation measures would be provided in the submissions/preferred infrastructure report. If Stage 1 is approved, the conditions of approval, which would include references to the final mitigation measures, would guide subsequent stages of Sydney Metro West. Stage 1 would be carried out in accordance with the conditions of approval and the revised list of mitigation measures.

Table 27-6: Environmental management measures – Stage 1

Reference	Impact/issue	Mitigation measure	Application location(s)[1]
Traffic and transport			
TT1	Changes to the network	The community would be notified in advance of proposed road and pedestrian network changes through appropriate forms of community liaison.	All
TT2	Traffic incidents	In the event of a traffic related incident, coordination would be carried out with Transport for NSW, including Transport Coordination and/or the Transport Management Centre's Operations Manager.	All
TT3	Emergency vehicles access	Access to properties for emergency vehicles would be provided at all times.	All
TT4	Road safety	Vehicle access to and from construction sites would be managed to maintain pedestrian, cyclist and motorist safety. Depending on the location, this may require manual supervision, physical barriers, temporary traffic signals and modifications to existing signals or, on occasions, police presence.	All
TT5	Road safety	Additional enhancements for pedestrian, cyclist and motorist safety near the construction sites would be implemented during construction. This would include measures such as: • Assessing the suitability of construction haulage routes through sensitive land use areas with respect to road safety • Deployment of speed awareness signs in conjunction with variable message signs near construction sites to provide alerts to drivers • Providing community education and awareness about sharing the road safely with heavy vehicles • Specific construction driver training to understand route constraints, safety and environmental considerations such as sharing the road safely with other road users and limiting the use of compression braking • Requiring technology and equipment to improve vehicle safety, eliminate heavy vehicle blind spots, and monitor vehicle location and driver behaviour.	All
TT6	Road safety	All trucks would enter and exit construction sites in a forward direction, where feasible and reasonable.	All
TT7	Congestion	Construction site traffic would be managed to minimise movements during peak periods.	All
TT8	Congestion	Construction site traffic immediately around construction sites would be managed to minimise vehicle movements through school zones during pick up and drop off times.	WMS, PMS, BNS, FDS
TT9	Congestion	Opportunities to minimise impacts at the Alexandra Avenue/Bridge Road intersection would be determined in consultation with Transport for NSW.	WMS
TT10	Loss of parking	Where existing parking is removed to facilitate construction activities, consultation would occur with the relevant local council to investigate opportunities to provide alternative parking facilities.	All
TT11	Loss of parking	Construction sites would be managed to minimise the number of construction workers parking on surrounding streets by: • Encouraging workers to use public or active transport • Encouraging ride sharing • Provision of alternative parking locations and shuttle bus transfers where feasible and reasonable.	All
TT12	Change of bus stop locations	Any relocation of bus stops and kiss-and-ride facilities would be carried out in consultation with Transport for NSW including Transport Coordination (for relevant locations), the relevant local council and bus operators. Wayfinding and customer information would be provided to notify customers of relocated bus stops.	WMS, NSMS, BNS
TT13	Bus priority	Opportunities to improve bus priority along the temporary detour at Westmead metro station construction site would be investigated during detailed design.	WMS
TT14	Active transport	Pedestrian and cyclist access would be maintained during the temporary closure of Alexandra Avenue. Wayfinding and customer information would be provided to guide pedestrians and cyclists to alternative routes.	WMS
TT15	Impacts on active transport	Where existing cyclist facilities (e.g. bicycle parking) would be temporarily unavailable to facilitate construction activities, suitable replacement facilities would be provided for this duration.	WMS, PMS
TT16	Taxi relocation	Any relocation of taxi ranks would be carried out in consultation with Transport for NSW, the relevant local council and taxi operators. Wayfinding and customer information would be provided to notify customers of relocated taxi ranks.	SOPMS

Reference	Impact/issue	Mitigation measure	Application location(s)[1]
TT17	Impacts on special events	During major special events, impacts to the transport and traffic network would be reduced by (as necessary): • Minimising the level of construction activity, and if necessary, ceasing all construction activity • Maintaining appropriate access to all areas within the event precinct • Erection of hoardings, site fencing and gates at key locations within the construction site boundary to permit pedestrian movements adjacent to the construction site and separate pedestrians from construction vehicles • Scheduling deliveries to the construction site outside of event periods. For special events that require specific traffic measures, those measures would be developed in consultation with Transport for NSW, including Transport Coordination (for relevant locations) and the organisers of the event.	PMS, CSMF, SOPMS
TT18	Property access	Access to existing properties and buildings would be maintained in consultation with property owners.	All
TT19	Construction vehicle impacts	Traffic control measures required at the Parramatta metro station construction site access on George Street would be determined in consultation with Transport for NSW.	PMS
TT20	Construction vehicle impacts	Adjustments to site access arrangements and the local road network would be explored during detailed design to minimise conflicts with heavy vehicle movements.	NSMS, FDS
TT21	Construction vehicle impacts	Construction site traffic generated at the Five Dock Station construction site would be managed to avoid or minimise travel during the evening peak period.	FDS
TT22	Construction vehicle impacts	Construction site traffic generated at the Five Dock Station construction site would be managed to minimise movements during church service times at St Albans Anglican Church.	FDS
TT23	Construction vehicle impacts	Opportunities to provide vehicle access and egress directly to Parramatta Road and minimise the use of Loftus Street at the Burwood North Station construction site would be explored during detailed design.	BNS
TT24	Cumulative construction traffic impacts	Co-ordination of traffic management arrangements between major construction projects would occur in consultation with Transport for NSW including Transport Coordination.	TBS
Noise and vibration			
NV01	Community preference for noise mitigation and management	Further engagement and consultation would be carried out with: • The affected communities to understand their preferences for mitigation and management measures. • 'Other sensitive' receivers such as schools, medical facilities or places of worship to understand periods in which they are more sensitive to impacts. Based on this consultation, appropriate mitigation and management options would be considered and implemented where feasible and reasonable to minimise the impacts.	All
NV02	Alternative construction methodologies	Alternative construction methodologies and measures that minimise noise and vibration levels during noise intensive works would be investigated and implemented where feasible and reasonable. This would include consideration of: • The use of hydraulic concrete shears in lieu of hammers/rock breakers • Sequencing works to shield noise sensitive receivers by retaining building wall elements • Locating demolition load out areas away from the nearby noise sensitive receivers • Providing respite periods for noise intensive works • Minimising structural-borne noise to adjacent buildings including separating the structural connection prior to demolition through saw-cutting and propping, using hand held splitters and pulverisers or hand demolition • Installing sound barrier screening to scaffolding facing noise sensitive neighbours • Using portable noise barriers around particularly noisy equipment, such as concrete saws • Modifying demolition works sequencing / hours to minimise impacts during peak pedestrian times and / or adjoining neighbour outdoor activity periods.	All
NV03	Construction noise – respite periods	Appropriate respite would be provided to affected receivers in accordance with the Sydney Metro Construction Noise and Vibration Standard. This would include consideration of impacts from Stage 1 utility and power supply works when determining appropriate respite periods for affected receivers. When determining appropriate respite, the need to efficiently undertake construction would be balanced against the communities' preferred noise and vibration management approach.	All
NV04	Construction noise – out of hours work	The use of noise intensive equipment at construction sites with 'moderate' and 'high' out-of-hours noise management level exceedances would be scheduled for standard construction hours, where feasible and reasonable. Where this is not feasible and reasonable, the works would be undertaken as early as possible in each work shift.	All
NV05	Night-time noise impacts	Air brake silencers would be used on heavy vehicles that access construction sites multiple times per night or over multiple nights.	All
NV06	Sleep disturbance impacts from heavy vehicles	Perimeter site hoarding would be designed with consideration of on-site heavy vehicle movements with the aim of minimising sleep disturbance impacts.	All
NV07	Noise emissions from equipment	Long term construction site support equipment and machinery would be low noise emitting and suitable for use in residential areas, where feasible and reasonable. Examples include: • Low noise water pumps for use in water treatment facilities • Low noise generators and compressors • Low noise air conditioner units for use of amenities buildings.	All

Reference	Impact/issue	Mitigation measure	Application location(s)[1]
NV08	Acoustic sheds	For all sites where acoustic sheds are proposed, the sheds would be designed and constructed to minimise noise emissions. This would likely include the following considerations: • All significant noise producing equipment that would be used during the night-time would be inside the shed, where feasible and reasonable • Noise generating ventilation systems such as compressors, scrubbers, etc, would also be inside the shed and external air intake/discharge ports would be appropriately acoustically treated • The door of the acoustic shed would be kept closed during the night-time period, where feasible and reasonable. Where night-time vehicle access is required, the doors would be designed and constructed to minimise noise breakout.	WMS, SOPMS, BNS, FDS, TBS
NV09	Ground-borne noise	Feasible and reasonable measures would be implemented to minimise ground-borne noise where exceedances are predicted. This may require implementation of less ground-borne noise and less vibration intensive alternative construction methodologies.	All
NV10	Ground-borne noise – cross passages	The proximity of cross passages to nearby receivers and the corresponding construction ground-borne noise and vibration impacts during the excavation works would be considered when determining locations. Relocation of cross passages to be further away from sensitive receivers to mitigate potential construction impacts would be considered, where feasible and reasonable.	Metro rail tunnels
NV11	Ground-borne noise – underground rockbreaking	An activity specific Construction Noise and Vibration Impact Statement (in accordance with the requirements of the Construction Noise and Vibration Standard) would be developed for rockbreaking in the tunnel and at cross passages, specifically addressing the activity where it is required between 10pm-7am.	Metro rail tunnels
NV12	Blasting Management Strategies	Blasting would be planned during hours that would cause the least disruption and disturbance to the nearest receivers. Notification protocols prior to blasting for the nearest sensitive receivers would be established.	WMS, PMS, SSF, SOPMS, NSMS, BMS, FDS, TBS
NV13	Blasting Monitoring	Attended vibration and overpressure measurements would be completed at the start of any blasting activities to confirm that vibration levels are within the blasting criteria.	WMS, PMS, SSF, SOPMS, NSMS, BMS, FDS, TBS
NV14	Construction traffic noise	Further assessment of construction traffic would be completed during detailed design, including consideration of the potential for exceedances of the NSW Road Noise Policy base criteria (where greater than 2 dB increases are predicted). The potential impacts would be managed using the following approaches, where feasible and reasonable: • On-site spoil storage capacity would be maximised to reduce the need for truck movements during sensitive times • Vehicle movements would be redirected away from sensitive receiver areas and scheduled during less sensitive times • The speed of vehicles would be limited and the use of engine compression brakes would be avoided • Heavy vehicles would not be permitted to idle near sensitive receivers.	All
NV15	Noise impacts to horses at Rosehill Racecourse Stables	Consultation with the owners and operators of the horse stables near the Clyde stabling and maintenance facility construction site would be carried out so that potential impacts to horses are appropriately managed.	CSMF
NV16	Construction vibration	Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure (in consultation with a structural engineer) and attended vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure. For heritage items, the more detailed assessment would specifically consider the heritage values of the structure in consultation with a heritage specialist to ensure sensitive heritage fabric is adequately monitored and managed.	All
NV17	Building condition surveys – construction vibration	Condition surveys of buildings and structures near to the tunnel and excavations would be undertaken prior to the commencement of excavation at each site, where appropriate. For heritage buildings and structures the surveys would consider the heritage values of the structure in consultation with a heritage specialist.	All
NV18	Cumulative construction noise impacts	The likelihood of cumulative construction noise impacts would be reviewed during detailed design when detailed construction schedules are available. Co-ordination would occur between potentially interacting projects to minimise concurrent or consecutive works in the same areas, where possible. Specific mitigation strategies would be developed to manage impacts. Depending on the nature of the impact, this could involve adjustments to construction program or activities of Sydney Metro West or of other construction projects.	All
NV19	Operational road traffic noise impacts	Further assessment of operational road traffic noise mitigation would be undertaken for receivers identified as being eligible for consideration of treatment. The mitigation would likely include at-property treatment. Receivers that are identified as requiring at-receiver noise mitigation would be identified and, where possible, offered treatment prior to the start of construction works which have the potential to affect them.	WMS
Non-Aboriginal heritage			
NAH1	Archival recording	Archival recording and reporting of the following heritage items would be carried out in accordance with the NSW Heritage Office's How to Prepare Archival Records of Heritage Items (1998), and Photographic Recording of Heritage Items Using Film or Digital Capture (2006): • Shops (and potential archaeological site)(Parramatta LEP Item No. I703) • Kia Ora (and potential archaeological site) (Parramatta LEP Item No. I716) • RTA Depot (Parramatta LEP Item No. I576) • State Abattoirs (SEPP Listing No. A) • White Bay Power Station (SHR Listing No. 01015)	PMS, CSMF, SOPMS, TBS
NAH2	Demolition	A method for the demolition of existing buildings and/or structures at specified construction sites would be developed to minimise direct and indirect impacts to adjacent and/or adjoining heritage items.	PMS, CSMF, SOPMS, TBS

Reference	Impact/issue	Mitigation measure	Application location(s)[1]
NAH3	Salvage	Prior to commencement of demolition of heritage elements at White Bay Power Station within The Bays construction site, significant heritage fabric would be identified for salvage and reuse opportunities for salvaged fabric considered.	TBS
NAH4	Visual impacts	The policies of the White Bay Power Station Conservation Management Plan would be considered in regard to visual impacts of the Stage 1 works, particularly the acoustic shed (or other acoustic measures) and any temporary structures. Significant view lines would be retained during Stage 1 works.	TBS
NAH5	Heritage interpretation	Where heritage items, including significant archaeology are impacted by Stage 1 works, consideration would be given to their inclusion in the Heritage Interpretation Plan for future stages.	All
NAH6	Archaeology	An archaeological research design(s) would be prepared and implemented identifying archaeological testing or monitoring requirements, which would be carried out in accordance with Heritage Council guidelines, and where appropriate supervised by a suitably qualified Excavation Director with experience in managing State significant archaeology.	All
NAH7	Archaeology	An Archaeological Excavation Report would be prepared by the Excavation Director and be provided to the NSW Heritage Division within two years of the completion of archaeological excavations specified in the archaeological research design(s).	All
NAH8	Archaeology	In the event that State significant archaeology associated with early convict occupation is located at Parramatta metro station: • In situ conservation would be considered. If in situ conservation is not feasible and reasonable, a strategy to mitigate impacts would be prepared in consultation with the NSW Heritage Council (or delegate) • An Archaeological Method Statement would be prepared in consultation with the NSW Heritage Council (or delegate) for management of the archaeological remains, whether for conservation or archaeological investigation and recording • An accessible publication would be prepared within two years of archaeological excavations to document the archaeological investigations • Sydney Metro would provide for the meaningful curation, display and public access of any artefacts collected. This may involve partnerships with museums, local heritage centres and/or universities.	PMS
NAH9	Direct heritage impacts	The impacted gardens within the State Abattoirs would be reinstated with sympathetic landscaping that is in keeping with the provisions of the Conservation Management plan	SOPMS
Aboriginal heritage			
AH1	Consultation	Aboriginal stakeholder consultation would be carried out in accordance with the NSW Department of Planning, Industry and Environment's (Environment, Energy and Science Group), Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010.	All
AH2	Test excavation	Archaeological test excavation (and salvage when required) would be carried out where intact natural profiles with the potential to contain significant archaeological deposits are encountered at the specified construction sites and the Parramatta power supply route. Excavations would be conducted in accordance with the methodology outlined in the Aboriginal cultural heritage assessment report.	PMS, CSMF, TBS and PSR
AH3	Aboriginal heritage interpretation	If Aboriginal archaeological remains are recovered during Stage 1, results would be incorporated into Aboriginal heritage interpretation for the Concept in consultation with registered Aboriginal parties.	All
AH4	Unexpected finds	In the event that a potential burial site or potential human skeletal material is exposed during construction, the Sydney Metro Exhumation Management Plan would be implemented.	All
Property and land use			
LU1	Temporary use	Except where required for subsequent construction activities associated with future stages of the Concept, temporary use areas for construction purposes would be stabilised and appropriately rehabilitated as soon as feasible and reasonable following completion of construction. This would be carried out in consultation with the relevant landowner.	All
Landscape character and visual amenity			
LV1	Visual impacts	Where feasible and reasonable, the elements within construction sites would be located to minimise visual impacts (for example storing materials and machinery behind fencing).	All
LV2	Visual impacts	The design and maintenance of construction site hoardings would aim to minimise visual amenity and landscape character impact.	All
LV3	Visual impacts	Graffiti would be removed promptly from hoardings and any other aspects of construction sites.	All
LV4	Visual impacts	All structures (including acoustic sheds or other acoustic measures, site offices and workshop sheds) would be finished in a colour which aims to minimise their visual impact, if visible from areas external to the construction site. This finish is to be applied to all visible fixtures and fittings (including exposed downpipes).	WMS, PMS, SOPMS, SNMS, BNS, FDS
LV5	Lighting impacts	Lighting of construction sites would be orientated to minimise glare and light spill impacts on adjacent receivers.	All
LV6	Public art	Public art would be adopted on temporary hoarding, particularly around future station precincts. Implementation would be as soon as feasible and reasonable after the commencement of construction, and any public art would remain for the duration of the construction period.	All
LV7	Visual impacts affecting events	Works would be coordinated with the Department of Planning, Industry and Environment to manage the potential impact of construction on sporting events in other areas of Sydney Olympic Park.	SOPMS
LV8	Visual impacts affecting events	Works would be coordinated with City of Canada Bay Council to manage the potential impact of construction on sporting events at Concord Oval.	BNS
LV9	Overshadowing	Where feasible and reasonable the location and height of the acoustic shed at the Five Dock Station (if required) would be designed to minimise overshadowing of Fred Kelly Place between 10am and 3pm in mid-winter.	FDS

Reference	Impact/issue	Mitigation measure	Application location(s)[1]
LV10	Activation of streetscapes	Opportunities to provide temporary activation in the vicinity of the Five Dock Station western construction site during construction would be explored in consultation with the City of Canada Bay Council.	FDS
LV11	Trees	Opportunities for the retention and protection of existing street trees and trees within the site would be identified during detailed construction planning.	All
LV12	Trees	Existing trees to be retained would be protected prior to the commencement of construction in accordance with Australian Standard AS4970 the Australian Standard for Protection of Trees on Development Sites and Adjoining Properties.	All
LV13	Trees	Trees removed by Stage 1 would be replaced to achieve no net loss to tree numbers and/or canopy in proximity to the site as a minimum in the long term (and part of future stages of Metro West).	All
LV14	Trees	Opportunities would be investigated with the relevant local council to provide plantings in proximity to the impacted areas prior to construction commencing where feasible and reasonable.	All
Business impacts			
BI1	General business impacts	Small business owner engagement would be undertaken to assist small business owners adversely impacted by construction.	All
BI2	Power and utility interruptions	Planned power and utility interruptions would be scheduled to before or after typical business hours where feasible and reasonable. Prior notice would be provided to all affected business owners of the interruptions.	All
BI3	Business visibility and accessibility	Hoarding and screening impacting the visibility of business would be minimised where feasible and reasonable, without compromising public safety or the effective management of construction airborne noise. Clear pathways and signage would be implemented around construction sites to maximise visibility of retained businesses, including sufficient lighting along pedestrian footpaths during night-time where relevant.	All
Social impacts			
S1	Impacts on social infrastructure	Consultation would be carried out with managers of social infrastructure located near construction sites about the timing and duration of construction works and management of potential impacts, with the aim of minimising potential disruptions to the use of the social infrastructure from construction activity.	WMS, PMS, CSMF, SSF, SOPMS, NSMS, BNS, FDS, TBS
S2	Loss of social infrastructure	Engagement would be carried out with Parramatta City Council to identify alternative locations for the Parramatta Artist Studios to provide opportunities for facilitating local creative and cultural activities.	PMS
S3	Social impacts	A Community Benefit Plan would be developed to guide the development of community benefit initiatives (by Principal Contractors) during construction of Stage 1 to make a positive contribution to the potentially affected community. The key objectives of the plan would include: • Identify opportunities to create environmental and community benefits and provide positive social outcomes • Respond to community priorities and needs in the locality of each relevant construction site.	WMS, PMS, SOPMS, NSMS, BNS, FDS, TBS
S4	Impacts on events or festivals	In addition to mitigation measure TT17, consultation would be carried out with festival and event organisers in proximity to construction sites to mitigate potential impacts on the operation of the festival or event.	PMS, FDS
S5	Promote local cultural and identity	In addition to mitigation measure LV16, consultation would be carried out with stakeholders to identify opportunities for public art to reflect community values, culture and identity of the local community.	WMS, PMS, SOPMS, NSMS, BNS, FDS
S6	Activiation of streetscapes	In addition to mitigation measure LV10, potential temporary activation in the vicinity of the Five Dock Station western construction site would include opportunities to provide spaces and places for the community to gather and meet each other, culture and identity.	FDS
Groundwater and ground movement			
GW1	Loss of groundwater available to existing groundwater (bore supply) users	Site inspection would be carried out on private domestic supply bore GW305646 to confirm the current viability of that bore. If found to be viable, the bore would be monitored throughout construction. Make good measures would be implemented if a loss of yield were to occur.	BNS
GW2	Potential reduced baseflow to Toongabbie Creek, Domain Creek, A'Becketts Creek, Duck Creek, Haslams Creek, Powells Creek and the Mason Park wetlands, Bicentennial Park wetlands, Brickpit and Powells Creek Reserve	A review of additional geotechnical and hydrogeology data would be undertaken to confirm the geological and groundwater conditions and determine, based on these local conditions, whether predicted groundwater drawdown from Stage 1 is likely to occur in the vicinity of these creeks. Where the additional data review shows local conditions and predicted groundwater drawdown are likely to cause surface water/groundwater interaction, then additional site investigations (in accordance with GW3) would be undertaken for those creeks or surface water bodies.	WMS, CSMF, SOPMS, NSMS

Reference	Impact/issue	Mitigation measure	Application location(s)[1]
GW3	Potential reduced baseflow to Toongabbie Creek, Domain Creek, A'Becketts Creek, Duck Creek, Haslams Creek, Powells Creek and the Mason Park wetlands, Bicentennial Park wetlands, Brickpit and Powells Creek Reserve Requirements for baseline monitoring of hydrological attributes	Additional site investigations would be carried out at creeks or surface water bodies where the additional data review in GW2 shows there is a likely surface water/groundwater interaction. This would involve baseline monitoring of creek flows (streamflow gauging) prior to construction, and baseflow streamflow analysis to confirm the existing groundwater baseflow contribution to streamflow for each creek. Where a significant reduction in baseflow is predicted due to Stage 1, design responses would be implemented at station and shaft excavations to reduce potential baseflow loss.	WMS, CSMF, SOPMS, NSMS
GW4	Requirements for baseline monitoring of hydrological attributes. Migration of contaminants in groundwater and reduction in beneficial uses of aquifers	Monitoring of groundwater levels and quality at the site area would occur before, during and after construction. This would also include monitoring of potential contaminants of concern. Groundwater level data would be regularly reviewed during and after construction by a qualified hydrogeologist.	WMS, PMS, CSMF, SSF, SOPMS, NSMS, BNS, FDS, TBS
GW5	Ground movement and settlement	A detailed geotechnical model for Stage 1 would be developed and progressively updated during design and construction. The detailed geotechnical model would include: • Assessment of the potential for damage to structures, services, basements and other sub-surface elements through settlement or strain • Predicted changes to groundwater levels, including at nearby water supply works. Where building damage risk is rated as moderate or higher (as per the CIRIA 1996 risk-based criteria), a structural assessment of the affected buildings/ structures would be carried out and specific measures implemented to address the risk of damage. Where a significant exceedance of target changes to groundwater levels are predicted at surrounding land uses and nearby water supply works, an appropriate groundwater monitoring program would be developed and implemented. The program would aim to confirm no adverse impacts on groundwater levels or to appropriately manage any impacts. Monitoring at any specific location would be subject to the status of the water supply work and agreement with the landowner.	Where required
GW6	Ground movement and settlement	Condition surveys of buildings and structures in the vicinity of the tunnel and excavations would be carried out prior to the commencement of excavation at each site.	Where required
Soils			
SSWQ1	Acid sulfate soils	Prior to ground disturbance in areas of potential acid sulfate soil occurrence, testing would be carried out to determine the presence of actual and/or potential acid sulfate soils. If acid sulfate soils are encountered, they would be managed in accordance with the *Acid Sulfate Soil Manual* (ASSMAC, 1998)	PMS, CSMF, TBS
SSWQ2	Soil salinity	Prior to ground disturbance in high probability salinity areas, testing would be carried out to determine the presence of saline soils. If salinity is encountered, excavated soils would not be reused or it would be managed in accordance with Book 4 Dryland Salinity: Productive Use of Saline Land and Water (NSW DECC 2008). Erosion controls would be implemented in accordance with Blue Book (Landcom, 2004).	All
Surface water quality			
SSWQ3	Erosion and sedimentation	Erosion and sediment measures would be implemented at all construction sites in accordance with the principles and requirements in Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom 2004) and Volume 2D (NSW Department of Environment, Climate Change and Water 2008), commonly referred to as the 'Blue Book'. Additionally, any water collected from construction sites would be appropriately treated and discharged to avoid any potential contamination or local stormwater impacts. Temporary sediment basins would be designed in accordance with Managing Urban Stormwater: Soils and Construction and Managing Urban Stormwater, Volume 2D: Main Road Construction (DECC, 2008).	All
SSWQ4	Working in waterways and surrounding low lying areas	Works in waterways and surrounding low lying areas would be carried out in accordance with progressive erosion and sediment control plans.	CSMF
SSWQ5	Wastewater discharge	The water treatment plants would be designed so that wastewater is treated to a level that is compliant with the ANZECC/ARMCANZ (2000) and ANZG (2018) default guidelines for 95 per cent species protection.	All
SSWQ6	Water quality monitoring	A surface water monitoring program would be implemented to observe any changes in surface water quality that may be attributable to Stage 1 and inform appropriate management responses. The program would be developed in consultation with the EPA and relevant Councils. The program would consider monitoring being undertaken as part of other infrastructure projects such as the WestConnex M4 East monitoring. Monitoring would occur during pre-construction and during construction at all waterways with the potential to be impacted. Monitoring sites could be located upstream and downstream of the potential discharges and would include sampling for key indicators of concern.	All
SSWQ7	Local stormwater capacity	Further design development would confirm the local stormwater system capacity to receive construction water treatment plant inflows. In the event there is a stormwater infrastructure capacity issue with existing infrastructure, mitigation measures such as storage detention to control water outflow during wet weather events would be implemented.	All

Reference	Impact/issue	Mitigation measure	Application location(s)[1]
Contamination			
C1	Management of low risk contamination	For sites where potential contamination risk is moderate, high or very high, a further review of data would be performed. Where the additional data review provides sufficient information to confirm that contamination is likely to have a very low or low risk, the site would then be managed in accordance with the Soil and Water Management Plan. This would typically occur where there is minor, isolated contamination that can be readily remediated through standard construction practices such as excavation and off-site disposal.	All
C2	Detailed Site Investigation	Where data from the additional data review (mitigation measure C1) is insufficient to understand the risk of contamination, a Detailed Site Investigation would be carried out in accordance with the National Environment Protection Measure (2013) and other guidelines made or endorsed by the NSW EPA. The sites requiring a Detailed Site Investigation would be confirmed following the additional data review (mitigation measure C1), however on the basis of the Stage 1 assessment, it is anticipated that Detailed Site Investigations would be required at the specified application locations.	CSMF, SSF, SOPMS, TBS
C3	Remediation	Where data from the additional data review (mitigation measure C1) or the Detailed Site Investigation (mitigation measure C2) confirms that contamination would have a moderate, high or very high risk, a Remediation Action Plan would be developed for the area of the construction footprint. Each Remediation Action Plan would detail the remediation works required to mitigate risks from contamination throughout and following completion of construction. The Remediation Action Plan would be prepared in accordance with relevant NSW EPA guidelines and where applicable, detail remediation methodologies in accordance with Australian Standards and other relevant government guidelines and codes of practice. Remediation would be performed as an integrated component of construction and to a standard commensurate with the proposed end use of the land. The sites requiring Remediation Action Plans and remediation would be confirmed following the additional data review (mitigation measure C1) and Detailed Site Investigation (mitigation measure C2), however on the basis of the Stage 1 assessment, it is anticipated that Remediation Action Plans and remediation could be required at the specified application locations.	CSMF, SSF, SOPMS, TBS
C4	Site Audit Statement	Where contamination is highly complex, such as significant groundwater contamination; contamination associated with vapour; contamination that requires specialised remediation techniques; or contamination that requires ongoing active management during and beyond construction, an accredited Site Auditor would review and approve the Remediation Action Plan, and would develop a Site Audit Statement and Site Audit Report upon completion of remediation. The sites requiring Site Audit Statements would be confirmed following the preparation of Remediation Action Plans (mitigation measure C3), however on the basis of the Stage 1 assessment, it is anticipated that Site Audit Statements would be required at the specified application locations.	CSMF, SOPMS, TBS, and as applicable
C5	Residual contamination following construction	Ongoing management and monitoring measures would be documented in an appropriate form and implemented for any areas where minor, residual contamination remains following construction.	As applicable
Hydrology and flooding			
HF1	Flooding behaviour impacts	Detailed construction planning would consider flood risk at construction sites. This would include: • Identification of measures to not worsen flood impacts on the community and on other property and infrastructure during construction up to and including the one per cent AEP flood event • Provide flood-proofing to excavations at risk of flooding or coastal inundation during construction, where feasible and reasonable, such as raised entry into shafts and/or pump-out facilities to minimise ingress of floodwaters into shafts and the dive structure • Review of site layout and staging of construction works to avoid or minimise obstruction of overland flow paths and limit the extent of flow diversion required. This includes design of site hoardings to minimise disruption to flow paths (if possible). Not worsen is defined as: • A maximum increase in flood levels of 50mm in a one per cent AEP flood event • A maximum increase in time of inundation on one hour in a one per cent AEP flood event • No increase in potential soil erosion and scouring from any increase in flow velocity in a one per cent AEP flood event.	PMS, CSMF, SSF, NSMS, TBS
HF2	Flooding behaviour impacts	On-site stormwater detention would be provided for the Clyde stabling and maintenance facility to manage peak site runoff rates and volumes due to increased imperviousness of the site.	CSMF
HF3	Flooding behaviour impacts	Further design refinement at the Clyde stabling and maintenance facility construction site would occur during detailed design to mitigate the identified potential impacts including: • The increases in flood levels of up to 0.08 metres in Duck Creek and adjacent properties in the one per cent AEP flood event • Increases in flow velocities and the potential increased risk of scour at the proposed creek crossings and in the downstream channels • The potential flooding impacts from filled features including the road overbridge approach.	CSMF
HF4	Flooding behaviour impacts	Drainage at construction sites would be designed, where feasible and reasonable, to mitigate potential alterations to local runoff conditions due to construction sites.	All
HF5	Flooding behaviour impacts	Detailed construction planning for The Bays Station construction would aim to minimise changes to existing levels in relation to potential impacts on flood behaviour, along the north-western side of site adjacent to low-lying property, to minimise reduction in floodplain storage.	TBS
HF6	Flood protection	Consultation would occur with the proponent of the Camellia Town Centre redevelopment to understand potential flood impacts from the redevelopment on Stage 1 and to identify any additional flood protection (if required).	PMS
HF7	Flooding emergency management	Construction planning regarding flooding matters would be carried out in consultation with the NSW State Emergency Service and the relevant local council.	PMS, CSMF, TBS
HF8	Impacts to flood mitigation works	Detailed construction planning for The Bays Station construction site would aim to avoid conflicts with the potential construction of flood mitigation works in Robert Street, in consultation with Inner West Council.	TBS

Reference	Impact/issue	Mitigation measure	Application location(s)[1]
Biodiversity			
B1	Impacts to fish passage	During construction, sufficient flow and fish passage would be maintained similar to current conditions during in-stream works where feasible and reasonable.	CSMF
B2	Impacts of proposed creek crossings	The A'Becketts Creek and Duck Creek crossings would be designed to: • Provide sufficient fish passage is accordance with Policy and guidelines for fish habitat conservation and management Update 2013 (DPI (Fisheries NSW) 2013) • Incorporate suitable scour protection • Avoid worsening existing flow velocities downstream from the crossing locations • Incorporate a vegetated riparian zone within the realigned open channel sections where feasible and reasonable.	CSMF
B3	Impacts to groundwater dependent ecosystems	Additional investigations and assessment would be completed to confirm the potential for impacts to groundwater dependant ecosystems due to groundwater drawdown, and to identify any required mitigation through design.	WMS, CMSF, NSMS, BNS, FDS
Air quality			
AQ1	Dust impacts	The following best-practice dust management measures would be implemented during all construction works: • Regularly wet-down exposed and disturbed areas including stockpiles, especially during dry weather • Adjust the intensity of activities based on measured and observed dust levels and weather forecasts • Minimise the amount of materials stockpiled and position stockpiles away from surrounding receivers • Regularly inspect dust emissions and apply additional controls as required • Implement all relevant measures listed in the UK IAQM corresponding to the highest level of risk determined around each Stage 1 construction site.	All
AQ2	Exhaust emissions from the combustion of fossil fuels	Plant and equipment would be maintained in a proper and efficient manner. Visual inspections of emissions from plant would be carried out as part of pre-acceptance checks.	All
AQ3	Odour emissions	The following best-practice odour management measures would be implemented during relevant construction works: • The extent of opened and disturbed contaminated soil at any given time would be minimised • Temporary coverings or odour supressing agents would be applied to excavated areas where appropriate • Regular monitoring would be conducted during excavation to verify that no offensive odours are being generated.	All
Spoil, waste management and resource use			
WR1	Compliance with legislative and policy requirements	All waste would be assessed, classified, managed, transported and disposed of in accordance with the Waste Classification Guidelines.	All
WR2	Disposal of hazardous materials	A hazardous material survey would be completed for those buildings and structures suspected of containing hazardous or special waste materials (particularly asbestos) prior to their demolition. If hazardous waste or special waste (e.g. asbestos) is encountered, it would be handled and managed in accordance with relevant legislation, codes of practice and Australian standards.	All
WR3	Waste minimisation	Construction waste would be minimised by accurately calculating materials brought to the site and limiting materials packaging.	All
WR4	Reuse and recycling	Waste streams would be segregated to avoid cross-contamination of materials and maximise reuse and recycling opportunities.	All
WR5	Reuse on Sydney Metro West sites	A materials tracking system would be implemented for material transferred between Sydney Metro West sites and to offsite locations such as licensed waste management facilities.	All
Hazards			
HA1	Risks to people, property and the environment associated with transport and storage of explosives	The method for delivery of explosives would be developed prior to the commencement of blasting (if proposed) in consultation with the Department of Planning, Industry and Environment and be timed to avoid the need for on-site storage.	All
HA2	Impacts on underground utilities	Dial before you dig searches and non-destructive digging would be carried out to identify the presence of underground utilities.	All
HA3	Impacts on underground utilities	Ongoing consultation would be carried out with utility providers for high pressure gas or petroleum pipelines to identify appropriate construction methodologies to be implemented. Any interaction with high pressure gas or petroleum pipelines would comply with the relevant standards, including AS 2885 Pipelines – Gas and Liquid Petroleum.	All
Sustainability and climate change			
SCC1	Sustainability implementation	Sustainability initiatives would be incorporated into the detailed design and construction to support the achievement of the Sydney Metro West sustainability objectives.	All
SCC2	Sustainability implementation	Best practice level of performance would be achieved using market leading sustainability rating tools during design and construction.	All
SCC3	Climate change risks	Climate change risk treatments would be confirmed and incorporated into the detailed design.	All
SCC4	Greenhouse gas emissions	An iterative process of greenhouse gas assessments and design refinements would be carried out during detailed design and construction to identify opportunities to minimise greenhouse gas emissions. Performance would be measured in terms of a percentage reduction in greenhouse gas emissions from a baseline inventory calculated at the detailed design stage.	All

Reference	Impact/issue	Mitigation measure	Application location(s)[1]
SCC5	Greenhouse gas emissions	25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction would be offset.	All
Cumulative impacts			

CI1	Occurrence of Cumulative impacts	Co-ordination and consultation with the following stakeholders would occur where required to manage the interface of projects under construction at the same time:
		• Other parts of Transport for NSW including Transport Coordination
		• Department of Planning, Industry and Environment
		• Sydney Trains
		• NSW Trains
		• Sydney Buses
		• Sydney Water
		• Port Authority of NSW
		• Sydney Motorways Corporation
		• Emergency service providers
		• Utility providers
		• Construction contractors.
		Co-ordination and consultation with these stakeholders would include:
		• Provision of regular updates to the detailed construction program, construction sites and haul routes
		• Identification of key potential conflict points with other construction projects
		• Developing mitigation strategies in order to manage conflicts. Depending on the nature of the conflict, this could involve:
		  • Adjustments to the Sydney Metro construction program, work activities or haul routes; or adjustments to the program, activities or haul routes of other construction projects
		  • Co-ordination of traffic management arrangements between projects.
			All

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (e.g. tunnel boring machine works); PSR: Power supply routes.

27.9 Performance outcomes

The Secretary's Environmental Assessment Requirements identified a number of desired performance outcomes. These desired performance outcomes outline the broader objectives to be achieved during design, construction, and operation and are separate to the performance outcomes identified for the Concept.

Table 27-7 identifies the Sydney Metro West performance outcomes and outlines how Stage 1 addresses these outcomes. Future design development and any design changes would also be considered against these environmental performance outcomes.

Table 27-7: Desired performance outcomes and project outcome

Desired performance outcome from Secretary's Environmental Assessment Requirements	Sydney Metro West Concept Performance Outcomes	How Stage 1 addresses performance outcomes
Place and design		
The project provides healthy, responsive, integrated, equitable and resilient places. **The project provides an increase in tree plantings and tree canopy.** **The project minimises adverse impacts on the visual amenity of the build and natural environment (including public open spaces)**	• The design reflects the Sydney Metro Design Objectives and the place and design principles • The Sydney Metro Design Quality Framework is implemented • Metro stations contribute positively to the surrounding urban environment and provide a sense of place • No net loss of tree numbers and tree canopy.	Stage 1 works would allow for the implementation of the Sydney Metro Design Objectives and place and design principles as part of the design process for future stages of Sydney Metro West. Stage 1 includes a commitment to achieve no net overall loss in tree number and/or canopy, and where feasible and reasonable increase the number of trees near Stage 1 construction sites in consultation with relevant local councils.

Desired performance outcome from Secretary's Environmental Assessment Requirements	Sydney Metro West Concept Performance Outcomes	How Stage 1 addresses performance outcomes
Spoil, waste management and resource use		
Spoil generated during the construction is effectively stored, handled, treated (if necessary), reused, and/or disposed of lawfully and in a manner that protects environmental values.	*Operation* • The use of potable water for non-potable purposes is avoided if non-potable water is available • The reuse of water is maximised, either on site or off site. *Construction* • 100 per cent of useable spoil is reused in accordance with the spoil reuse hierarchy • A minimum 95 per cent recycling target is achieved for construction and demolition waste • Products made from recycled content are prioritised • The use of potable water for non-potable purposes is avoided if non-potable water is available • The reuse of water is maximised, either on site or off site.	The design of Stage 1 tunnels and station excavations and the preferred construction methodology has taken into consideration the waste hierarchy by aiming to reduce the volume spoil generated, as far as practical. Opportunities to further reduce the generation of spoil through tunnel and station optimisation would be considered during future design. Spoil would be classified in accordance with Waste Classification Guidelines (NSW Environment Protection Authority, 2014). Spoil that is classified as virgin excavated natural material, excavated natural material, subject to a resource recovery order/resource recovery exemption under the Protection of the Environment Operations (Waste) Regulation 2014 or is otherwise reusable would be reused (consistent with the 100 per cent beneficial reuse performance outcome). Stage 1 would adopt a construction waste recycling target of 95 per cent. Waste streams would be segregated to avoid cross-contamination of materials and maximise recycling opportunities. Stage 1 would minimise water use and use non-potable water where feasible consistent with adopted sustainability initiatives and targets – refer to Section 8.20 (Sustainability and climate change – Concept).
Socio-economic, land use and property		
The project minimises adverse social and economic impacts and capitalises on opportunities potentially available to affected communities. **The project minimises impacts to property and business and achieves appropriate integration with adjoining land uses, including maintenance of appropriate access to properties and community facilities, and minimisation of displacement of existing land use activities, dwellings and infrastructure.** **The project minimises impacts on and achieves appropriate integration with adjoining land uses.**	**Social**	
	Operation • Negative impacts on customers and the community (including transport services, amenity, noise and vibration, water management and air quality) are minimised • Impacts on the availability and quality of public open space and social infrastructure are avoided • Access to local facilities, services and destinations is improved, supporting opportunities for community interaction and improving social cohesion • Placemaking at stations provides a focal point for the community improving social connections and connection to place • Legacy projects are delivered to benefit local communities. *Construction* • Negative impacts on customers and the community (including transport services, amenity, noise and vibration, water management and air quality) are minimised • Affected communities are communicated with in a clear and timely manner to enhance community benefits, reduce disruption and address community concerns.	The design of Stage 1 has aimed to avoid and minimise impacts on the availability and quality of public open space and social infrastructure. There would be some direct impacts on community assets (such as the loss of the premises for Parramatta Artist Studios at Parramatta and the Figtree Convention Centre at Sydney Olympic Park), while indirect impacts (such as on ease of access an amenity) could affect some public open space areas including at Five Dock and Burwood North. Mitigation measures have been proposed to address these impacts. The relocation of the Sydney Speedway (located on government owned land) to Eastern Creek would have an impact on the accessibility of this type of recreation infrastructure. This may be both positive or negative for different speedway spectators. The assessment of Stage 1 has also considered a range of potential social impacts including those relating to way of life, community, culture, health and wellbeing, concerns and aspirations. Mitigation measures have been developed to address these issues where required. Further details on social impacts and mitigation is provided in Chapter 17 (Social impacts – Stage 1). Community engagement activities carried out to date and the framework for future community engagement is detailed in Chapter 5 (Stakeholder and community engagement). Improved access to local facilities, services and destinations would be realised during future stages of Sydney Metro West.
	Business	
	Operation • Potential impacts to businesses are minimised • Connectivity is improved to, from and between businesses in Greater Parramatta, the Sydney CBD and other centres. *Construction* • Potential impacts to businesses are minimised • Affected businesses are communicated with in a clear and timely manner to reduce disruption and address concerns • Access to businesses for employees and customers is maintained • Assistance is provided to businesses that are adversely impacted.	The design development of Stage 1 aimed to avoid or minimise potential business impacts by minimising the amount of privately owned land needed for construction sites to reduce direct impacts on businesses (where possible). This included avoiding direct impacts on businesses at Westmead and North Strathfield. The design also aimed to maintain customer and vehicular delivery access for existing businesses. Stage 1 would include a program to assist small business owners adversely impacted by construction and measures to help maximise the visibility of business during the construction period Further details on business impacts and mitigation is provided in Chapter 16 (Business impacts – Stage 1).
	Land use and property	
	Operation • Future land use opportunities within metro station precincts are developed in cooperation with (as relevant) the Department of Planning, Industry and Environment, the Greater Sydney Commission, and local councils • Transport infrastructure is effectively integrated with land use planning. *Construction* • Acquisition of privately owned land is minimised by limiting the extent of construction sites and using existing Government owned land where possible • Residual land at the completion of construction is minimised • The need for partial acquisitions is minimised.	Stage 1 construction sites have been located to maximise use of Government owned land where possible (such as at North Strathfield and The Bays). Construction sites have also been optimised taking into account expected future operational requirements for the stations, as well as considering the key construction requirements for the tunnel and stations. In all cases, Stage 1 construction footprints have been reduced as much as practicable to minimise the need for land acquisition and temporary property impacts. Stage 1 construction sites have also been located within existing property boundaries. This has minimised the need for partial acquisitions, with only one potential partial acquisition identified for Stage 1 (at the Burwood North Station construction site). Station locations have been selected to link houses, jobs, education, health and other services. Stations also create opportunities for integrated station and precinct developments that provide for community needs including consideration of relevant planning controls and local character. Further details on property and land use impacts and mitigation is provided in Chapter 14 (Property and land use – Stage 1).

Desired performance outcome from Secretary's Environmental Assessment Requirements	Sydney Metro West Concept Performance Outcomes	How Stage 1 addresses performance outcomes
Noise and vibration		
The project ensures the compatibility of the Concept with the adjoining noise environment. **The project minimises adverse impacts on acoustic amenity of the surrounding community by effectively managing construction noise and vibration (including airborne noise, ground-borne noise and blasting).** **Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on the structural integrity of buildings and items including Aboriginal places and environmental heritage.**	*Operation* • Operational noise and vibration levels comply with the rail noise trigger levels in the Rail Infrastructure Noise Guidelines (Environment Protection Authority, 2013) and external noise criteria in the Noise Policy for Industry (Environment Protection Authority, 2017), where applicable. *Construction* • Construction noise and vibration impacts on local communities are minimised by controlling noise and vibration at the source, on the source to receiver path and at the receiver • Structural damage to buildings and heritage items from construction vibration is avoided.	The design development of Stage 1 aimed to avoid or minimise potential construction noise and vibration impacts. This included locating some facilities in industrial areas with fewer noise sensitive receivers (such as the Clyde Stabling and maintenance facility and the Silverwater services facility). Stage 1 would construction noise minimise impacts to the local community by: • Controlling noise and vibration at the source • Controlling noise and vibration on the source to receiver transmission path • Implementing practicable and reasonable measures to minimise the noise and vibration impacts of construction activities on local sensitive receivers. This includes provision of acoustic sheds (or other acoustic measures) where night works are proposed. Stage 1 would minimise impacts to structures by: • Controlling vibration at the source • Controlling vibration on the source to receiver transmission path • Implementing practicable and reasonable measures to minimise vibration impacts of construction activities on structures. Further details on noise and vibration impacts and mitigation is provided in Chapter 11 (Noise and vibration – Stage 1).
Transport and traffic		
The project minimises adverse transport and traffic impacts and optimises transport and traffic functioning. **The project minimises and manages impacts to network connectivity, safety and efficiency of the transport system during construction.**	*Operation* • The modal access hierarchy is implemented at stations • Sufficient customer capacity in stations and station plazas is provided to limit crowding or queuing in accordance with Fruin's Level of Service C (for 2056 demand) • Stations and interchanges are fully accessible and compliant with the Disability Discrimination Act 1992 and the Disability Standards for Accessible Public Transport 2002. *Construction* • Construction traffic and transport impacts on special events are minimised • Safe routes for pedestrians and cyclists are provided around construction sites • Safe access to properties is maintained • Road occupancy is minimised, particularly in the Parramatta and Sydney CBDs • Changes to the travel paths of road users, including bus routes, are minimised • Affected emergency services and public transport operators are provided early communication on changes in traffic conditions • Loss of on-street parking and loading zones is minimised • Heavy vehicle routes are developed in consultation with Transport for NSW, including Transport Coordination • The use of local roads by heavy vehicles is minimised • Safe access and egress is provided to and from construction sites.	The design development of Stage 1 has included a focus on minimising the need for works in existing rail corridors (at Westmead, Parramatta and North Strathfield) and avoiding direct impacts to major roads where possible. Impact on existing parking would be minimised by limiting the extent of construction sites, hiving dedicated access/egress points and by encouraging workers to use public transport. Where more substantial loss of existing parking is expected, such as at Parramatta, there is a commitment to work with the local council to investigate opportunities to provide alternative parking facilities. Stage 1 would include measures maintain pedestrian, cyclist and motorist safety around construction sites, including safe access to properties. Construction vehicle routes for Stage 1 were developed in consultation with relevant sections of Transport for NSW, including Transport Coordination to minimise the use of local roads and use the most efficient route to the arterial road network. Left in left out or straight through access-egress is proposed at most construction sites. Where this is not practicable (such as at Sydney Olympic Park metro station and North Strathfield Station constructions sites) traffic volumes and sight distances allow for safe right turns. Stage 1 allows for future integration with existing and future local and regional transport infrastructure and planning strategies. Further details on transport and traffic impacts and mitigation is provided in Chapter 10 (Transport and traffic – Stage 1).
Aboriginal heritage		
The long-term protection, conservation and management of the heritage significance of Aboriginal objects and places.	*Operation* • The design of stations include Aboriginal heritage interpretation in consultation with registered Aboriginal parties. *Construction* • Impacts on areas of moderate or higher archaeological potential and significance are avoided or minimised, where feasible and reasonable • Accidental impacts to heritage items are avoided.	Impacts to Aboriginal heritage have been minimised by avoiding direct impacts to previously recorded Aboriginal sites where possible, and by locating most of the Parramatta metro station construction site outside of the known extent of the Parramatta Sand Body, which has demonstrated archaeological potential. One known Aboriginal site (at Parramatta metro station construction site) and areas of archaeological sensitivity at Clyde stabling and maintenance facility, and The Bays Station construction sites would be directly affected by Stage 1. Options for heritage interpretation would be considered as part of future stages of Sydney Metro West. Further details on Aboriginal heritage impacts and mitigation is provided in Chapter 13 (Aboriginal heritage – Stage 1).

Desired performance outcome from Secretary's Environmental Assessment Requirements	Sydney Metro West Concept Performance Outcomes	How Stage 1 addresses performance outcomes
Non-Aboriginal heritage		
The long-term protection, conservation and management of the heritage significance of items of environmental heritage.	*Operation* • Design is sympathetic to retained and adjacent heritage items • Appropriately qualified and suitably experienced heritage architect and relevant stakeholders are consulted during design • The design of stations include non-Aboriginal heritage interpretation. *Construction* • Direct impacts on World Heritage and National Heritage List items are avoided • Impacts on State Heritage Register items are avoided or minimised so that the overall heritage value of the item is maintained • Impacts to non-Aboriginal heritage items and archaeology are avoided or minimised where feasible and reasonable • Accidental impacts to heritage items are avoided.	The Stage 1 design is sympathetic to the historic significance of surrounding listed heritage items, and where practicable, avoids and minimises impacts to heritage. The Stage 1 tunnel alignment was developed to avoid potential direct impacts to the World Heritage listed Old Government House within Parramatta Park. Stage 1 construction sites were selected to avoid direct impacts to State and local heritage items where possible, including State heritage listed Parramatta Station and Roxy Cinema (Parramatta), St Alban's Church (Five Dock), and the White Bay Power Station and Glebe Island Silos (The Bays). The design and mitigation strategies are reviewed by the Sydney Metro Design Review Panel. Further details on Aboriginal heritage impacts and mitigation is provided in Chapter 14 (Non-Aboriginal heritage – Stage 1).
Contamination and soils		
The environmental values of land, including soils, subsoils and landforms, are protected. **Risks arising from the disturbance and excavation of land and disposal of soil are minimised, including disturbance to acid sulfate soils and site contamination.** **Land must be (or be made) suitable for intended future use.**	**Soils**	
	Construction • Impacts on aquatic environments from the disturbance of acid sulfate soils are avoided • Pollution of surface water is minimised through the implementation of appropriate erosion and sediment controls.	Stage 1 would effectively manage acid sulfate soils in accordance with the Acid Sulfate Soil Manual (Acid Sulfate Soil Management Advisory Committee, 1998). The manual includes procedures for the investigation, handling, treatment and management of such soils. Erosion and sediment measures would be implemented at all construction sites in accordance with the principles and requirements in Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom 2004) and Volume 2D (NSW Department of Environment, Climate Change and Water 2008), commonly referred to as the 'Blue Book'. Further details on soil impacts and mitigation is provided in Chapter 19 (Soils and surface water quality – Stage 1).
	Contamination	
	Operation • Residual contamination does not pose a risk to Sydney Metro customers or staff. *Construction* • Contamination risks to human health and ecological receivers are minimised through effective management of existing contaminated land • Contaminated land is remediated to be suitable for the intended future land use.	The Stage 1 design has aimed to avoid or minimise potential interaction with known contaminated sites. This has included avoiding the former Shell Clyde Refinery site (Durham Street, Rosehill), where there is known groundwater contamination. Stage 1 would include measures to better understand contaminated related risks and management/ remediation requirements. Further details on contamination impacts and mitigation is provided in Chapter 20 (Contamination – Stage 1).
Water – hydrology and flooding		
Long term impacts on surface water and groundwater hydrology (including drawdown, flow rates and volumes) are minimised. **Minimise adverse impacts on existing flooding characteristics.**	**Hydrology and flooding**	
	Operation • Increases in flood levels are minimised, particularly within private properties, during events up to and including the one per cent annual exceedance probability • No additional private properties are affected by flood events up to and including the 1% annual exceedance probability • The potential for soil erosion and scouring is minimised for events up to and including a 1% annual exceedance probability event • Dedicated evacuation routes are not impacted in flood events up to and including the probable maximum flood • The performance of the downstream drainage network is maintained. *Construction* • Dedicated evacuation routes are not impacted in flood events up to and including the probable maximum flood.	Construction would be carried out in a manner that minimises the potential for adverse flooding impacts, through staging of works and the implementation of mitigation measures. The following criteria would be met for Stage 1: • A maximum increase in flood levels of 50mm in a 1% annual exceedance probability flood event • A maximum increase in time of inundation on one hour in a 1% annual exceedance probability flood event • No newly-affected properties in the 1% annual exceedance probability event • No increase in potential soil erosion and scouring from any increase in flow velocity in a 1% annual exceedance probability flood event. Stage 1 would avoid impacts to dedicated evacuation routes in flood events up to and including the probable maximum flood (during construction) at most sites. Mitigation measures have been proposed to address increase in flood depths in Robert Street near The Bays Station construction site. Further details on hydrology and flooding impacts and mitigation is provided in Chapter 21 (Hydrology and flooding – Stage 1).

Desired performance outcome from Secretary's Environmental Assessment Requirements	Sydney Metro West Concept Performance Outcomes	How Stage 1 addresses performance outcomes
	Groundwater and ground movement	
	• Groundwater supply for licenced groundwater users is not significantly affected by groundwater drawdown • The groundwater accessible to groundwater dependent ecosystems is not significantly reduced • Structural damage to buildings from ground movement associated with excavation, tunnelling or groundwater drawdown is avoided.	The Stage 1 has minimised potential groundwater impacts by: • Tanking of stations at Parramatta, Five Dock and The Bays to avoid ongoing groundwater inflow • Tanking of tunnels to avoid ongoing groundwater inflow. Stage 1 includes a commitment to implement make good measures in relation to any potential loss of yield for existing groundwater (bore supply) users due to construction. Stage 1 includes a commitment to further groundwater monitoring to better understand potential impacts on groundwater dependant ecosystems and inform mitigation as part of the design process. The specific risk to most buildings and structures due to ground movement associated with Stage 1 would be negligible, with superficial damage to buildings unlikely. Where building damage risk is rated as moderate or higher (as per the CIRIA 1996 risk-based criteria), a structural assessment of the affected buildings/structures would be carried out and specific measures implemented to address the risk of damage. Further details on groundwater impacts and mitigation is provided in Chapter 18 (Groundwater – Stage 1).
Water – Quality		
To protect the NSW Water Quality Objectives where they are currently being achieved and contribute towards achievement of the Water Quality Objectives over time where they are currently not being achieved, including downstream of the project to the extent of the project impact including estuarine and marine waters (if applicable).	*Operation* • The water quality criteria for water discharge, determined in consultation with NSW Environment Protection Authority, is met. *Construction* • The discharge water quality requirements outlined in applicable environment protection licence(s) are met • Existing water quality of receiving surface watercourses is maintained.	Wastewater from Stage 1 tunnelling activities would be treated, and standard erosion and sediment control measures would be implemented for all surface works areas to minimise pollutant loading to the downstream waterways during construction. Wastewater would be treated to comply with the ANZECC/ARMCANZ (2000) and ANZG (2018) guidelines and runoff from construction works would be designed to meet the standards outlined in the Blue Book. With these management measures, pollutant loading to the receiving waterways would be low with the possibly of better quality where existing water quality does not meet the ANZECC/ARMCANZ (2000) and ANZG (2018) guidelines. Discharges from construction water treatment plants would be monitored for compliance with the discharge criteria in environmental protection licence(s) issued to Stage 1. Further details on water quality impacts and mitigation, and an assessment of Stage 1 against NSW water quality objectives, is provided in Chapter 19 (Soils and surface water quality – Stage 1).
Biodiversity		
The avoidance and minimisation of impacts on terrestrial and aquatic biodiversity. **Offsets and/or supplementary measures are assured which are equivalent to any remaining impacts of project construction and operation.**	*Construction* • Impacts on biodiversity are avoided (where possible) and minimised, including the clearing of native vegetation • Significant impacts to flow regimes in receiving waterways are avoided • Design of waterway modifications and crossings incorporates best practice principles • The Concept does not contribute to key threatening processes associated with weeds and pathogens • Biodiversity impacts are offset in accordance with the *Biodiversity Conservation Act 2016*.	The Stage 1 construction footprint is predominantly set in built up areas. The limited amount of native vegetation to be disturbed by Stage 1 is of poor to moderate quality and threatened species habitats are very limited. Impacts to threatened species and communities were assessed as not significant. As most construction sites are not located within or adjacent to major overland or mainstream flow paths, there is a low potential to impact downstream velocity and scour. Mitigation measures have been proposed to address predicted increases in flow velocities during the 1% AEP event as a result of proposed culvert crossings of A'Becketts Creek and Duck Creek and formalisation of sections of these creek channels. Stage 1 includes a commitment to further groundwater monitoring to better understand potential impacts on groundwater dependant ecosystems (including from any changes to the baseflow in nearby watercourses) and inform mitigation as part of the design process. The likelihood of Stage 1 contributing key threatening processes key threatening processes associated with weeds and pathogens was assessed as low. The Construction Environmental Framework includes a requirement to implement weed management measures and mitigation measures to prevent introduction and spread of amphibian chytrid fungus, *Phytopthera cinnamomi* and exotic rust fungi. Biodiversity credit obligations were calculated using the Biodiversity Assessment Method Calculator. A total of six credits would be required associated with impacts to Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion (Plant community type 920) and Southern Myotis (*Myotis macropus*). The NSW Department of Primary Industries Policy and Guidelines for Fish Habitat Conservation and Management (NSW Department of Primary Industries, 2013) are applicable and the 0.15 hectares of impacted Mangrove Forest would be offset at a 10:1 ratio due to impacts on a mapped Coastal Wetland area. Further details on biodiversity impacts and mitigation is provided in Chapter 22 (Biodiversity – Stage 1).

Desired performance outcome from Secretary's Environmental Assessment Requirements	Sydney Metro West Concept Performance Outcomes	How Stage 1 addresses performance outcomes
Sustainability		
Operating costs are reduced. **Effective and efficient use of resources.** **Conservation of natural resources is maximised.**	• The construction and operation of Sydney Metro West is consistent with the Sydney Metro Environment and Sustainability Policy • Sustainability initiatives are incorporated into the planning, design and construction of the Concept • Infrastructure Sustainability Council of Australia (ISCA) IS rating of 75 – Version 1.2 (or equivalent) and a 5-Star Green Star rating are achieved during design and construction for appropriate components • Design of stations and stabling buildings achieve at least a 15 per cent improvement over performance requirements set out in Section J of the National Construction Code.	Stage 1 would be consistent with the directions identified in the Sydney Metro Environment and Sustainability Policy and has adopted sustainability principles, initiatives and targets that will be incorporated in a Sydney Metro West Sustainability Plan. Stage 1 includes a commitment to achieving an equivalent or improved level of sustainability performance compared to previous metro projects. This would include achieving a minimum Infrastructure Sustainability Council of Australia (ISCA) IS rating of 75 – Version 1.2 (or equivalent) and a 5-Star Green Star rating (or equivalent) depending on the specific Stage 1 component. Stage 1 would mandate a minimum 15 per cent improvement on the current (2019) minimum performance requirement stipulated in the National Construction Code/Building Code of Australia. Further details on sustainability is provided in Section 8.20 (Sustainability and climate change – Concept) and Chapter 26 (Sustainability and climate change – Stage 1).
Other issues		
No desired performance outcome from Secretary's Environmental Assessment Requirements	**Air quality**	
	• Air quality impacts are minimised during construction and operation.	Stage 1 includes a commitment to implementing best practice dust and odour management measures. Further details on air quality impacts and mitigation is provided in Chapter 23 (Air quality– Stage 1).
	Hazards	
	• Dangerous goods are transported, stored and used so as to not cause a hazardous event.	Potential hazards associated with the on-site storage, use and transport of chemicals, fuels and materials used during Stage 1 would be managed in accordance with the Construction Environmental Management Framework, *Work Health and Safety Act 2011*, the Work Health and Safety Regulation 2017, the Storage and Handling of Dangerous Goods Code of Practice (WorkCover NSW, 2005) and Applying SEPP 33 (Department of Planning, 2011).
	Climate change and greenhouse gas	
	Operation • Comprehensively address climate change risks during the design life of Sydney Metro West for all risks rated 'medium' or higher • 100 per cent of the greenhouse gas emissions associated with consumption of electricity during operation are offset. *Construction* • 25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction are offset.	Climate change risk treatments would be confirmed and incorporated into the detailed design for Stage 1. Stage 1 includes a commitment to offset 25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction.
	Cumulative impacts	

	Construction
	• Cumulative impacts are minimised through co-ordination of construction activities and communication processes with nearby projects.
		Stage 1 includes a commitment to coordinating and consulting with relevant stakeholders to manage the interface of projects under construction at the same time. This would include:
		• Provision of regular updates to the detailed construction program, construction sites and haul routes
		• Identification of key potential conflict points with other construction projects
		• Developing mitigation strategies in order to manage conflicts. Depending on the nature of the conflict, this could involve:
		  • Adjustments to the Sydney Metro construction program, work activities or haul routes; or adjustments to the program, activities or haul routes of other projects
		  • Coordination of traffic management arrangements between projects.

27.10 Project justification

27.10.1 Addressing the need

Sydney is Australia's financial and economic capital, housing half of the country's globally competitive service sector jobs. The Greater Parramatta to Sydney CBD corridor is one of three key economic corridors nominated in the Greater Sydney Region Plan (Greater Sydney Commission, 2018a). The corridor is of national economic significance and contains nearly 620,000 high productivity jobs, which is around 20 per cent of the jobs in Greater Sydney and generates eight per cent of the nation's Gross Domestic Product per year.

Recognising the importance of the corridor, several land use planning and development initiatives have commenced in Westmead, Parramatta, Sydney Olympic Park, The Bays and the Sydney CBD. These initiatives are expected to account for more than 60 per cent of planned population growth and more than 80 per cent of planned jobs growth in the corridor by 2036.

Sydney's growing population will continue to increase demand on the existing transport network and by 2056, NSW transport networks will need to accommodate 28 million trips per day (Transport for NSW, 2018). The existing rail network is congested, with customers on most rail lines often experiencing significant crowding on trains and station platforms during the morning and evening peaks. Despite planned upgrades and more services which will provide some short term relief, the T1 Western Line is expected to reach capacity in 2024 and the T9 Northern Line is expected to reach capacity in 2027.

As train and station crowding reduces service reliability, this results in fewer services operating in a given time period and in turn leads to further crowding. Reliability impacts in the Sydney CBD cause network-wide impacts, reducing network capacity and increasing crowding on trains and platforms.

There is a strong link between public transport and land use change. Transport accessibility and amenity are critical to supporting employment, housing supply and urban renewal opportunities and ultimately to support Sydney's economic and population growth. Transport accessibility and amenity issues, including crowding and capacity constraints within the Greater Parramatta to Sydney CBD corridor, as well as traffic congestion from high levels of car use, are limiting the achievement of planned growth because these areas are less attractive to households and developers.

Sydney Metro West would address this substantial need by more than doubling rail capacity from Parramatta to the Sydney CBD. At ultimate capacity, Sydney Metro West would be able to move more than 40,000 people an hour in each direction and would complement the suburban and intercity services between Parramatta and the Sydney CBD. Sydney Metro would result in numerous transport benefits including:

- Substantially improving the public transport networks accessibility to key economic centres across the Greater Parramatta to Sydney CBD corridor
- Reducing crowding on trains and on station platforms
- Increasing the reach and use of Sydney's public transport network by providing new station locations at Burwood North, Five Dock and The Bays and by providing a direct connection to Sydney Olympic Park
- Improving travel times for commuters
- Providing an alternative to the suburban rail network with additional capacity to reduce the impacts of scheduled maintenance and major unavoidable incidents
- Providing the opportunity for mode shift from car to public transport, which could result in road user travel time savings.

By improving the connections between key economic centres, Sydney Metro West would foster significant growth in jobs, including directly supporting the creation of new jobs within the corridor particularly at key precincts including Westmead, Parramatta, Sydney Olympic Park and The Bays.

Sydney Metro West would provide city-shaping benefits as the significant increase in transport connectivity, capacity and amenity in the Greater Parramatta to Sydney CBD corridor, would boost the economic productivity of Sydney and facilitate planned land use outcomes in the CBDs, planned precincts and urban renewal areas.

Sydney Metro West would also provide a fast, reliable and frequent connection between Greater Parramatta and the Sydney CBD and would:

- Relieve the congested T1 Western Line, T9 Northern Line and T2 Inner West and Leppington Line
- Provide travel time savings for customers in Western Sydney and along the Greater Parramatta to Sydney CBD corridor
- Reduce station crowding at some stations
- Provide rail transport to areas where it is currently not available
- Connect Greater Parramatta and the Sydney CBD to support the vision for a metropolis of three cities
- Support delivery of the '30-minute city' as identified in Future Transport Strategy 2056
- Reinforce the role of Greater Parramatta as the Central River City
- Improve connectivity to major attractions and key precincts located along the corridor, including Sydney Olympic Park and The Bays
- Support urban renewal and increased housing supply
- Increase accessibility across Sydney and provide customers with a new world-class metro service.

27.10.2 Biophysical, economic and social considerations including the principles of ecologically sustainable development

Comprehensive investigations have been carried out in the preparation of the Environmental Impact Statement to assess the biophysical, economic and social impacts. The key potential impacts that cannot be avoided are summarised above in Section 27.7. As described in Section 27.8, the project would incorporate environmental management and design features so that any unavoidable potential impacts are managed and mitigated as far as feasible and reasonable and to an acceptable level.

Biophysical, economic and social considerations have also been assessed in the context of the principles of ecologically sustainable development. The EP&A Act adopts the definition of ecologically sustainable development contained in the Protection of the *Environment Administration Act 1991*. An assessment of the biophysical, economic and social impacts of Sydney Metro West in the context of the principles of ecologically sustainable development is provided below.

Precautionary principle

The environmental risk analysis documented in Chapter 29 (Environmental risk analysis) addresses the potential impacts of the Concept and Stage 1. That analysis, together with the detail assessment carried out in preparing this Environmental Impact Statement indicates that there would be no threat of serious or irreversible damage to the environment.

In addition, the lack of full scientific certainty has not been used as a reason for postponing measures to prevent environmental degradation. As detailed in each impact assessment chapter, mitigation measures have been proposed to manage identified risks/threats of environmental damage.

The assessments carried out are consistent with accepted scientific and assessment methodologies and have considered relevant statutory and agency requirements. The assessments have applied a conservative approach with regard to proposed construction and operational arrangements, and the modelling used has been carried out in collaboration with key stakeholders and relevant statutory and agency requirements.

Intergenerational equity

The objectives of Sydney Metro West are essentially around ensuring an efficient and reliable public transport network. This would benefit current and future generations. Once operational, Sydney Metro West would leave a positive legacy for future generations. It would provide long term benefits by strengthening connections and access across Sydney, providing improved connectivity on the rail network and improving the capacity, reliability and efficiency of the transport system. The Concept would address emerging issues with respect to capacity and congestion which otherwise would be more difficult to address at a future stage. The Concept would improve the quality of the transport experience for customers.

In addition to the broader Sydney transport operational benefits, the 'door-to-door' experience provided by Sydney Metro West could also result in long-term health benefits with the creation of safer and more appealing conditions for pedestrians, cyclists and other transit users. These benefits would also flow through to future generations.

Sydney Metro West would result in a greater demand on electricity however operational electricity use would be fully offset. Significant changes to carbon and energy policy (and legislation) are currently occurring in Australia which aim to shift electricity generation from coal fired to renewable sources. As more electricity is generated from renewable sources, the climate change benefits of using electric rail would be improved. A range of measures to mitigate greenhouse gas emissions have been developed and would be implemented.

Conservation of biological diversity and ecological integrity

Conservation of biological diversity and ecological integrity has been considered throughout the project development and design stages (refer Chapter 26 (Sustainability)). The construction footprint has been developed to avoid or minimise impact to areas of high ecological value. Detailed assessments have been carried out to identify flora and fauna impacts and a range of mitigation measures identified for implementation. Impacts on biological diversity and ecological integrity have been assessed as minor.

Improved valuation and pricing of environmental resources

Economic appraisal of Sydney Metro West draws on a number of established methodologies which provide for the valuation of externalities, including environmental externalities, and their inclusion in the appraisal process. Environmental parameters which can be valued include air pollution, greenhouse gas emissions, noise pollution, water run-off, nature and landscape and urban separation. Valuations typically adopt broad average values.

The value placed on the environment was inherent in the development of the design. In addition, the costs associated with the planning and design of measures to avoid/minimise adverse environmental impacts and the costs to implement them have been built into the overall project costs. Ongoing and detailed design together with specific issue-based management plans would represent further commitment to the recognition of the value of protecting environmental resources.

28 Environmental risk analysis

28 Environmental risk analysis

This chapter provides an environmental risk analysis for the Concept and Stage 1.

28.1 Secretary's environmental assessment requirements

The Secretary's Environmental Assessment Requirements relating to environmental risk analysis, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 28-1.

Table 28-1: Secretary's Environmental Assessment Requirements – Environmental risk analysis

Reference	Secretary's Environmental Assessment Requirements	Where addressed
3. Key issues		
3.3	For each Stage 1 key issue, the Proponent must: d. identify, describe and quantify (if possible) the impacts associated with the issue, including the likelihood and consequence (including realistic worst case scenario) of the impact (comprehensive risk assessment), the impacts of concurrent activities and cumulative impacts (parallel and sequential) with other projects	Section 28.3 Section 28.5

28.2 Environmental risk analysis methodology

The environmental risk analysis was undertaken in accordance with the principles of the Australian and New Zealand standard AS/NZS ISO 31000:2018 Risk Management – Guidelines. This involved identifying foreseeable risks of the Concept and Stage 1 and understanding the implications that could occur from each risk, that is, the potential impact. The risk of each potential impact was evaluated by identifying the consequence of the potential impact and the likelihood of each impact occurring.

The first step in the risk analysis involved evaluating the consequence of an identified potential impact, which requires making professional judgements about the possible results of an impact if it occurs. The definitions of the consequences used are provided in Table 28-2. This is followed by identifying the likelihood of the potential impact occurring with the definitions of likelihood provided in Table 28-3. The consequence and likelihood are combined to identify the level of risk of the potential impact, as shown in the risk matrix in Table 28-4.

Table 28-2: Consequence definitions

Consequence level	Definition
Catastrophic	• Long-term (greater than 12 months) and irreversible large-scale environmental impact with loss of valued ecosystems • Extended substantial disruptions and impacts to stakeholder(s) or customers.
Severe	• Long-term (6 to 12 months), long-term environmental impairment in neighbouring or valued ecosystems. Extensive remediation required • Severe disruptions or long-term impacts to stakeholder(s) or customers
Major	• Medium-term (between 3 and 6 months), impacts external ecosystem and considerable remediation is required • Major impacts or disruptions to stakeholder(s) or customers.
Moderate	• Medium-term (between 1 and 3 months), short-term and/or well-contained environmental effects. Minor remedial actions probably required • Moderate impacts or disruptions to stakeholder(s) or customers.
Minor	• Short-term (less than 1 month), change from normal conditions within environmental regulatory limits and environmental effects are within site boundaries • Minor or short-term impacts to stakeholder(s) or customers.
Insignificant	• No noticeable or visible changes to environment and/or highly localised event • Negligible impact to environment, stakeholder(s) or customers.

Table 28-3: Likelihood definitions

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

Table 28-4: Risk matrix

Likelihood	Definition					
	Insignificant	**Minor**	**Moderate**	**Major**	**Severe**	**Catastrophic**
Almost certain	Medium	High	High	Very high	Very high	Very high
Very likely	Medium	Medium	High	High	Very high	Very high
Likely	Low	Medium	Medium	High	High	Very high
Unlikely	Low	Low	Medium	Medium	High	High
Very unlikely	Low	Low	Low	Medium	Medium	High
Almost unprecedented	Low	Low	Low	Low	Medium	Medium

28.3 Identification of key issues

Various environmental risk identification and analyses have been carried out during the development of Sydney Metro West – refer to Chapter 3 (Sydney Metro West development and alternatives). Most relevant to this chapter is the risk analysis carried out for the Sydney Metro West Scoping Report – Westmead to The Bays and Sydney CBD (Sydney Metro, 2019). This document, along with the assessments in this Environmental Impact Statement, identifies the key environmental issues associated with the Concept and Stage 1.

28.4 Environmental risk analysis – Concept

Using the framework described above, a preliminary environmental risk analysis was carried out for the Concept. A preliminary risk analysis workshop was held on 13 December 2018 to categorise issues as 'key' or 'other' to form the basis of the Scoping Report in seeking the Secretary's Environmental Assessment Requirements.

The risk analysis identifies an initial risk rating for each of the environmental issues and provides a description of how the risk ratings were derived. Further details regarding the existing environment and potential impacts associated with each environmental issue are provided for the Concept in Chapter 8 (Concept environmental assessment).

A further risk workshop and follow up risk analysis was carried out once results from the impact assessment and the detailed specialist investigations were available.

This enabled the risk analysis to be refined and performance outcomes to be assigned to each environmental issue. Performance outcomes for each of the potential risks are provided for the Concept in Chapter 8 (Concept environmental assessment).

The purpose of the Concept risk assessment is to identify key and other issues for assessment of future stages. The following guiding principles were applied:

- Risk ratings were considered at the broader issue level (for example construction noise and vibration). This allows for a focus on these issues during the design, development and assessment of subsequent stages of the Concept
- Only initial risk ratings were considered. Mitigation measures to inform a residual risk rating would be identified as part of assessments of future stages. Based on performance outcomes in Chapter 27 (Synthesis) and experience on previous projects, the potential risks and impacts can be appropriately managed to acceptable levels.

This risk analysis will be re-examined at key stages during future environmental assessments for subsequent stages of the Concept.

The environmental risk analysis for the Concept is shown in Table 28-5.

Table 28-5: Environmental risk analysis – Concept

Potential risks	Risk rating			Discussion
	Consequence	Likelihood	Risk rating	
Operational road transport and traffic				
• Potential deterioration of traffic performance on surrounding road network due to permanent altered traffic arrangements, road or lane closures • Potential changes to availability, location and number of parking spaces or loading zones • Potential alterations to existing pedestrian and cyclist arrangements to enable safe and convenient access and egress from the new metro stations • Changes to bus stop locations, routes and timetables to provide transport integration with metro stations • Potential for permanent changes to property access, particularly adjacent commercial and retail properties	Minor	Unlikely	Low	The Concept would improve the transport system by providing a stand-alone railway network with the capacity to operate 30 trains an hour in each direction. It would integrate with the existing transport network, help to relieve congestion on the existing rail network and stations, and reduce the number of cars on the surrounding road network. Changes to the network would likely include alterations to bus stop locations or the provision of a small number of kiss-and-ride and/or taxi spaces around the stations to enhance transport interchange. The Concept would not involve the provision of any major traffic generating features such as park-and-ride.
Construction transport and traffic				
• Potential temporary deterioration of traffic performance on surrounding road network to an unacceptable level of service, due to construction vehicles and temporary road or lane closures • Temporary loss of parking spaces or loading zones potentially affecting accessibility to transport, services and/or businesses • Potential temporary reduced pedestrian and cyclist access or flows due to construction • Potential temporary impacts on access to private (commercial and/or residential) property • Potential temporary reduced safety and amenity for traffic, pedestrians and cyclists due to construction activities, including within existing stations, and due to potential conflicts with construction vehicles. This would be managed through implementation of measures such as manual supervision, physical barriers, temporary traffic signals and modifications to existing signals • Potential temporary impacts on reliability of public transport services (Sydney Trains and buses), including relocation of bus stops, bus diversions and activities within the rail corridor	Moderate	Almost certain	High	A substantial number of heavy vehicles would be temporarily required to transport material to and from construction sites. Additionally, construction activities may require: • The temporary or permanent closure of some sections of roadways • Temporary alterations to pedestrian and cyclist facilities • Temporary alterations to existing public transport infrastructure or timetables.
Operational noise and vibration				
• Potential exceedances of airborne noise criteria from the stabling and maintenance facility • Potential exceedances of airborne noise criteria from stations or other surface infrastructure for fresh air ventilation, mechanical and electrical equipment, substations, public address systems • Potential exceedances of human comfort vibration levels from train operations • Potential exceedances of building or structure damage vibration levels from train operations • Potential exceedances of ground-borne noise criteria from train operations	Moderate	Very unlikely	Low	Operational noise and vibration levels are anticipated to comply with relevant guidelines. Train operation would mainly occur underground within twin tunnels. Ground-borne noise and vibration levels from operating trains are anticipated to be minor with the implementation of standard environmental management measures. The Clyde stabling and maintenance facility would be located aboveground, but within an industrial area with minimal sensitive receivers except the Rosehill Gardens racecourse and the stables which are located nearby.
Construction noise and vibration				
• Potential temporary exceedances of airborne noise management levels from tunnelling and surface construction sites during standard construction hours • Potential temporary exceedances of airborne noise management levels from tunnelling and surface construction sites outside standard construction hours • Potential temporary construction traffic potentially resulting in an increase in traffic noise greater than 2 dB • Potential temporary exceedances of human comfort or damage vibration levels from tunnelling or surface activities • Potential temporary exceedances of ground-borne noise criteria from tunnelling	Major	Almost certain	Very high	Temporary construction activities would occur across multiple construction sites. Some construction sites would be directly adjacent to residential areas/properties – including at Westmead, North Strathfield, Burwood North and Five Dock. Construction activities would likely temporarily exceed the relevant noise management levels for at least some locations and for some of the construction period. Additionally, activities outside of standard daytime construction hours would likely be required at some locations.

Potential risks	Risk rating			Discussion
	Consequence	Likelihood	Risk rating	
Non-Aboriginal heritage				
• Potentially unsympathetic design of operational infrastructure that detracts from the heritage significance of nearby heritage item(s) • Potential direct and indirect impacts on local and s170 register listed items during construction • Potential direct and indirect impacts on State Heritage Register listed items during construction • Potential indirect impacts on Commonwealth, or National heritage during construction • Potential damage to heritage items from vibration and settlement during tunnelling, construction and operation • Potential temporary change to the values of a heritage conservation area during construction • Potential impacts of temporary construction activities within the curtilage of listed items, but with no direct impacts on the significant components • Potential impacts on unknown heritage items (e.g. archaeological items) during construction	Moderate	Almost certain	High	Components of the Concept may impact heritage listed items or conservation areas during construction and operation but would be designed to minimise potential impacts.
Aboriginal heritage				
• Potential impacts on known Aboriginal heritage items • Potential impacts on areas of known Aboriginal cultural sensitivity • Potential impacts on unidentified Aboriginal heritage items	Major	Likely	High	Components of the Concept may impact on previously recorded Aboriginal heritage sites. Construction activities are expected to avoid or minimise impacts to known Aboriginal heritage items, however there would be potential impacts to items within the Parramatta Sand Body (a resource known to contain high potential for Aboriginal archaeology).
Property and land use				
• Potential incompatibility between Concept infrastructure and facilities and intended future surrounding land use (including restrictions on future development due to subsurface tunnels conflicting with a strategic plan) • Property acquisition • Potential direct impacts on other infrastructure during construction including utilities and Sydney Trains managed property	Major	Likely	High	The proposed stations would support planned growth and provide opportunities to integrate with existing or planned land use objectives. Several of the stations would be located within existing (or future) major commercial/strategic centres, and the proposed stations could potentially influence the development and delivery timeframes of surrounding precincts. Station place and design principles have been identified that will be supported by the Sydney Metro Design Quality Framework, Design Review Panel, and Design Guidelines. Acquisition of properties would be undertaken in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and the land acquisition reforms announced by the NSW Government. Sydney Metro has appointed Personal Managers to offer residents and small businesses assistance and support throughout the acquisition process.
Landscape character and visual amenity				
• Potential changes (potentially positive and negative) to visual setting and landscape character during operation associated with the introduction of new stations, new public spaces, and other surface infrastructure (stabling facility, fresh air tunnel ventilation facilities, etc.) • Potential temporary impacts on landscape character during construction due to activities associated with new stations, ancillary infrastructure, and the stabling and maintenance facility (e.g. loss of street trees, parking/use of plant and equipment etc.) • Potential temporary impacts on visual amenity from private/public places as a result of acoustic sheds or other acoustic measures and hoardings associated with construction sites • Potential temporary light spill from construction sites at night • Potential light spill from stations, the stabling and maintenance facility and other operational infrastructure	Major	Likely	High	The stations, stabling and maintenance facility and ancillary infrastructure would introduce new built elements into the surrounding environment. The introduction of a new metro stations is expected to result in a positive landscape character impact and improved visual amenity during operation for areas surrounding stations, particularly where new stations are replacing building stock with unsympathetic visual design or which is old and in poor condition. Demolition of buildings for surface infrastructure would be required, resulting in a change to the current visual environment. The introduction of construction sites and use of acoustic sheds or other acoustic measures would result in a temporary change in the visual landscape.
Groundwater and ground movement				
• Potential groundwater drawdown/lowering of the water table due to dewatering during tunnel and station excavations and/or drawdown incurred by bed cracking or interference with geological features beneath surface-water bodies and drainage lines • Potential impacts on groundwater users due to reduced groundwater yields, reduced groundwater quality and/or direct impacts and damage to existing groundwater bores • Potential reduced baseflow in surface creeks or other surface water features due to groundwater drawdown • Potential ground movement/settlement due to tunnelling and other excavations • Potential ongoing operational changes to groundwater flows and levels from underground stations and other untanked structures	Moderate	Likely	Medium	The excavation of the tunnels and underground stations during construction may result in localised changes to the hydrogeological environment associated with groundwater drawdown. The tunnels and the majority of stations are proposed to be tanked, which would limit the potential impacts of this component of the Concept to the construction phase. Ground movement and settlement is expected to be negligible.

Potential risks	Risk rating			Discussion
	Consequence	Likelihood	Risk rating	
Soils and water quality				
• Potential temporary erosion of soils resulting in offsite sedimentation of waterways and exceedances of water quality criteria during construction • Potential exposure of acid sulfate soils during construction resulting in off-site discharge of acidic water • Potential exposure of soil salinity/saline soils during construction resulting in off-site discharge of saline water resulting in exceedances of water quality trigger levels • Potential water quality impacts on nearby watercourses due to discharge of treated groundwater, contaminated water, or spills during construction and operation • Potential contamination of land or groundwater due to spills and leaks during construction	Minor	Unlikely	Low	Potential impacts such as erosion and sedimentation, and spill or leaks are anticipated to be manageable through the implementation of standard environmental management measures. Groundwater captured from the tunnel excavation would be treated prior to discharge. Acid sulfate soils are likely to occur, and would need to be managed at the Parramatta, Clyde stabling and maintenance facility, and The Bays construction sites.
Contamination				
• Disturbance of contaminated land during construction potentially causing impact to human health or receiving environments • Disturbance of contamination (soil or groundwater) potentially exacerbating existing contamination risks by mobilising otherwise stable contamination and potentially causing contaminated media to migrate across sites or off-site • Potential contamination of groundwater and land due to spills and leaks during operation	Major	Likely	High	Known contaminated sites could be encountered and disturbed at Clyde stabling and maintenance facility, Silverwater services facility, Sydney Olympic Park and The Bays construction sites. Localised contaminated soils could also be encountered at other locations. Appropriate management approaches would be developed to manage contamination.
Social impacts and community infrastructure				
• Health and liveability benefits associated with increased access to public transport during operation • Improved access to employment, education and entertainment opportunities during operation • Potential temporary changes to the way of life for residents close to the construction sites • Potential permanent loss of community facilities/open space, and changes in access to community facilities during operation • Potential community concern and disruption to people from property acquisition and/or termination of existing residential or commercial leases • Potential community concern with proposed changes to the character of local areas • Potential temporary social impact on broader community from construction activities • Potential temporary impacts, or temporary loss of, community facilities/open space due to construction activities and/or changes to access during construction	Major	Likely	High	The Concept would facilitate transit-oriented development through the generation of new rail catchment areas. Health and liveability benefits would primarily be associated with increased active transport opportunities around stations. Acquisition of residential and commercial properties is required for the proposed station sites and construction areas and would be managed in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and the land acquisition reforms announced by the NSW Government. Sydney Metro has appointed Personal Managers to offer residents and small businesses assistance and support throughout the acquisition process. Construction activities may result in some temporary social impacts, both for individuals and the community at various sites along the corridor. Construction activities may result in the temporary or permanent loss of community facilities and/or public open space. Opportunities to minimise these impacts (such as replacement of facilities within the local area) would be explored.
Business impacts				
• Potential alterations to access, visibility and amenity of business premises during operation • Potential temporary disruptions to servicing, deliveries and access during construction (including from traffic congestion) • Potential temporary loss of power and utilities by planned or accidental shutdowns during construction • Potential temporary reduced visibility during construction activities, due to hoardings and other structures • Potential temporary reduced amenity (particularly due to noise, vibration, visual and air quality impacts) during construction • Property acquisition or termination of existing leases, and associated business impacts	Major	Likely	High	Operation of the Concept would provide benefits for some businesses located close to new metro stations. Acquisition of premises owned or leased by businesses is required for the proposed station sites and construction areas. This would be managed in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and the land acquisition reforms announced by the NSW Government. Sydney Metro has appointed Personal Managers to offer residents and small businesses assistance and support throughout the acquisition process. Businesses adjacent to construction sites may also be temporarily impacted by changes to amenity, access and visibility of the business. Businesses that supply to the construction sector and certain business types near construction sites may experience increased business activity.
Hydrology and flooding				
• Potential alterations to existing stormwater flows and the existing stormwater drainage infrastructure • Potential impacts on construction activities due to changes to flooding regimes • Potential impacts on flood-prone areas (e.g. increase in flood risk outside the construction sites) due to new structures or displacing flood storage areas • Potential temporary flooding of the tunnels or other infrastructure during construction and operation	Moderate	Likely	Medium	A number of sites are located within flood prone land. The protection of the infrastructure from potential floods and any potential impacts on off-site flood behaviour are anticipated to be manageable through appropriate project design.

Potential risks	Risk rating			Discussion
	Consequence	Likelihood	Risk rating	
Biodiversity				
• Potential impacts on threatened ecological communities within or proximate to the construction footprint • Potential impacts on groundwater dependent ecosystems • Potential impacts on native vegetation • Potential impacts on threatened flora species • Potential impacts on threatened fauna species, migratory and endangered populations due to clearing of habitat, demolition of existing buildings and structures and/or as a result of collisions with construction plant and vehicles • Potential indirect impacts on biodiversity values such as from light and noise impacts, sedimentation, spread of weeds	Minor	Likely	Medium	The potential for biodiversity impacts is anticipated to be limited. While construction sites may provide suitable habitat for some threatened fauna species and endangered populations, the potential removal of this habitat is considered to be minor and these species are likely to be highly mobile. Any species present are likely to be accustomed to impacts such as noise and light spill which are already occurring. Loss of mangrove and riparian vegetation would occur in sections of Duck Creek and A'Becketts Creek, however these impacts would be minimised as much as possible. Any residual impacts would be offset in accordance with the *Biodiversity Conservation Act 2016*.
Air quality				
• Potential impacts on local air quality around stations, services facilities and at the stabling and maintenance facility from train operations (brake wear and metal wear), routine maintenance activities and emergency conditions (e.g. in-tunnel fire) • Potential temporary impacts on local air quality due to construction plant and equipment and increase in vehicle movements during construction • Potential temporary impacts on local air quality during construction due to dust generation from exposed surfaces, spoil stockpiles or spoil haulage	Minor	Unlikely	Low	The operation of the Concept could contribute to long-term improvements in air quality associated with a potential mode shift by customers from road to rail. Potential temporary air quality impacts during construction and operation are anticipated to be minor and similar to other infrastructure projects of this nature and scale. These impacts would be manageable through the implementation of standard environmental management measures.
Greenhouse gas and energy				
• Emissions of greenhouse gases from embodied energy in materials • Emissions of greenhouse gases from construction activities including energy use for tunnel boring machines over and above emissions for similar projects of a comparable scale	Minor	Unlikely	Low	The Concept could contribute to a long-term reduction in greenhouse gas emissions associated with a potential mode shift by customers from road to rail. The generation of greenhouse gas emissions during construction would be similar to other infrastructure projects of this nature and scale. These impacts would be manageable through the implementation of standard environmental management measures. Options to reduce greenhouse gas emissions and energy use when compared to other metro projects would be investigated.
Climate change adaptation				
• Impact of climate change on rail operations and infrastructure • Impact of climate change on customer and staff comfort	Moderate	Very unlikely	Low	Potential climate change impacts have been considered through design development and would be managed through the implementation of appropriate design standards.
Spoil, waste management and resource use				
• Potential impacts associated with inappropriate management of waste during construction and operation • Potential temporary impacts associated with the management and disposal of excess spoil from tunnel construction • Potential increased demand on electricity and water supply during construction and operation • Potential temporary increased demand on local and regional resources including sand and aggregate during construction • Potential temporary increased diesel use during construction	Minor	Unlikely	Low	Spoil generated during the construction of the Concept would be classified in accordance with NSW Waste Classification Guidelines (Environment Protection Authority, 2014) and managed consistently with the adopted hierarchy of management options (reuse on Sydney Metro sites, reuse off site, recycling, disposal). The generation of waste and the anticipated resource consumption during construction would be similar to other infrastructure projects of this nature and scale. These impacts would be managed through the implementation of standard environmental management measures (such as application of the waste management hierarchy). Waste generated by the construction and operation of the Concept would be managed in accordance with the Sydney Metro West Sustainability Plan, and waste hierarchy outlined in the *Waste Avoidance and Resource Recovery Act 2001*. Construction activities would be unlikely to result in any resource becoming scarce or in short supply.

Potential risks	Risk rating			Discussion
	Consequence	Likelihood	Risk rating	
Hazards				
• Potential incidents associated with transport and storage of hazardous substances and dangerous goods during construction • Potential for tunnel collapse during construction • Potential impacts to utilities • Potential hazards to customers and public safety and security • Potential unauthorised access to the rail corridor	Major	Almost unprecedented	Low	Potential hazards and risks during construction and operation would be managed through the implementation of appropriate design standards and construction methodologies.
Cumulative impacts				
• Potential temporary cumulative construction noise and traffic associated with other major projects • Temporary spoil management and disposal from multiple tunnelling projects in Sydney • Temporary construction fatigue of local communities affected by multiple projects either at the same time or occurring consecutively	Major	Almost certain	Very high	Construction activities may be carried out concurrently with, or consecutively to, a number of other major infrastructure projects in Sydney. This may result in temporary cumulative impacts associated with noise and traffic during construction, particularly around Parramatta and The Bays. Strategies for spoil management and community engagement would consider coordination with other projects.

28.5 Environmental risk analysis – Stage 1

Following the environmental risk analysis for the Concept, issues relevant to Stage 1 have been subjected to a further risk analysis of the specific Stage 1 impacts and mitigation measures.

The purpose of the Stage 1 risk analysis was to provide early identification of high residual impacts to allow a focus on these areas during the refinement of the design and the development of construction planning and methodologies. As a result, the risk analysis for Stage 1 was carried out at a greater level of detail than the Concept. The following considerations guided the risk analysis:

- Risk ratings were considered at a more detailed issue level (for example construction airborne noise and vibration from daytime works)
- Industry standard practice was considered in determining initial risk ratings, and project-specific mitigation and performance outcomes were applied for residual risk ratings.

Further details regarding the existing environment and potential impacts associated with each environmental issue are provided for Stage 1 in Chapters 10 to 26. The environmental risk analysis for Stage 1 is documented in Table 28-6.

Table 28-6: Environmental risk analysis – Stage 1

Potential impact	Initial risk rating (unmitigated)			Effect of key Stage 1 proposed mitigation measures[1]	Residual risk rating (with mitigation)		
	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating		Residual consequence	Residual likelihood	Residual risk rating
Construction transport and traffic							
Potential temporary deterioration of traffic performance on surrounding road network to an unacceptable level of service due to construction vehicles and temporary road or lane closure	Moderate	Almost certain	High	Mitigation measures in relation to minimising construction vehicle movements in peak periods and during school drop off and pick up times would reduce the likelihood of traffic conflicts and congestion	Moderate	Likely	Medium
Temporary loss of parking spaces or loading zones undermining accessibility to transport, services and/or businesses. While impacts to on-street car parking would be minimal, the Parramatta metro station construction site would require the demolition of the City Centre car park and some off-street parking spaces – a loss of 850 parking spaces. The demolition of the City Centre car park was previously identified in the Draft Parramatta CBD Public Car Parking Strategy (City of Parramatta, 2017) along with measures to offset potential loss of car parking in Parramatta CBD. Parking spaces would also be lost from streets near Westmead, Parramatta, Silverwater, North Strathfield, Burwood North, and Five Dock construction sites	Moderate	Almost certain	High	Minimising the demand for parking at construction sites would reduce the consequence of impacts from loss of parking at construction sites	Minor	Almost certain	High
Potential temporary reduced pedestrian and cyclist access or flows due to construction	Moderate	Likely	Medium	Provision and management of alternative routes, including signage, would reduce the consequence of impacts on cyclists and pedestrians	Minor	Likely	Medium
Potential temporary changes to access to private property	Moderate	Likely	Medium	Maintaining access to adjacent properties and buildings would reduce the consequence and likelihood of impacts	Minor	Unlikely	Low
Potential temporary reduced safety and amenity for traffic, pedestrians and cyclists due to construction activities, including within existing stations, and due to potential conflicts with construction vehicles	Major	Unlikely	Medium	Measures at site access points and additional road safety enhancements for pedestrian, cyclist and motorist safety near the construction sites would reduce the likelihood of impacts	Major	Very unlikely	Medium
Potential temporary impacts to the availability of on street parking in local streets surrounding construction sites	Moderate	Likely	Medium	Minimising demand for parking at construction sites would reduce the consequence and likelihood impacts	Minor	Unlikely	Low
Potential temporary delays to emergency vehicles in the vicinity of the Westmead metro station construction site	Severe	Likely	High	Access for emergency vehicles would be maintained at all times and emergency service providers would be consulted during construction. This would reduce the likelihood of impacts	Severe	Almost unprecedented	Medium
Potential temporary impacts on reliability of public transport services (Sydney Trains and buses), including temporary relocation of bus stops, bus diversions and activities within the rail corridor, particularly in Westmead, Parramatta, North Strathfield and Burwood North	Minor	Almost certain	High	Consultation with the relevant council and public transport service operators, and use of wayfinding signage would reduce the consequence of impacts	Insignificant	Almost certain	Medium
Construction noise and vibration							
Potential temporary exceedances of airborne noise management levels from tunnelling and surface construction sites during standard construction hours impacting sensitive receivers	Major	Almost certain	Very high	Application of feasible and reasonable noise mitigation measures, including use of low noise equipment, acoustic sheds and respite periods would reduce the likelihood and consequence of noise impacts	Moderate	Very likely	High
Potential temporary exceedances of airborne noise management levels from tunnelling and surface construction sites outside standard construction hours impacting sensitive receivers	Major	Almost certain	Very high	Minimising noisy activities at night-time and offering additional mitigation measures as outlined in the Sydney Metro Construction Noise and Vibration Standard (Appendix E would reduce the likelihood and consequence of night-time noise impacts	Moderate	Very likely	High
Temporary construction traffic resulting in a potential increase in traffic noise greater than 2 dB	Moderate	Likely	Medium	Minimising truck movements past sensitive receivers and during night-time periods would reduce the likelihood and consequence of traffic noise impacts	Minor	Unlikely	Low
Potential temporary exceedances of human comfort or damage vibration levels from tunnelling or surface activities	Moderate	Very likely	High	Further assessment of relevant structures to determine appropriate vibration levels and adjusting work methods where required would reduce the consequence of potential impacts	Minor	Very likely	Medium
Potential temporary exceedances of ground-borne noise criteria from tunnelling	Moderate	Very likely	High	Measures such as scheduling of noisy activities, prior notification to receivers, monitoring, and the additional mitigation measures outlined in the Sydney Metro Construction Noise and Vibration Standard (Appendix E) would reduce the consequence of impacts	Minor	Very likely	Medium

Potential impact	Initial risk rating (unmitigated)			Effect of key Stage 1 proposed mitigation measures[1]	Residual risk rating (with mitigation)		
	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating		Residual consequence	Residual likelihood	Residual risk rating
Non-Aboriginal heritage							
Potential direct and indirect impacts on local and s170 register listed items during construction	Major	Likely	High	Use of low impact demolition methods would reduce the likelihood of indirect impacts on heritage items. Archival reporting and heritage interpretation would reduce the consequence of direct impacts on heritage items	Minor	Likely	Medium
Potential indirect impacts associated with views and vibration on State significant items during construction including the Roxy Theatre (Parramatta) and White Bay Power Station (The Bays)	Major	Likely	High	Use of low impact demolition methods would reduce the likelihood of impacts on State significant heritage items	Major	Very unlikely	Medium
Potential direct and indirect impacts on the State significant State Abattoir (Sydney Olympic Park).	Moderate	Very likely	High	Reinstatement of the garden in accordance with the Conservation Management Plan would reduce the consequence of impacts	Minor	Very likely	Medium
Potential damage to heritage items from vibration and settlement during tunnelling and construction	Moderate	Unlikely	Medium	Feasible and reasonable measures would be informed by detailed assessments and condition surveys to reduce the likelihood of vibration impacts on heritage items	Moderate	Very unlikely	Low
Temporary impacts on the values of The Valley heritage conservation area near The Bays Station construction site	Minor	Likely	Medium	Measures to reduce the visual impacts to The Bays Station construction site would also reduce the likelihood of impacts to the conservation area	Minor	Very unlikely	Low
Potential impacts of temporary construction activities within the curtilage of listed items, but with no direct impacts on the significant components	Moderate	Unlikely	Medium	Use of low impact demolition methods would reduce the likelihood of indirect impacts on heritage items	Moderate	Very unlikely	Low
Potential impacts during construction on unknown heritage items (e.g. archaeological items) associated with the earliest phases of European settlement, including convict huts, yards and gardens at Parramatta CBD	Moderate	Very likely	High	Archaeological research design(s) informing archaeological testing, monitoring and mitigation measures, prepared in consultation with the NSW Heritage Division, including in situ conservation of State significant archaeology where feasible and reasonable, would reduce the consequence of impacting archaeological items	Minor	Very likely	Medium
Aboriginal heritage							
Potential impacts on a known Aboriginal heritage item (at the Parramatta metro station construction site)	Major	Almost certain	Very high	Archaeological test excavation, including salvage when required, and interpretation, would reduce the consequence of the impact	Minor	Almost certain	High
Potential impacts on areas of known Aboriginal cultural sensitivity such as the Parramatta Sand Body	Major	Very likely	High	Archaeological test excavation, including salvage when required, and interpretation, undertaken in consultation with Aboriginal parties would reduce the consequence of the impact	Minor	Very likely	Medium
Potential impacts on unidentified Aboriginal heritage items, particularly in areas with potential archaeological sensitivity such as Clyde stabling and maintenance facility and The Bays Station construction sites.	Major	Likely	High	Archaeological test excavation, including salvage when required, and interpretation, carried out in consultation with Aboriginal parties would reduce the likelihood and consequence of impacts on unidentified Aboriginal heritage items	Moderate	Unlikely	Medium
Property and land use							
Potential restrictions on future development due to subsurface tunnels and other infrastructure	Minor	Unlikely	Low	In most cases, subsurface acquisition does not affect the continued existing or intended future uses of property at the surface. As such, mitigation measures are not required	Minor	Unlikely	Low
Landscape character and visual amenity							
Potential temporary impacts on landscape character during construction activities associated with new stations, ancillary infrastructure, and the stabling and maintenance facility (e.g. loss of street trees, use of plant and equipment etc.)	Major	Almost certain	Very high	Design of construction sites, including location of structures and buildings, design of hoardings, public art opportunities, and retention and replacement of trees would reduce the consequence of impacts on landscape character	Moderate	Almost certain	High
Potential temporary impacts on visual amenity from private/ public places as a result of acoustic sheds (or other acoustic measures) and hoardings associated with construction sites	Major	Almost certain	Very high	Design of acoustic measures and hoardings would seek to reduce the impact on views, would be maintained and kept free of graffiti, and would incorporate public art where appropriate to reduce consequence of impacts to visual amenity	Moderate	Almost certain	High
Potential temporary light spill from construction sites at night	Moderate	Very likely	High	Lighting of construction sites would be orientated to minimise glare and light spill, thereby reducing the consequence and likelihood of light spill impacts on adjacent receivers	Minor	Unlikely	Low
Business impacts							
Potential temporary disruptions to servicing, deliveries and customer access during construction (including from traffic congestion and loss of parking)	Major	Likely	High	Access to businesses would be maintained for customers, servicing and deliveries, reducing the likelihood of business disruption	Major	Unlikely	Medium
Potential need for some businesses to find new suppliers	Minor	Very unlikely	Low	Engagement with small business owners adversely impacted by construction would reduce the consequence of the potential impact	Insignificant	Very unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Effect of key Stage 1 proposed mitigation measures[1]	Residual risk rating (with mitigation)		
	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating		Residual consequence	Residual likelihood	Residual risk rating
Potential temporary loss of power and utilities during planned or accidental shutdowns during construction	Moderate	Likely	Medium	Planned power and utility interruptions would be scheduled to outside of typical business hours where feasible and reasonable, reducing the likelihood of impacts	Moderate	Very unlikely	Low
Potential temporary reduced business visibility through the presence of construction activities, hoardings and other structures	Major	Likely	High	Appropriate design and location of hoarding, clear pathways, signage and lighting would maximise visibility of businesses. EEngagement with small business owners adversely impacted by construction would be undertaken. These measures would reduce the likelihood and consequences of reduced business visibility	Minor	Unlikely	Low
Potential temporary reduction in amenity at nearby business premises (particularly due to noise, vibration, visual and air quality impacts)	Moderate	Likely	Medium	Noise, visual and air quality mitigation measures would minimise local amenity impacts of construction, reducing the consequences of these impacts for businesses. Engagement with small business owners adversely impacted by construction would reduce the consequence of the potential impact	Minor	Likely	Medium
Impacts to businesses located within properties being acquired	Minor	Very unlikely	Low	Sydney Metro manages property acquisition in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*, and has appointed Personal Managers to support small businesses throughout the acquisition process. As such no further mitigation measures are required	Minor	Very unlikely	Low
Social impacts							
Potential temporary impacts on the way of life for local communities, local employees and visitors due to travel disruptions and changes to routines	Moderate	Likely	Medium	Access would be maintained to local services, business and public transport infrastructure. Consultation with the relevant council and public transport service operators, and use of wayfinding signage would minimise disruptions reducing the consequence of impacts	Minor	Likely	Medium
Potential community concern with proposed changes to the character of local areas	Moderate	Likely	Medium	The development and implementation of a community benefit plan would provide local benefits to counteract and reduce the likelihood of potential impacts	Moderate	Unlikely	Medium
Potential community concern and disruption to people from property acquisition	Major	Likely	High	Sydney Metro manages property acquisition in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*, and has appointed Personal Managers to support residents throughout the acquisition process, reducing the consequence and likelihood of impacts	Moderate	Unlikely	Medium
Potential temporary impacts on community facilities or open space due to construction activities including changes to access and amenity during construction	Moderate	Likely	Medium	Noise, traffic, access and local amenity mitigation measures would reduce the consequence and likelihood of impacts affecting the useability of social infrastructure, including community facilities and open space	Minor	Unlikely	Low
Groundwater and ground movement							
Potential impacts on groundwater supply due to reduced groundwater yields or reduced groundwater quality at two groundwater bores near Westmead and Burwood North	Moderate	Unlikely	Medium	Groundwater levels and quality, including existing viable water bores, would be monitored throughout construction, and make good measures would be implemented if a loss of yield were to occur, reducing the consequence and likelihood of impacts from groundwater drawdown	Insignificant	Unlikely	Low
Potential loss or changes to baseflow of surface water features due to groundwater drawdown	Moderate	Likely	Medium	Additional site investigations would be carried out at potentially affected watercourses to confirm the existing groundwater baseflow contribution to the streamflow. Where a significant reduction in baseflow is identified, design responses would be implemented to reduce potential baseflow loss reducing the consequence and likelihood of potential impacts from groundwater drawdown	Minor	Unlikely	Low
Potential ground movement/ settlement due to tunnelling and other excavations	Moderate	Likely	Medium	A structural assessment of the potentially affected buildings/ structures would be carried out and specific measures implemented to address the risk of damage, reducing the likelihood of adverse impacts from ground movement/ settlement	Moderate	Very unlikely	Low
Soils and surface water quality							
Temporary erosion of soils resulting in off-site sedimentation of waterways during construction, potentially resulting in exceedances of water quality criteria	Moderate	Unlikely	Medium	Erosion and sediment control measures would be implemented in accordance with the principles and requirements in Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom 2004) and Volume 2D (NSW Department of Environment, Climate Change and Water 2008), and water collected from construction sites would be appropriately treated prior to discharge, reducing the consequences of soil erosion	Minor	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Effect of key Stage 1 proposed mitigation measures[1]	Residual risk rating (with mitigation)		
	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating		Residual consequence	Residual likelihood	Residual risk rating
Potential exposure of acid sulfate soils during construction, potentially resulting in off-site discharge of acidic water	Moderate	Unlikely	Medium	Acid sulfate soil testing would be carried out to determine the presence of actual and/or potential acid sulfate soils, enabling management measures to be implemented in accordance with the Acid Sulfate Soil Manual (ASSMAC, 1998) that would reduce the likelihood of discharging acidic water	Moderate	Very unlikely	Low
Potential exposure of soil salinity/saline soils during construction resulting in off-site discharge of saline water, potentially resulting in exceedances of water quality trigger levels	Minor	Likely	Medium	Soil salinity testing would be carried out to determine the presence of saline soils, enabling management measures to be implemented in accordance with Book 4 Dryland Salinity: Productive Use of Saline Land and Water (NSW DECC 2008) that would reduce the likelihood of impacts	Minor	Very unlikely	Low
Potential temporary water quality impacts on nearby watercourses due to discharge of treated groundwater, contaminated water, or spills during construction	Major	Unlikely	Medium	Prior to discharge, water would be treated to comply with ANZECC/ ARMCANZ (2000) and ANZG (2018) default guidelines for 95 per cent species protection	Major	Very unlikely	Medium
Potential contamination of land or groundwater due to spills and leaks during construction	Moderate	Likely	Medium	Locating all fuels in a sealed bunded area, together with the use of spill kits, would reduce the likelihood of soil or groundwater contamination	Moderate	Very unlikely	Low
Contamination							
Disturbance of contaminated land during construction potentially causing impacts to human health or receiving environments	Major	Likely	High	Areas with a higher potential for contamination would be subject to a Detailed Site Investigation and, if necessary, a Remedial Action Plan to reduce contamination risks during and following completion of construction, reducing the consequence of contamination and the likelihood if impacts	Moderate	Unlikely	Medium
Disturbance of contamination (soil or groundwater) potentially exacerbating existing contamination risks by mobilising otherwise stable contamination and causing on-site and off-site migration	Major	Likely	High	Areas with a higher potential for contamination would be subject to a Detailed Site Investigation and, if necessary, a Remedial Action Plan to reduce contamination risks from throughout and following completion of construction, reducing the consequence of contamination and the likelihood of impacts	Moderate	Unlikely	Medium
Potential impacts from the management or incorrect disposal of contaminated soils	Major	Likely	High	Contaminated soils would be kept separate from other spoil, and classified for disposal, reducing the likelihood of cross-contamination or inappropriate disposal	Major	Very unlikely	Medium
Potential disturbance of existing leachate and gas management systems at Sydney Olympic Park	Moderate	Likely	Medium	A Remedial Action Plan would be developed for the site and approved by an EPA accredited site auditor, to reduce contamination risks from construction and ensure that ongoing active management beyond construction is carried out, where required. This would reduce the potential consequence and likelihood of impacts	Minor	Unlikely	Low
Hydrology and flooding							
Alterations to existing stormwater flows and drainage infrastructure	Moderate	Likely	Medium	Drainage would be designed, where feasible and reasonable, to avoid or minimise obstruction of overland flow paths and limit the extent of flow diversions, reducing the likelihood of adverse alterations to local runoff conditions	Moderate	Unlikely	Medium
Potential impacts on existing flood emergency management arrangements at Parramatta, Clyde and The Bays	Major	Unlikely	Medium	Emergency flood planning would be carried out in consultation with the NSW State Emergency Service and the relevant local council, reducing the likelihood of impacts on flood evacuation routes	Major	Very unlikely	Medium
Impacts on flood-prone areas (e.g. increase in flood risk outside the construction sites) due to new structures or filling at the Clyde stabling maintenance facility and The Bays Station construction sites	Major	Likely	High	Detailed construction planning would consider flood risk at and around construction sites, including identification of measures to not worsen flood impacts, reducing the potential consequence and likelihood of off-site flood impacts	Minor	Unlikely	Low
Biodiversity							
Impacts on Cumberland Plain Woodland in the Sydney Basin Bioregion threatened ecological communities within or proximate to the construction footprint at Westmead	Insignificant	Likely	Low	The unmitigated risk rating is low because only 0.03 of a threatened ecological community is directly impacted, and this is already in poor condition represented by regrowth native species amongst plantings and weeds. No further mitigation measures are required	Insignificant	Likely	Low
Potential impacts on groundwater dependent ecosystems	Minor	Unlikely	Low	Additional investigations would be carried out to assess potential impacts to groundwater dependent ecosystems from groundwater drawdown. This would be used to inform any further mitigation measures, if required and reduce the likelihood of impacts	Minor	Very unlikely	Low
Impacts on Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion at Clyde	Moderate	Almost certain	High	Any removed vegetation would be offset reducing the consequence of vegetation clearing	Insignificant	Almost certain	Medium

Potential impact	Initial risk rating (unmitigated)			Effect of key Stage 1 proposed mitigation measures[1]	Residual risk rating (with mitigation)		
	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating		Residual consequence	Residual likelihood	Residual risk rating
Impacts on habitat for the Southern Myotis (*Myotis macropus*)	Moderate	Almost certain	High	Any removed vegetation comprising Southern Myotis habitat would be offset reducing the consequence of habitat loss	Insignificant	Almost certain	Medium
Potential indirect impacts on threatened fauna species, migratory and endangered populations due to clearing of habitat, demolition of existing buildings and structures, from light and noise impacts, sedimentation, spread of weeds and/or as a result of collisions with construction plant and vehicles	Minor	Likely	Medium	The implementation of measures such as those to control light spill and minimise construction noise would reduce the likelihood of impacts	Minor	Unlikely	Low
Impacts of proposed creek crossings at Clyde including fish passage	Major	Likely	High	The creek crossings would be designed to provide sufficient fish passage where possible, incorporate suitable scour protection, avoid worsening of existing flow velocities, and incorporate a vegetated riparian zone where feasible and reasonable, reducing the consequence of impacts	Minor	Likely	Medium
Air quality							
Potential temporary impacts on local air quality due to construction plant and equipment and increase in vehicle movements	Minor	Likely	Medium	Vehicles, plant and equipment would be maintained in a proper and efficient manner, reducing the likelihood of air quality impacts from plant	Minor	Very unlikely	Low
Potential temporary impacts on local air quality during construction due to dust generation from exposed surfaces, spoil stockpiles or spoil haulage	Moderate	Likely	Medium	Best practice dust management measures would be implemented during all construction works, reducing the likelihood and consequence of air quality impacts from dust	Minor	Unlikely	Low
Potential temporary impacts on local air quality during demolition	Moderate	Likely	Medium	Best practice measures would be implemented during demolition, including demolition sequencing and water suppression, reducing the consequence and likelihood of potential impacts	Minor	Unlikely	Low
Potential temporary mobilisation of airborne hazardous materials, odours or vapours as a result of uncovering contaminated soils or hazardous materials during excavation or demolition	Major	Unlikely	Medium	Best practice odour management measures would be implemented, including minimising the disturbance of contaminated soil, use of odour suppression agents, and regular monitoring. These mitigation measures would reduce the consequence and likelihood of mobilising airborne hazardous materials, odours or vapours	Moderate	Very unlikely	Low
Spoil, waste management and resource use							
Potential temporary impacts associated with inappropriate management of waste during construction	Minor	Unlikely	Low	Waste would be assessed, classified, managed and disposed in accordance with the Waste Classification Guidelines, reducing the likelihood of impacts	Minor	Very unlikely	Low
Potential temporary impacts associated with the management and disposal of spoil from tunnel construction	Minor	Unlikely	Low	Spoil would be managed in accordance with the spoil management hierarchy, and 100 per cent of usable spoil would be reused. This would reduce the likelihood of impacts associated with spoil management	Minor	Very unlikely	Low
Potential temporary increased demand on electricity and water supply during construction	Minor	Likely	Medium	Sustainability initiatives would be incorporated into the detailed design and construction to minimise demand for water and electricity, reducing the likelihood of the potential impacts	Minor	Very unlikely	Low
Potential temporary increased demand on local and regional resources including sand, aggregate and fuel during construction resulting in resource becoming in short supply	Minor	Unlikely	Low	Sustainability initiatives would be incorporated into the detailed design and construction to minimise demand for resources, reducing the likelihood of the potential impacts	Minor	Very unlikely	Low
Hazards							
Potential incidents associated with transportation and storage of hazardous substances and dangerous goods during construction	Moderate	Very unlikely	Low	Storage and handling of dangerous goods and hazardous substances would be in accordance with the *Dangerous Goods (Road and Rail Transport) Act 2008* and Dangerous Goods (Road and Rail Transport) Regulation 2014, and would comply with the Australian Dangerous Goods Code. As such, no mitigation measures are required	Moderate	Very unlikely	Low
Potential damage, rupture and/or failure to shut down, isolate or otherwise appropriately manage underground utilities, resulting in the release of sewage, water, gas or electrical currents	Moderate	Very unlikely	Low	Dial before you dig searches and non-destructive digging would be carried out to identify the presence of underground utilities, and ongoing consultation would be carried out with utility providers for high pressure gas or petroleum pipelines to identify appropriate construction methodologies, reducing the likelihood of impacts to utilities	Moderate	Almost unprecedented	Low
Sustainability and climate change							
Emissions of greenhouse gases from embodied energy in materials	Minor	Likely	Medium	Sustainability initiatives, including a sustainable procurement strategy would reduce the consequence of impacts	Insignificant	Likely	Low

Potential impact	Initial risk rating (unmitigated)			Effect of key Stage 1 proposed mitigation measures[1]	Residual risk rating (with mitigation)		
	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating		Residual consequence	Residual likelihood	Residual risk rating
Emissions of greenhouse gases from construction activities, including emissions associated with energy use for tunnel boring machines	Minor	Likely	Medium	Sustainability initiatives, including offsetting 25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction would reduce the potential consequence of this impact	Insignificant	Likely	Low
Cumulative impacts							
Potential temporary cumulative construction impacts, including potential construction fatigue with other major projects	Major	Almost certain	Very high	Coordination and consultation with relevant agencies and stakeholders would occur to manage the interface of projects under construction at the same time, including identifying conflicts and strategies to manage conflicts, such as making adjustments to construction program, work activities or haul routes, and coordination of traffic management arrangements between projects	Moderate	Almost certain	High

Note 1: Mitigation also includes measures proposed as part of the Construction Environmental Management Framework described in Chapter 28 (Synthesis of the Environmental Impact Statement).

28.6 Conclusions and next steps

The Concept environmental risk analysis (refer to Section 28.4) has identified the following issues as having a high or medium risk rating:

- Construction transport and traffic
- Construction noise and vibration
- Non-Aboriginal heritage
- Aboriginal heritage
- Landscape character and visual amenity
- Business impacts
- Social impacts
- Soils and surface water quality
- Contamination
- Hydrology and flooding
- Biodiversity
- Air quality
- Cumulative impacts.

These risks would be considered in greater detail during the assessment of future stages of Sydney Metro West. The risk analysis for the Concept will be re-examined during future environmental assessments for subsequent stages.

The Stage 1 environmental risk analysis (refer to Section 28.5) has identified that the following issues would have a high residual risk after implementation of the mitigation measures proposed in this Environmental Impact Statement:

- Construction transport and traffic
- Construction noise and vibration
- Aboriginal heritage
- Landscape character and visual amenity
- Cumulative impacts.

This suggests that an increased focus would be required on these aspects throughout construction of Stage 1 to reduce these risks further to meet an acceptable risk level. In particular, Sydney Metro has developed a Construction Noise and Vibration Standard (Appendix E) and Construction Traffic Management Framework (Appendix F) to manage the noise and vibration and transport and traffic related impacts respectively. The high residual risk rating for Aboriginal heritage and landscape character and visual amenity is based on the very high residual likelihood of unavoidable impacts at some of the construction sites.

Coordination and engagement with proponents for other concurrent or consecutive construction projects would continue through design and construction of Stage 1 so that opportunities to reduce or manage construction fatigue are identified. Ongoing community and stakeholder engagement would also be carried out so that potential cumulative impacts are better understood and reduced where possible.

Issues that would have a medium residual risk include:

- Non-Aboriginal heritage
- Business impacts
- Social impacts
- Soils and surface water quality
- Contamination
- Hydrology and flooding
- Biodiversity
- Air quality.

The assessment carried out for these issues has determined the likely extent of impacts can be suitably managed with the implementation of recommended feasible and reasonable mitigation measures. The implementation of the Construction Environmental Management Framework (Appendix D) would help to further reduce these potential impacts.

Issues that have a low residual risk can be adequately managed through detailed design and construction, and by the implementation of standard management measures so that all necessary environmental criteria and guidelines would be achieved. Issues with a low residual risk level include:

- Property and land use
- Groundwater and ground movement
- Spoil, waste management and resource use
- Hazards
- Sustainability and climate change.

29 Project justification and conclusion

29 Project justification and conclusion

This chapter presents the justification for the Concept and Stage 1 and a conclusion to the Environmental Impact Statement. The justification is based on the strategic need for the Concept and Stage 1 and in particular whether the Concept and Stage 1 has achieved the objectives of Sydney Metro West and has met the object of the *Environmental Planning and Assessment Act 1979*.

29.1 Summary of strategic need

Sydney Metro is Australia's biggest public transport project. Services between Rouse Hill and Chatswood started in May 2019 on the first stage of this new stand-alone automated railway network, which is revolutionising the way Sydney travels.

Sydney is expanding and the NSW Government is working hard to deliver an integrated transport system that meets the needs of customers now and in the future. The delivery of Sydney Metro West, is critical to keeping Sydney moving.

Sydney Metro West would involve the construction and operation of a largely underground metro rail line, around 24 kilometres long between Westmead and the Sydney CBD including new metro stations at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock, The Bays and Sydney CBD. The location of the Sydney CBD station will be determined following further investigations and community and stakeholder engagement.

Sydney Metro West would provide city-shaping benefits as the significant increase in transport connectivity, capacity and amenity in the Greater Parramatta to Sydney CBD corridor would boost the economic productivity of Sydney and unlock planned land use outcomes in the CBDs, planned precincts and urban renewal areas.

Sydney Metro West would also provide a fast, reliable and frequent connection between Greater Parramatta and the Sydney CBD and would:

- Provide a direct, fast, reliable and frequent connection between Greater Parramatta and the Sydney CBD, linking communities along the way that have previously not been serviced by rail
- Relieve the congested T1 Western Line, T9 Northern Line and T2 Inner West and Leppington Line
- Double the rail capacity between the Parramatta and Sydney CBDs
- Significantly boost economic opportunities for Greater Parramatta
- Support new residential and employment zones along the Greater Parramatta to Sydney CBD corridor, including at Sydney Olympic Park and The Bays – providing improved transport for the additional 420,000 new residents and 300,000 new workers forecast to be located within the corridor over the next 20 years
- Allow customers fast and easy transfers with the T1 Western Line at Westmead, T9 Northern Line at North Strathfield and the Sydney Trains suburban rail network and Sydney Metro in the Sydney CBD
- Allow for transfers with the future Parramatta Light Rail (Stage 1) at Westmead and Parramatta, as well as the planned Parramatta Light Rail (Stage 2) at Sydney Olympic Park
- Create an anticipated 10,000 direct and 70,000 indirect jobs during construction (based on Sydney Metro analysis).

Seeking planning approval for Stage 1, for the major civil construction work between Westmead and The Bays would allow:

- Additional time to consult with the stakeholders on the end-state design of stations including urban design, transport integration and placemaking outcomes
- Earlier commencement of critical construction activities which would allow Sydney Metro West as a whole to be delivered quicker and more efficiently facilitating earlier realisation of the benefits of Sydney Metro West
- Each future planning approval stage to be focussed on the critical issues associated with the particular works and the particular locations
- Additional time to solve certain design elements including the station location and tunnel alignment through the complex Sydney CBD environment.

Biophysical, economic and social considerations have been assessed in the context of the principles of ecologically sustainable development. This is discussed in Chapter 27 (Synthesis of the Environmental Impact Statement) and summarised below:

- Precautionary principle: The environmental risk analysis documented in Chapter 28 (Environmental risk analysis) addresses the potential impacts of the Concept and Stage 1. That analysis, together with the assessment carried out in preparing this Environmental Impact Statement indicates that there would be no threat of serious or irreversible damage to the environment
- Intergenerational equity: The objectives of Sydney Metro West are essentially around ensuring an efficient and reliable public transport network. This would benefit current and future generations. Once operational, Sydney Metro West would leave a positive legacy for future generations. It would provide long term benefits by strengthening connections and access across Sydney, providing improved connectivity on the rail network and improving the capacity, reliability and efficiency of the existing transport system
- Conservation of biological diversity and ecological integrity: Conservation of biological diversity and ecological integrity has been considered throughout the development and design stages. The construction footprint has been developed to avoid or minimise impact to areas of high ecological value. Detailed assessments have been carried out to identify flora and fauna impacts and a range of mitigation measures identified for implementation as detailed in Chapter 22 (Biodiversity – Stage 1). Impacts on biological diversity and ecological integrity have been assessed as minor
- Improved valuation and pricing of environmental resources: The value placed on the environment was inherent in the development of the design. In addition, the costs associated with the planning and design of measures to avoid/minimise adverse environmental impacts and the costs to implement them have been built into the overall costs. Ongoing and detailed design together with specific issue-based management plans would represent further commitment to the recognition of the value of protecting environmental resources.

29.2 Achieving the Sydney Metro West objectives

Table 29-1 and Table 29-2 provides an assessment of the Concept and Stage 1 against the Sydney Metro West network and corridor objectives as detailed in Chapter 2 (Strategic need and justification).

Table 29-1: Assessment against the Sydney Metro West network objectives

Sydney Metro West objectives	Assessment
Ensure transport services are meeting the needs of customers	• Relieves the congested T1 Western Line, T9 Northern Line and T2 Inner West and Leppington Line • Provides travel-time savings for customers in Western Sydney and along the corridor • Reduces station crowding at some stations • Provides rail transport to areas where this is currently not available.
Deliver outcomes that align with and support key strategic land use and transport frameworks including the Smart Cities Plan, Greater Sydney Region Plan, Future Transport Strategy and the relevant District Plans	• Connects Greater Parramatta and the Sydney CBD and support the vision for a metropolis of three cities • Supports the delivery of the '30-minute city' as identified in Future Transport 2056 strategy • Acts as a catalyst for realising the vision of the Greater Parramatta and the Olympic Peninsula • Reinforces Greater Parramatta as the Central River City.
Boost Sydney's international competitiveness, productivity and employment growth by supporting new and existing strategic centres	• Supports three-cities vision to re-balance economic opportunities • Parramatta CBD would become more attractive for business investment, and facilitates the planned growth of an additional 49,000 jobs by 2036 • Facilitates the planned growth of an additional 70,000 jobs by 2036 in the Westmead health and medical research innovation district, Sydney Olympic Park state significant lifestyle precinct and The Bays future knowledge hub • Improves connectivity to major attractions and key precincts located along the corridor, including Sydney Olympic Park and The Bays.

Support future housing needs by increasing housing supply, choice and affordability	• Facilitates the planned growth for an additional 46,000 homes within the walking catchment of proposed metro stations
	• Facilitiates more choices of affordable housing close to where people work resulting in:
	  • Improved liveability from improved commute time and a less congested transport network
	  • Improved household budgets from reduced reliance on cars
	  • Lower cost for parking spaces in new developments.

Improve liveability and provide a catalyst for positive change by enabling urban renewal opportunities, enhancing housing supply and supporting productivity of centres	• Supports the masterplanned growth in precincts and urban renewal areas targeting an additional 169,000 jobs and 46,000 dwellings for 106,000 people between 2016 and 2036
	• Centralised growth would be accommodated within masterplanned precincts and urban renewal areas. This would streamline opportunities for masterplanned growth with careful planning of transport, social infrastructure, services and placemaking
	• More opportunities for people to live close to where they work in mixed-use precincts such as Westmead, Sydney Olympic Park and The Bays while:
	  • Reducing impacts on amenity from continued reliance on cars
	  • Increasing opportunities for walking and cycling.

Improve access to and resilience of the transport network through integrated land use and transport planning, including integration of Sydney Metro West with other modes	• Effectively doubles rail capacity from Parramatta to the Sydney CBD with the delivery of a new high capacity rail connection • Reduces congestion and help alleviate platform and station crowding • Provides new stations at localities not serviced by the existing Sydney Trains suburban rail network, including Burwood North, Five Dock and The Bays • Provides a more direct connection to Sydney Olympic Park • Provides additional interchange capability at Westmead, North Strathfield and in the Sydney CBD.
Ensure value for money and a sustainable and deliverable solution.	• Decreased emissions from reliance on cars to support Sydney's growing population • Proactively addresses forecast future crowding issues before the rail network reaches capacity and results in economic impacts • Supports timely investment in planned urban renewal and growth areas attracting businesses, workers and residents.

Table 29-2: Assessment against the Sydney Metro West Greater Parramatta to Sydney CBD corridor objectives

Sydney Metro West objectives	Assessment
Contribute towards the vision for a three cities metropolis established by the Greater Sydney Commission including the '30-minute city' concept	• Supports the vision for 30-minute cities as outlined in the Greater Sydney Region Plan by providing customers an easy connection to key destinations including cities, health and education precincts, diverse employment centres and residential precincts • Enables an additional 730,000 jobs and 630,000 people to be within 30-minutes of the Parramatta and Sydney CBD.
Support additional housing supply and employment growth opportunities and support urban renewal initiatives within the Greater Parramatta to Sydney CBD corridor including key government precincts such as the Greater Parramatta and Olympic Peninsula and The Bays	• Supports planned improvements in land use and a broader range of housing opportunities, which can offer improved and more affordable housing with better access to services and employment, and improved liveability • By improving the connections between key economic centres, Sydney Metro West would foster significant growth in jobs • Directly supports the creation of new jobs within the corridor, particularly at key precincts including Westmead, Parramatta, Sydney Olympic Park and The Bays • Enables an additional 169,000 jobs within walking catchments of proposed metro stations. Of these new jobs, 47 per cent would not otherwise be achieved without Sydney Metro West.
Achieve customer outcomes including relieving congestion on the busy T1 Western Line and T2 Inner West and Leppington Line, increased rail patronage and mode shift, reduced travel times between key destinations, providing new access to mass transit rail and relieving bus and road congestion in the western corridor	• Effectively doubles rail capacity from Parramatta to the Sydney CBD moving up to 40,000 people an hour in each direction • Significantly reduces train crowding on the T1 Western Line, T2 Inner West and Leppington Line and the T9 Northern Line • Reduces crowding at Central, Parramatta, Strathfield, Epping and Burwood stations • Substantially improves the public transport network accessibility to key economic centres across the Greater Parramatta to Sydney CBD corridor • Increases the reach and use of Sydney's public transport network by providing new stations, increasing access to Parramatta and Sydney CBDs by rail, providing a direct connection to Sydney Olympic Park and additional interchange capability at Westmead, North Strathfield and Sydney CBD • Improves travel times between key employment centres such as Parramatta, Sydney CBD, North Sydney, Chatswood and Sydney Olympic Park • Improves resilience within the public transport network by providing an alternative to the existing Sydney Trains suburban railway route for customers during planned and unplanned network incidents • Provides the opportunity to optimise the bus network by reducing the number of buses on congested corridors such as Parramatta Road and Victoria Road and increasing bus services on other parts of the network • Provides the opportunity for mode shift from car to public transport, which could result in road user travel time savings.

29.3 Objects of the *Environmental Planning and Assessment Act 1979*

The objects of the *Environmental Planning and Assessment Act 1979* (EP&A Act) provide a policy framework within which the justification of the Sydney Metro West can be considered. Table 29-3 outlines those objects and provides comment on their relevance to Sydney Metro West.

Table 29-3: Relevance of the Objects of the EP&A Act to Sydney Metro West

Environmental Planning and Assessment Act 1979 Objects	Comments
To promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources	Sydney Metro West has been designed to avoid impacts on the environment and to minimise the need for land acquisition, as well as impacts on existing development and local communities. Sydney Metro West has been designed to conserve the State's natural and other resources. During construction and operation of Sydney Metro West, opportunities would be taken to reduce material use and maximise the use of materials with low embodied environmental impact, where practical. In particular water efficiency measures would be implemented with a focus on achieving water savings and targeting water recycling and reuse.
To facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment	Sustainability has been a key driver for Sydney Metro West. Sydney Metro West is supported by the Sydney Metro Environmental and Sustainability Policy and the future development of a Sydney Metro West Sustainability Plan (refer to Chapter 26 (Sustainability and climate change – Stage 1)). Further details on addressing the principles of ecologically sustainable development are also provided in Chapter 27 (Synthesis of the Environmental Impact Statement).
To promote the orderly and economic use and development of land	Sydney Metro West would provide a significant increase in transport connectivity, capacity and amenity in the Greater Parramatta to Sydney CBD corridor, which would boost the economic productivity of Sydney and unlock planned land use outcomes in the CBDs, planned precincts and urban renewal areas including The Bays, the Parramatta Road Corridor, Sydney Olympic Park, and Westmead. It has been designed to minimise impacts to the surrounding natural and built environments, and to minimise disruption to existing development patterns. Provision of a mostly underground metro system is an orderly and economic approach to delivery of the Sydney Metro West in the context of existing development along the corridor.
To promote the delivery and maintenance of affordable housing	Sydney Metro West would provide public transport accessibility to future growth areas including The Bays, the Parramatta Road Corridor, Sydney Olympic Park, and Westmead and an affordable transport option for future residents. This would support the planned growth for an additional 46,000 homes in the corridor by 2036.
To protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats	Stage 1 is largely contained within a highly urbanised area that does not possess large expanses of intact native vegetation with high biodiversity value. As the majority of Stage 1 would be underground or in pre-existing built-up areas, direct impacts to terrestrial biodiversity has been largely avoided and/or minimised. Sydney Metro West impacts on terrestrial and aquatic ecology have been assessed in detail and measures to avoid, mitigate and offset potential impacts on native animals and plants have been developed (refer to Chapter 22 (Biodiversity – Stage 1)).
To promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage)	The design development of Stage 1 has included a focus on avoiding or minimising potential Aboriginal and non-Aboriginal heritage impacts. This has included developing a tunnel alignment and selecting construction sites that avoid potential direct impacts to heritage items and potential archaeological sites. Impacts on heritage items would be minimised during construction and works would be carried out in accordance with relevant management strategies for specific heritage items where impacts are unavoidable.
To promote good design and amenity of the built environment	Sydney Metro West has been designed to minimise impacts to community facilities and open space. Landscape character and visual amenity impacts from Stage 1 would be managed in accordance with the Construction Environmental Management Framework, which specifies key operational requirements, environmental management procedures, and a communications and consultation strategy. The approach to design and placemaking for the Sydney Metro West Concept, as well as place and design principles for each of the metro stations and facilities, is discussed in Chapter 7 (Placemaking).
To promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants	The construction of all buildings would be completed consistent with the applicable Australian and international safety standards.
To promote the sharing of the responsibility for environmental planning between the different levels of government in the State	The responsibility for environmental planning and approval in relation to Sydney Metro West rests primarily with the NSW Government. Consultation has however, occurred across all levels of the government including councils for the seven local government areas through which Sydney Metro West passes, including City of Cumberland, City of Parramatta, Municipality of Strathfield, Municipality of Burwood, City of Canada Bay, Inner West Council and the City of Sydney.
To provide increased opportunity for community participation in environmental planning and assessment	The Sydney Metro West development process has involved extensive consultation with the community and stakeholders (refer to Chapter 5 (Stakeholder and community engagement)).

29.4 Conclusion

Sydney Metro West has been assessed as critical State significant infrastructure in accordance with the provisions under Division 5.2 of Part 5 of the EP&A Act. In particular, it addresses the requirements of the Secretary of the Department of Planning, Industry and Environment. It also includes consideration of the issues raised by the community and stakeholders during the development of Sydney Metro West.

Key environmental issues have been examined throughout the design development process. Consultation has been carried out with affected stakeholders during the assessment process so that key potential impacts of the Concept and Stage 1 have been identified at an early stage, and where possible, avoided or appropriate mitigation measures developed. This has resulted in a number of changes to the earlier designs that have mitigated many of the potential significant impacts.

Notwithstanding, it is inevitable that a project of this scale and location in a heavily urbanised environment would have some residual (unavoidable) impacts, particularly during construction.

Key potential residual impacts associated with Stage 1 are identified in Chapters 10 to 26 and would largely include:

- Potential temporary construction traffic and pedestrian impacts with respect to temporary road closures and local traffic diversions
- Potential temporary construction noise and vibration
- Some moderate potential impacts on State heritage items and on some Aboriginal and non-Aboriginal archaeological deposits
- Potential temporary local community amenity impacts associated with an increase in noise levels, traffic movements and congestion, dust, and changes in visual outlook
- Potential temporary cumulative impacts given the potential overlap with a number of large infrastructure projects in the Parramatta area and around The Bays.

The potential residual impacts identified would not result in any unacceptable impacts and further mitigation would be considered during the detailed design stage including the decision on appropriate construction methodologies and the implementation of the environmental management practices.

With respect to the Concept, some uncertainties remain, including overall construction staging, and the location of the metro station and the tunnel alignment in the Sydney CBD. At this stage, a reasonable worst case assessment indicates that any adverse impacts during construction and operation would be similar to those identified for Stage 1 and no unacceptable impacts are anticipated. These uncertainties and issues will be addressed in future stage(s) which requires assessment and approval of more detailed development application(s).

Identified potential residual impacts need to be considered within the context of the overall objectives of Sydney Metro West and the significant transportation and other benefits that Sydney Metro West would provide over the medium to longer term and particularly for future generations. The consequences of not proceeding (do nothing) would result in unacceptable impacts on the transport network, particularly in terms of the inability to support growth and urban renewal. This would ultimately constrain Sydney's future liveability and global competitiveness.

On balancing the strategic need and benefits of the project with the residual impacts, Sydney Metro West is considered to be in the public interest.

30 References

30 References

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Appendix A

Assessment Requirements

Appendix A

Assessment requirements

Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 1.

Some of the Secretary's Environmental Assessment Requirements outlined in Table 1 make reference to requirements specified in the Scoping Report. All Scoping Report requirements and where they are addressed in this Environmental Impact Statement are outlined in Table 2 of this Appendix.

Table 1: Secretary's Environmental Assessment Requirements

Reference	Secretary's Environmental Assessment Requirements	Where addressed
General SEARs		
1. Environmental Impact Assessment Process		
1.1	The Environmental Impact Statement (EIS) must be prepared in accordance with Part 3 of Schedule 2 of the Environmental Planning and Assessment Regulation 2000 (the EP&A Regulation).	Appendix B
1.2	It is the Proponent's responsibility to determine whether the Proposal needs to be referred to the Commonwealth Department of the Environment and Energy (DoEE) for an approval under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). If DoEE has determined that an approval is required under the EPBC Act, supplementary environmental assessment requirements may need to be issued to ensure a streamlined assessment under an Accredited Assessment can be achieved.	Chapter 4
1.3	Where the Proposal requires approval under the EPBC Act and is being assessed under the Bilateral Agreement the EIS should address: a. consideration of any Protected Matters that may be impacted by the development where the Commonwealth Minister has determined that the Proposal is a Controlled Action;	N/A
	b. identification and assessment of those Protected Matters that are likely to be significantly impacted;	
	c. details of how significant impacts to Protected Matters have been avoided, mitigated and, if necessary, offset; and	
	d. consideration of, and reference to, any relevant conservation advices, recovery plans and threat abatement plans.	
1.4	The onus is on the Proponent to ensure legislative requirements relevant to the Proposal are met.	Chapter 4
2. Environmental Impact Statement		
2.1	The EIS must include, but not necessarily be limited to, the following: <u>General Information</u> a. executive summary;	Executive summary
	b. a description of the Concept, including key components and activities including: • project overview; • station and ancillary facility locations and the proposed route (including use of plans);	Chapter 6
	c. a description of the staged approach to obtaining approval for the project;	
	d. a description of Stage 1, including key components and activities (including ancillary components and activities) required to construct that stage;	Chapter 9
	e. a description of associated strategic investigations (such as Pyrmont and Rydalmere stations) that do not comprise part of the Concept;	Chapter 6
	<u>Concept - Strategic Justification</u> f. a summary of the strategic need with regard to its critical State significance and relevant State Government policy;	Chapter 2
	g. a statement of the strategic objective(s), including: • how the Concept will integrate with the broader transport network (existing and proposed); • an analysis of any feasible alternatives; • a description of feasible options within the Concept (including station numbers and locations); and • a description of how alternatives to and options within the Concept were analysed and optimised to inform the selection of the preferred alternative / option. The description must contain sufficient detail to enable an understanding of why the preferred alternative to and options(s) within the Concept were selected;	Chapter 2 Chapter 3
	Statutory and Regulatory Context h. statutory context of the Proposal (as a whole) including: • how it meets the provisions of the *Environmental Planning and Assessment Act 1979* (the EP&A Act) and the EP&A Regulation; • a list of any approvals that must be obtained under any other Act or law before the Proposal may lawfully be carried out; • identification of the existing environmental planning instruments and other current government strategic plans and policies relevant to the project and land subject to the Proposal (including State environmental planning policies, land use and infrastructure strategies and local strategic planning statements);	Chapter 4
	Stage 1 – Environmental Impacts and Mitigation Measures i. a concise description of different construction methods that were analysed and justification for preferred methods;	Chapter 9

Reference	Secretary's Environmental Assessment Requirements	Where addressed
2.1 cont.	j. a concise description of the general biophysical and socio-economic environment that is likely to be impacted by the project (including offsite impacts). Elements of the environment that are not likely to be affected by Stage 1 do not need to be described;	Chapter 27
	k. demonstration of how the Stage 1 design has been developed to avoid or minimise likely adverse impacts;	
	l. identification and assessment of key issues as provided in the 'Key Issues SEARs';	Chapters 10 to 26
	m. a statement of and quantification (where appropriate) of outcomes and performance criteria Stage 1 will commit to target for each key issue;	Chapter 27
	n. measures to avoid, minimise or offset impacts must be linked to the impact(s) they treat, so it is clear which measures will be applied to each impact;	
	o. consideration of the interactions between measures proposed to avoid or minimise impact(s), between impacts themselves and between measures and impacts; and	Chapters 10 to 26
	p. an assessment of the relevant cumulative impacts taking into account other State Significant projects that have been approved but where construction has not commenced, projects that have commenced construction, and projects that have recently been completed (such as WestConnex, Parramatta Light Rail Stage 1 and approved construction in the relevant precincts);	Chapter 8 Chapters 10 to 26
	Impact Assessment q. a chapter that synthesises the environmental impact assessment and provides: • a succinct but full description of the Proposal for which approval is sought; • a description of any uncertainties that still exist around the footprint, construction methodologies for Stage 1 and how these will be resolved in subsequent approval stages; • a compilation of the impacts that have not been avoided; • for Stage 1, a compilation of the proposed measures associated with each impact to avoid or minimise (through design refinements or ongoing management during construction or during latter stages) or offset these impacts; • a compilation of the performance outcome(s) and criteria the Proponent target and how these will be monitored; and • the reasons justifying carrying out Stage 1 as proposed, having regard to the biophysical, economic and social considerations, including ecologically sustainable development and cumulative impacts; and	Chapter 27
	r. relevant project plans, drawings, diagrams in an electronic format that enables integration with mapping and other technical software.	Chapter 6 Chapter 9 to 25
2.2	The EIS(s) must only include data and analysis that is reasonably needed to make a decision on the Proposal. Relevant information must be succinctly summarised in the EIS and included in full in appendices. Irrelevant, conflicting or duplicated information must be avoided.	Whole EIS
3. Assessment of Key Issues		
3.1	The level of assessment of likely impacts must be proportionate to the significance of, or degree of impact on, the issue, within the context of the Proposal location and the surrounding environment. The level of assessment must be commensurate to the degree of impact for the concept or project and sufficient to ensure that the impacts can be understood and assessed.	Whole EIS
3.2	Concept Key Issues For each **Concept** key issue, to the extent it relates to the nature of the concept, the Proponent must: a. describe the overarching biophysical and socio-economic environment, as far as it is relevant to that issue;	Chapter 8
	b. describe the policy context, as far as it is available and relevant to the issue;	
	c. address the listed matters in the 'Key Issues SEARs';	
	d. describe how potential negative impacts have been avoided (through strategic design);	
	e. identify how potential negative impacts that have not been avoided (through strategic design) will be minimised or managed;	
	f. identification of potential positive impacts or benefits; and	
	g. outline further detailed assessment required to be carried out in subsequent stages (except Stage 1).	
3.3	Stage 1 Key Issues For each **Stage 1** key issue, the Proponent must: a. describe the biophysical and socio-economic environment, as far as it is relevant to that issue, including substantiated baseline data that is reflective of current guidelines where relevant;	Chapters 10 to 26
	b. describe the legislative context, as far as it is relevant to the issue;	
	c. address the listed matters in the 'Key Issues SEARs';	
	d. identify, describe and quantify (if possible) the impacts associated with the issue, including the likelihood and consequence (including realistic worst case scenario) of the impact (comprehensive risk assessment), the impacts of concurrent activities and cumulative impacts (parallel and sequential) with other projects;	Chapter 28
	e. demonstrate how potential impacts have been avoided (through design or construction methodologies);	Chapters 10 to 26
	f. detail how likely impacts that have not been avoided through design will be minimised, and the predicted effectiveness of these measures (against performance criteria where relevant);	
	g. detail how any residual impacts will be managed or offset, and the approach and effectiveness of these measures; and	
	h. measures to monitor the avoidance, minimisation and offsetting of impacts to ensure performance outcomes and criteria are met.	

Reference	Secretary's Environmental Assessment Requirements	Where addressed
3.4	Where multiple options to avoid or minimise impacts are available, they must be identified and considered, and the proposed measure justified considering the public interest.	Chapters 10 to 26
3.5	The assessment of each key issue must have consideration (as relevant) to the listed guidelines.	Chapters 10 to 26
4. Consultation		
4.1	The Proposal must be informed by consultation, including with relevant local, State and Commonwealth government agencies, infrastructure and service providers, special interest groups, affected landowners, businesses and the community with specific consultation for each station precinct and ancillary facility.	Chapter 5
4.2	The Proponent must document the consultation process and demonstrate how the Proposal has responded to the inputs received.	Chapter 5
4.3	The Proponent must describe the timing and type of community consultation undertaken, the mechanisms for community feedback, the mechanisms for keeping the community informed, and procedures for complaints handling and resolution.	Chapter 5
Key Issues		
1. Place and Design		
1.1 (Concept)	Outline a design process that is informed, collaborative and iterative (including the use of design review panels and consultation with community and other stakeholders).	Chapter 5 Chapter 7 Chapter 8
1.2 (Concept)	Design principles and outcomes for each station and facility that are reflective of the design objectives in Better Placed.	Chapter 7
1.3 (Concept)	Design principles and outcomes should include how crowd management and operational efficiency can be achieved for major events.	Chapter 7
1.1 (Stage 1)	Visual and related amenity impacts of construction including on streetscapes, key sites and buildings (including existing landscape works, greenspace and tree canopy).	Chapter 15
1.2 (Stage 1)	Open space and tree impacts, including: a. estimating the number of trees to be cleared that will not be covered by a biodiversity offset strategy; and	Chapter 15
	b. for areas where trees are to be cleared before construction, investigate means to increase the number of trees and canopy within proximity of the impacted areas by providing additional planting before construction.	
2. Spoil		
2.1 (Stage 1)	Relevant commitments made in Section 9.17.2 of the Scoping Report	Chapter 24 Refer to Table 2 of this appendix for Scoping Report requirements
2.2 (Stage 1)	Spoil generation and reuse, including: a. type and quantity;	Chapter 24
	b. onsite storage (including capacity to minimise amenity impacts);	
	c. reuse potential and disposal sites;	
	d. transport and handling options (including traffic, distance, road safety and related amenity and environmental impacts); and	
	e. illegal dumping.	
3. Social and Economic (including property, land use and business impacts)		
3.1 (Concept)	Economic Commitments made in Section 7.11.3 of the Scoping Report, and strategic economic impacts.	Chapter 8 Refer to Table 2 of this appendix for Scoping Report requirements
3.2 (Concept)	Social Commitments made in Section 7.10.3 of the Scoping Report, and how the community would experience the Proposal at a strategic level (from environmental, amenity and social changes).	Chapter 8 Refer to Table 2 of this appendix for Scoping Report requirements
3.3 (Concept)	Property and Land Use Commitments made in Section 7.5.3 of the Scoping Report, and land use change potentially influenced by the Proposal.	Chapter 8 Refer to Table 2 of this appendix for Scoping Report requirements
3.1 (Stage 1)	Economic Affected properties, businesses, recreational users and land and water users, including property acquisitions/adjustments, access, amenity and relevant statutory rights.	Chapter 16
3.2 (Stage 1)	Social Commitments made in Section 9.10.2 of the Scoping Report; and	Chapter 17 Refer to Table 2 of this appendix for Scoping Report requirements
3.3 (Stage 1)	Address impacts to different aspects of people's lives set out in the SIA Guideline.	Chapter 17

Reference	Secretary's Environmental Assessment Requirements	Where addressed
3.4 (Stage 1)	Property and Land Use Commitments made in Section 9.5.2 of the Scoping Report; and land use compatibility (including potential restrictions on future development, both above-ground and sub-surface);	Chapter 14 Refer to Table 2 of this appendix for Scoping Report requirements
3.5 (Stage 1)	Permanent and temporary property acquisition, including easement acquisition; and temporary or permanent leasing arrangements;	Chapter 14
3.6 (Stage 1)	Temporary loss of public open space; and	Chapter 17
3.7 (Stage 1)	Disruption to utilities and services.	Chapter 9
4. Noise and Vibration		
4.1 (Concept)	Commitments made in Section 7.2.4 of the Scoping Report; and the compatibility of the Concept with the adjoining noise environment.	Chapter 8 Refer to Table 2 of this appendix for Scoping Report requirements
4.1 (Stage 1)	Commitments made in Section 9.2.2 of the Scoping Report.	Chapter 11 Refer to Table 2 of this appendix for Scoping Report requirements
4.2 (Stage 1)	The assessment of construction noise and vibration must address: a. the nature of construction activities and related noise characteristics;	Chapter 11
	b. the intensity and duration of noise (both air and ground borne) and vibration impacts. This must include consideration of extended construction impacts associated with ancillary facilities (and the like) and construction fatigue;	
	c. the identification and nature of receivers, existing and proposed, during the construction period;	
	d. the nature of the impact and the sensitivity of receivers and level of impact including for out of hours works;	
	e. the need to balance timely conclusion of noise and vibration-generating works with periods of receiver respite, and other factors that may influence the timing and duration of construction activities (such as traffic management);	
	f. noise impacts of out-of-hours works (including utility works associated with the SSI including those undertaken under another assessment pathway), possible locations where out-of-hours works would be undertaken, the activities that would be undertaken, the estimated duration of those activities and justification for these activities in terms of the Interim Construction Noise Guideline (DECCW, 2009);	
	g. sleep disturbance (including the number of noise-awakening events);	
	h. a cumulative noise and vibration assessment inclusive of impacts from Stage 1, including concurrent construction activities within Stage 1 and the construction of other relevant development in the vicinity of Stage 1;	
	i. details and analysis of the predicted effectiveness of mitigation measures to adequately manage identified impacts, including impacts as identified in (h);	
	j. any potential residual noise and vibration impacts following application of mitigation measures; and	
	k. a description of how receiver feedback received would be taken into account in the design of mitigation measures, including any tailored mitigation, management and communication strategies for sensitive receivers.	
4.3 (Stage 1)	The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage).	Chapter 11
4.4 (Stage 1)	Blast impacts (if required) can comply with current guidelines.	Chapter 11
5. Transport and Traffic		
5.1 (Concept)	Commitments made in Section 7.1.3 of the Scoping Report.	Chapter 8 Refer to Table 2 of this appendix for Scoping Report requirements
5.1 (Stage 1)	Commitments made in Section 9.1.2 of the Scoping Report.	Chapter 10 Refer to Table 2 of this appendix for Scoping Report requirements
5.2 (Stage 1)	Transport and traffic (vehicle, pedestrian and cyclists) impacts of construction, including, but not necessarily limited to: a. a considered approach to route identification and scheduling of construction vehicle movements;	Chapter 10
	b. the indicative daily number, frequency and size of construction related vehicles (passenger, commercial and heavy vehicles, including spoil management movements) across the construction schedule;	
	c. the nature of existing traffic (types and number of movements) on construction access routes (including consideration of peak traffic times and sensitive road users and parking arrangements);	
	d. construction worker parking;	
	e. access constraints and impacts on public transport (infrastructure and services), pedestrians and cyclists and property; and	

Reference	Secretary's Environmental Assessment Requirements	Where addressed
5.2 (Stage 1) cont.	f. the need to close, divert or otherwise reconfigure elements of the road, pedestrian and cycle network associated with construction of the project and the duration of these changes; and	Chapter 10
	g. impacts to on-street parking, loading, servicing and pick up, including to residents and businesses.	
6. Aboriginal Heritage		
6.1 (Concept)	Commitments made in Section 7.4.3 of the Scoping Report.	Chapter 8 Refer to Table 2 of this appendix for Scoping Report requirements
6.1 (Stage 1)	Direct and/or indirect impacts (including cumulative impacts) associated with construction to the heritage significance of: a. Aboriginal places, objects and cultural heritage values, as defined under the *National Parks and Wildlife Act 1974* and in accordance with the principles and methods of assessment identified in the current guidelines; and	Chapter 13
	b. Aboriginal places of heritage significance, as defined in the Standard Instrument – Principal Local Environmental Plan.	
6.2 (Stage 1)	Where impacts to Aboriginal objects and/or places are proposed, consultation must be undertaken with Aboriginal people in accordance with the current guidelines.	Chapter 13
6.3 (Stage 1)	The assessment must consider requirements for: a. *in-situ* conservation of items and or/areas;	Chapter 13
	b. the need for further archaeological testing and/or detailed archaeological investigations; and	
	c. measures to avoid, minimise and/or mitigate potential impacts.	
7. Non-Aboriginal Heritage		
7.1 (Concept)	Commitments made in Section 7.3.3 of the Scoping Report.	Chapter 8 Refer to Table 2 of this appendix for Scoping Report requirements
7.1 (Stage 1)	Potential direct and/or indirect impacts (including cumulative impacts) to the heritage significance of: a. environmental heritage, as defined under the *Heritage Act 1977*; and	Chapter 12
	b. items listed on National and World Heritage lists; and	
	c. heritage items and conservation areas identified in environmental planning instruments applicable to the project area.	
7.2 (Stage 1)	Where impacts to State or locally significant heritage items are identified, the assessment must: a. include a significance assessment, a statement of heritage impact for all heritage items and a historical archaeological assessment;	Chapter 12
	b. consider any relevant conservation management plan;	
	c. consider impacts to the item of significance caused by, but not limited to, vibration, demolition, archaeological disturbance, altered historical arrangements and access, visual amenity, landscape and vistas, curtilage, subsidence and architectural noise treatment (as relevant) and whether these are temporary or permanent	
	d. outline measures to avoid and minimise those impacts during construction in accordance with current guidelines; and	
	e. be undertaken by a suitably qualified heritage consultant(s) and/or historical archaeologist (note: where archaeological excavations are proposed the relevant consultant must meet the NSW Heritage Council's Excavation Director criteria).	Chapter 1 of Technical Paper 3 (Non-Aboriginal heritage impact assessment)
8. Contamination and Soils		
8.1 (Concept)	Commitments made in Section 7.8.3 and 7.9.3 of the Scoping Report.	Chapter 8 Refer to Table 2 of this appendix for Scoping Report requirements
8.1 (Stage 1)	Commitments made in Section 9.8.2 of the Scoping Report.	Chapter 19 Refer to Table 2 of this appendix for Scoping Report requirements
8.2 (Stage 1)	The risk of contamination and identify if remediation of the land is required, having regard to the ecological and human health risks posed by the contamination in the context of past, existing and future land uses. Where assessment and/or remediation is required, the Proponent must document how the assessment and/or remediation would be undertaken in accordance with current guidelines.	Chapter 20
9. Water – Hydrology and Flooding		
9.1 (Concept)	Commitments made in Section 7.12.3 of the Scoping Report, including potential scale of impacts and where the Proposal will need to respond to the existing hydrological environment.	Chapter 8 Refer to Table 2 of this appendix for Scoping Report requirements

Reference	Secretary's Environmental Assessment Requirements	Where addressed
9.1 (Stage 1)	The existing hydrological regime for any surface and groundwater resource (including mapping, the reliance by users, and for ecological purposes) likely to be impacted, including stream orders.	Chapter 18 Chapter 21 Technical Paper 9 (Hydrology and flooding) Technical Paper 7 (Hydrogeology)
9.2 (Stage 1)	A water balance for ground and surface water including the proposed intake and discharge locations, volume, frequency and duration.	Chapter 19
9.3 (Stage 1)	Requirements for baseline monitoring of hydrological attributes.	Chapter 18
9.4 (Stage 1)	The impact on surface and groundwater hydrology in accordance with the current guidelines, including: a. natural processes within rivers, wetlands, estuaries, marine waters and floodplains;	Chapter 18 Chapter 21
	b. impacts from any permanent and temporary interruption of groundwater flow;	
	c. stormwater and wastewater management on natural hydrological attributes and the conveyance capacity of existing stormwater systems where discharges are proposed through such systems or details of alternative disposal options; and	
	d. water take (direct or passive) from all surface and groundwater sources with estimates of annual volumes during construction.	
9.5 (Stage 1)	Flood behaviour for a range of flood events up to the probable maximum flood (taking into account sea level rise and storm intensity due to climate change) including: a. potential flood affectation of other properties, assets and infrastructure;	Chapter 21
	b. consistency (or inconsistency) with applicable Council floodplain risk management plans;	
	c. compatibility with the flood hazard of the land; and	
	d. compatibility with the hydraulic functions of flow conveyance in flood ways and storage areas of the land.	
10. Water - Quality		
10.1 (Concept)	Identify the ambient NSW Water Quality Objectives (NSW WQO) and environmental values for the receiving waters relevant to the Proposal, including the indicators and associated trigger values or criteria for the identified environmental values.	Chapter 8
10.1 (Stage 1)	Surface and groundwater quality impacts including: a. identifying and estimating the discharge water quality and degree of impact that any discharge(s) may have on the receiving environment, including consideration of all pollutants that pose a risk of non-trivial harm to human health and the environment;	Chapter 18 Chapter 19
	b. identifying the rainfall event that the water quality protection measures will be designed to cope with; and	Chapter 19
	c. assessing the significance of any identified impacts including consideration of the relevant ambient water quality outcomes.	
10.2 (Stage 1)	Demonstrating how Stage 1 will, to the extent that the project can influence, ensure that: a. where the NSW WQOs for receiving waters are currently being met, they will continue to be protected; and	Chapter 19
	b. where the NSW WQOs are not currently being met, activities will work toward their achievement over time; and	
	c. justify, if required, why the WQOs cannot be maintained or achieved over time.	
11. Biodiversity		
11.1 (Concept)	Commitments made in Section 7.13.3 of the Scoping Report.	Chapter 8 Refer to Table 2 of this appendix for Scoping Report requirements
11.1 (Stage 1)	Biodiversity impacts in accordance with section 7.9 of the *Biodiversity Conservation Act 2016* (BC Act), the Biodiversity Assessment Method (BAM), and be documented in a Biodiversity Development Assessment Report (BDAR).	Chapter 22
11.2 (Stage 1)	Impacts on biodiversity values not covered by the BAM. This includes a threatened aquatic species assessment (Part 7A *Fisheries Management Act 1994*) to address whether there are likely to be any significant impact on listed threatened species, populations or ecological communities listed under the *Fisheries Management Act 1994* (FM Act).	Chapter 22
11.3 (Stage 1)	If the project, or any component of the project, would be classified as a Key Threatening Process (KTP) in accordance with the listings in the BC Act, FM Act and the *Environmental Protection and the Biodiversity Conservation Act 2000* (EPBC Act).	Chapter 22
12. Sustainability		
12.1 (Concept and Stage 1)	The sustainability of the Proposal in accordance with (as relevant) Green Star or the Infrastructure Sustainability Council of Australia (ISCA) Infrastructure Sustainability Rating Tool (or equivalent) and commit to an appropriate target rating.	Chapter 8 Chapter 26
13. Other Issues		
13.1 (Concept)	Air quality, greenhouse gas and energy, climate change adaptation, waste management and resource use, hazard and risk assessments should be undertaken in accordance with the commitments in Section 7 of the Scoping Report.	Chapter 8 Refer to Table 2 of this appendix for Scoping Report requirements

Reference	Secretary's Environmental Assessment Requirements	Where addressed
13.1 (Stage 1)	Air quality, greenhouse gas and energy, climate change adaptation, waste management and resource use, hazard and risk assessments should be undertaken in accordance with the commitments in Section 9 of the Scoping Report.	Chapter 23 Chapter 24 Chapter 25 Chapter 26 Refer to Table 2 of this appendix for Scoping Report requirements

Scoping Report assessment requirements

The Secretary's Environmental Assessment Requirements include references to the assessment requirements set out in the Scoping Report - Westmead to The Bays and Sydney CBD (Sydney Metro 2019). These requirements and where they are addressed in this Environmental Impact Statement, are outlined in Table 2.

Table 2: Scoping Report requirements

Reference	Scoping Report requirements	Where addressed
Traffic and transport		
7.1.3 (Concept)	Description of how, at a conceptual level, Sydney Metro West will meet the transport related objectives of relevant strategic plans, including consideration of future growth areas	Chapter 7 Chapter 8
	Description of the overall strategy for managing construction sites to minimise potential adverse construction transport and traffic impacts	Chapter 8
	Identification of the types of adverse impacts which could occur on the regional and local road network during construction including: • Pedestrian and cyclist movements around the construction sites • Impacts on access to existing stations at Westmead and North Strathfield • Impacts on public transport (including rail, buses, school buses and light rail) • Impacts on private transport such as school bus services • Impacts on the performance of the surrounding road network • Impacts on emergency services, residential property access and local businesses	
	Identification of the likely traffic and transport impacts on the regional and local road network during operation and on existing and proposed public transport routes, taking into account relevant government transport planning strategies	
	Identification of the transport related benefits at a conceptual level including the principles for integrating with and encouraging active transport	Chapter 7 Chapter 8
	The proposed scope of future traffic and transport assessments to be carried out as part of planning approvals for subsequent stages	Chapter 8
	Consultation will be carried out with other sections of Transport for NSW and relevant local Councils to inform the traffic and transport impact assessment.	Chapter 5
9.1.2 (Stage 1)	Identification of haulage routes, site access and egress points	Chapter 10
	Identification of daily and peak traffic movements likely to be generated and the potential impacts on the local and regional traffic network	
	Identification of service adjustments required to rail and bus services to allow for construction activities to safely occur	
	Identification of temporary adjustments to vehicular, pedestrian, cyclist, emergency services and public transport access	
	Identification of adjustments to parking supply, loading zones, servicing access and taxi zones	
	Identification of temporary altered access to private property	
	Identification of measures to minimise or mitigate identified impacts, including an assessment of available options and the expected effect of the measures proposed, in accordance with relevant best practice guidelines.	
Noise and vibration		
7.2.4 (Concept)	Identification of the types of construction activities likely to generate high noise and vibration levels, and the likely affected receivers	Chapter 8
	Identification of potential operational noise and vibration impacts, with consideration of existing and future known land uses	
	Strategies for noise mitigation and management	
	The proposed scope of future noise and vibration assessments to be carried out as part of planning approvals for subsequent stages.	

Reference	Scoping Report requirements	Where addressed
9.2.2 (Stage 1)	Identification of the nature of construction activities	Chapter 11
	Identification of the intensity and duration of noise and vibration impacts. This will include a 'typical level' or 'typical range' in noise levels which would be expected as construction work move around the site as well as a realistic 'worst-case' noise level from each activity	
	Identification of the correlation between the likely noise impacts and the anticipated duration and timing of the activity	
	Identification of the nature, sensitivity and impact on potentially affected receivers, including consideration of particularly sensitive receivers if present within the vicinity (such as schools, hospitals, aged care facilities) and sensitive structures (particularly heritage structures and key utilities/infrastructure)	
	Identification of impacts associated with any work proposed to be undertaken outside standard daytime construction hours	
	Identification of the potential impacts associated with long term construction noise	
	Explanation of how the extent of potential impacts on sensitive receivers have been balanced against the duration of impacts	
	Identification of other factors that may influence the timing and duration of construction activities (such as traffic management)	
	Identification of feasible and reasonable mitigation and management measures to address identified construction noise impacts.	
Non-Aboriginal heritage		
7.3.3 (Concept)	Information on how the development of the Concept has avoided or minimised impacts on heritage items	Chapter 8
	Identification of items, areas of heritage significance and archaeological resources that could be affected during its construction and operation	
	A general assessment of the type of impacts that may affect heritage items	
	An outline of potential mitigation measures and strategies	
	The proposed scope of future non-Aboriginal heritage assessments to be carried out as part of planning approvals for subsequent stages	
	Consultation with heritage specialists within the Department of Premier and Cabinet and local councils.	Chapter 5
9.3.2 (Stage 1)	Identification of items and areas of heritage significance that would be materially affected by Stage 1, by field survey and research, including any buildings, work, relics, gardens, landscapes, views, trees or places of heritage significance	Chapter 12
	Consideration of the potential impacts on the values, settings and integrity of heritage areas and items and archaeological resources located near Stage 1, including items both above and below ground and, where such potential exists, the likely significance of those impacts	
	An outline of the proposed mitigation and management measures (including measures to avoid significant impacts and an evaluation of the effectiveness of the mitigation measures) in accordance with relevant best practice guidelines.	
Aboriginal heritage		
7.4.3 (Concept)	Further consideration of the Aboriginal archaeological potential along the Concept corridor	Chapter 8
	Identification of the potential to disturb Aboriginal heritage	
	An outline of potential mitigation measures and strategies	
	Identification of the proposed scope of future Aboriginal heritage assessments, including the need for further archaeological testing and/or detailed archaeological excavations, that would be carried out as part of planning approvals for subsequent stages	
	Consultation with heritage specialists within the Department of Premier and Cabinet, local councils and registered Aboriginal parties.	Chapter 5
9.4.2 (Stage 1)	Identification of the potential for Stage 1 to disturb Aboriginal heritage (sites, objects, remains values, features or places) and, where this is the case, to: a. Determine, in consultation with relevant stakeholders, the significance of the heritage resource to the Aboriginal community	Chapter 13
	b. Determine the extent and significance of impact to those resources	
	Identification of any requirements for in-situ conservation of items and/or areas (as appropriate), and the need for further archaeological testing and/or detailed archaeological investigations	
	Identification of appropriate measures to avoid, minimise and/or mitigate potential impacts.	
Property and land use		
7.5.3 (Concept)	Identification of likely future land use based on zoning, planning proposals, major development applications and consultation with local councils and the Department of Planning, Industry and Environment	Chapter 7
	Identification of direct impacts on property and land use	Chapter 8
	Identification of indirect positive and negative impacts on property and land use, including potential land use integration issues, potential opportunities and/or benefits for urban renewal and development at and around metro stations	
	Identification of the proposed scope of future property and land use assessments to be carried out for subsequent stages of the Concept.	
9.5.2 (Stage 1)	Identification of potential impacts on property and land use from Stage 1, including the following issues: a. Direct impacts on property and land use, including acquisition and leasing b. Impacts on Crown land and Commonwealth land.	Chapter 14

Reference	Scoping Report requirements	Where addressed
Landscape character and visual amenity		
7.6.3 (Concept)	A high-level description of the visual character and qualities of the Concept corridor	Chapter 8
	Identification of the types of visual impacts which may occur due to construction and operation	
	Identification of potential landscape character changes due to the introduction of the Concept	
	An outline of urban design principles and objectives to guide further design and help minimise the impacts of potential infrastructure on surrounding visual or urban form	
	The proposed scope of future landscape character and visual amenity assessments to be carried out as part of planning approvals for subsequent stages of the Concept.	
9.6.2 (Stage 1)	Description of the visual character and unique qualities of the area around Stage 1	Chapter 15
	Consideration of the heritage and other social values of the site to establish the potential sensitivity of receivers and visual absorption capacity	
	Identification of the visual impacts of Stage 1 during daytime and night-time conditions (including lighting)	
	Identification of measures to avoid, minimise and/or mitigate potential impacts.	
Groundwater and geology		
7.7.3 (Concept)	Identification of sensitive groundwater users (registered groundwater bores) near the Concept corridor	Chapter 8
	Identification of the types of groundwater impacts (such as drawdown and settlement) that may occur during construction and operation	
	The proposed scope of future groundwater and geology assessments to be carried out as part of planning approvals for subsequent stages of the Concept.	
9.7.2 (Stage 1)	The NSW Aquifer Interference Policy (Department of Primary Industries, 2012) will be considered as relevant during the preparation of the hydrogeology assessment.	
	Description of the aquifer system(s) traversed by Stage 1	Chapter 18
	Identification of existing groundwater levels along the alignment and near the stations and portals	
	Identification of sensitive groundwater receivers (registered groundwater bores)	
	Discussion of the nature and extent of potential impacts on groundwater associated with construction and the ongoing presence of infrastructure including tunnels and station excavations. This would take into account existing groundwater levels, the geological context, the extent to which the infrastructure is 'tanked' (designed to inhibit the inflow of groundwater) and experience on other projects (including groundwater inflow rates)	
	Identification of potential impacts on groundwater quality	
	Identification of proposed monitoring/management measures to address identified impacts.	
Soils and surface water quality		
7.8.3 (Concept)	An overview of existing catchment and Water Quality Objectives for waterbodies within the Concept corridor	Chapter 8
	Identification of potential impacts on soils and water quality including surface water quality, acid sulfate soils, erosion and sedimentation	
	The proposed scope of future soil and water assessments to be carried out as part of planning approvals for subsequent stages	
	Consultation with the Environment Protection Authority.	Chapter 5
9.8.2 (Stage 1)	Identification of potential impacts on surface water quality	Chapter 19
	Identification of the potential to disturb acid sulfate soils and the associated impacts	
	Consideration of the potential impacts associated with erosion and sedimentation	
	Identification of proposed monitoring and management measures to address identified impacts.	
Contamination		
7.9.3 (Concept)	A review of available data and previous reports	Chapter 8
	Identification of the potential to encounter contamination	
	Identification of the proposed scope of future contamination assessments to be carried out as part of planning approvals for subsequent stages of the Concept	
	Consultation with the Environment Protection Authority.	Chapter 5
9.9.2 (Stage 1)	Review of previous contamination assessments (where available)	Chapter 20
	Review of historical aerial photography and plans to identify potential contamination sources along and/or adjacent to Stage 1 construction sites	
	Review of publicly available data (web-based information searches)	
	A site inspection to identify potential contamination sources and verify those potential areas of concern identified in the review of historical and available information	
	Recommendations for additional investigations and/or management of potentially contaminated sites which could be encountered during construction.	

Reference	Scoping Report requirements	Where addressed
Social impacts and community infrastructure		
7.10.3 (Concept)	Identification of the regional level social and community facilities along the corridor (including public open spaces and recreational areas)	Chapter 8
	Identification of potential social impacts on the community and community facilities / services which could occur during construction and operation	
	Identification and assessment of potential social benefits	
	Identification of the proposed scope of future social impact assessments to be carried out as part of planning approvals for subsequent stages.	
9.10.2 (Stage 1)	Identification of the existing social environment and any impacts to social conditions, communities and community values within the areas around the Stage 1 construction sites	Chapter 17
	Review of community characteristics, including identification of significant community infrastructure	
	Assessment of the social impact on the directly affected community and its facilities and/or services around the Stage 1 construction sites	
	Identification any community facilities that would be lost as a result of Stage 1, and if alternative facilities are available or if the facilities can be replaced in the local area	
	Identification of community facilities adjacent to construction sites that may be impacted by reduced amenity or access	
	Identification of mitigation and management measures for any potential impacts.	
Business impacts		
7.11.3 (Concept)	Identification of the general types of businesses impacts (both direct and indirect) which could occur during construction and operation	Chapter 8
	The proposed scope of future business impact assessments to be carried out as part of planning approvals for subsequent stages.	
9.11.2 (Stage 1)	Identification of businesses that would be directly impacted by Stage 1	Chapter 16
	Identification of nearby local businesses that may be indirectly impacted by Stage 1	
	Assessment of the potential impacts of Stage 1 on local businesses	
	Identification of measures to avoid or mitigate the potential impacts.	
Hydrology and flooding		
7.12.3 (Concept)	Identification of the types of hydrology and flooding impacts which could occur during construction and operation	Chapter 8
	The proposed scope of future hydrology and flooding impact assessments to be carried out as part of planning approvals for subsequent stages of the Concept.	
9.12.2 (Stage 1)	Identification and assessment of potential impacts on stormwater quantity	Chapter 21
	Broad assessment of the potential change in stormwater runoff (increase or decrease)	
	Identification of potential impacts as a result of changes in surface water quantity, with respect to increases or decreases in stormwater runoff and the sensitivity of the downstream waters	
	Identification of any potential changes to flood levels, discharges, velocities, duration of flood inundation and flood hazards for the five per cent and one per cent Annual Exceedance Probability flood events, and the probable maximum flood	
	Identification of appropriate mitigation and management measures.	
Biodiversity		
7.13.3 (Concept)	Identification of the potential presence of any endangered ecological communities, threatened species or threatened species habitat and the nature of any potential impacts	Chapter 8
	Identification of the proposed scope of future biodiversity assessments to be carried out as part of planning approvals for subsequent stages.	
9.13.2 (Stage 1)	Identification and description of the flora and fauna species, habitat, populations and ecological communities (including groundwater dependent ecosystems) that occur or are considered likely to occur	Chapter 22
	Assessment of any direct and indirect impacts of Stage 1 on terrestrial and aquatic flora and fauna species, populations, ecological communities and their habitats, and groundwater dependent ecosystems	
	Assessment of the significance of the impacts of Stage 1 on species, ecological communities and populations, and groundwater dependent ecosystems listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, the *Biodiversity Conservation Act 2016* and the *Fisheries Management Act 1994* that occur or are considered likely to occur	
	Identification and description of mitigation measures using the principles of 'avoid, minimise, mitigate', and propose offsets where residual impacts would occur. Offsets would be determined in accordance with the NSW Biodiversity Offsets Scheme (Office and Environment and Heritage, 2017b) NSW Biodiversity Offsets Policy for Major Projects (NSW Office of Environment and Heritage, 2014b).	
Air quality		
7.14.3 (Concept)	Identification of the background air quality environment based on a desktop assessment	Chapter 8
	Identification of potential sources of air emissions during both construction and operation	
	The proposed scope of future air quality assessments to be carried out as part of planning approvals for subsequent stages.	

Reference	Scoping Report requirements	Where addressed
9.14.2 (Stage 1)	Identification of and describe the background air quality environment based on a desktop assessment	Chapter 23
	Identification of Identify potential sources of air emissions during Stage 1	
	Identification of potential sensitive receivers likely to be impacted by emissions to air during Stage 1	
	Identification of and describe mitigation measures using the principles of 'avoid, minimise, and mitigate'.	
Greenhouse gas and energy		
7.15.2 (Concept)	Identification of the activities which are likely to be the major source of greenhouse gas emissions during construction and operation	Chapter 8
	The proposed scope of future greenhouse gas assessments to be carried out as part of planning approvals for subsequent stages of the Concept.	
9.15.2 (Stage 1)	Identification of the potential greenhouse gas emissions from Stage 1	Chapter 26
	Identification of mitigation and management measures to reduce potential emissions of greenhouse gas.	
Climate change adaptation		
7.16.2 (Concept)	Identification of potential climate change risks to the Concept	Chapter 8
	Identification of high-level adaptation measures to respond to the identified risks	
	The proposed scope of future climate change assessments to be carried out as part of planning approvals for subsequent stages of the Concept.	
9.16.2 (Stage 1)	The climate change adaptation assessment for Stage 1 will: Identify possible climate related impacts with an emphasis on any that are projected to undergo a substantial change	Chapter 26
	Identify Stage 1 components that may be vulnerable to the climate change impacts	
	Identify possible current and future controls that may increase the resilience of particular Stage 1 components to climate impacts	
	Recommend what should be considered, and how to establish if further information is needed, to adequately assess climate change risk.	
Waste management and resource use		
7.17.2 (Concept)	Identification of the waste streams likely to be generated during construction and operation	Chapter 8
	Identification of the expected resource use during construction and operation	
	The proposed scope of future waste management assessments to be carried out as part of planning approvals for subsequent stages.	
9.17.2 (Stage 1)	Review of the likely waste streams and volumes generated during Stage 1, including spoil, wastewater and demolition materials	Chapter 24
	Review of the likely resources required during Stage 1, including energy, fuel and steel	
	Development of management strategies to adequately address waste during Stage 1. Measures would likely include: Measures for managing construction waste through the waste hierarchy established under the Waste Avoidance and Resource Recovery Act 2001 (i.e. avoidance of waste, resource recovery, disposal of waste	
	Targets for the beneficial reuse of spoil, wastewater and other construction wastes in accordance with a future Sydney Metro West sustainability plan	
	An approach for the assessment, handling, stockpiling and disposal of potentially contaminated materials and wastewater, in accordance with the Waste Classification Guidelines (Environment Protection Authority, 2014)	
	Identification of opportunities to reduce the demand on electricity and other resources	
	Identification of how spoil would be managed, including likely volumes, likely nature and classification of excavated material, opportunities for recycling, potential disposal sites, stockpile management, and method(s) and route of transportation. This would consider the cumulative effects of spoil haulage and disposal activities associated with other Sydney based tunnel projects, including other Sydney Metro projects, WestConnex and Western Harbour Tunnel and Beaches Link.	
Hazard and risk		
7.18.2 (Concept)	Identification of the types of hazards and risks that could occur during construction and operation	Chapter 8
	The proposed scope of future hazard and risk assessments to be carried out as part of planning approvals for subsequent stages.	
9.18.2 (Stage 1)	The following guidelines will be considered as relevant during the preparation of the hazard and risk assessment: • Hazardous and Offensive Development Application Guidelines: Applying SEPP 33 (Department of Planning, 2011a) • International Standard (ISO/IEC 31010:2009) Risk Management – Risk Assessment Techniques • Australian Code for the Transport of Dangerous Goods by Road and Rail (edition 7.6) (National Transport Commission, 2018) • Model Code of Practice: How to manage and control asbestos in the workplace (Safework Australia, 2018) • Code of Practice: How to Safely Remove Asbestos (Safework NSW 2016) • Storage and Handling of Dangerous Goods Code of Practice (WorkCover NSW, 2005), noting this Code is a guide for processes and controls to manage risks and is not to be relied upon to ascertain requirements under the Work Health and Safety Regulation 2011 • Australian Standard AS 2885 Pipelines – Gas and liquid petroleum • Hazardous Industry Planning Advisory Paper No. 6 - Guidelines for Hazard Analysis (Department of Planning, 2011b) • Multi-Level Risk Assessment (Department of Planning, 2011c).	Chapter 25

Reference	Scoping Report requirements	Where addressed
Cumulative impacts		
7.19.3 (Concept)	Details of known surrounding developments with the potential to interact with the construction and / or operation will be identified through consultation with stakeholders and a review of the Department of Planning, Industry and Environment's Major Projects database and local council development application registers.	Appendix G
	Identification of the types of potential cumulative impacts which could arise from the interaction of these projects. The assessment will also identify the proposed scope of future cumulative impact assessments to be carried out as part of planning approvals for subsequent stages.	Chapter 8
9.19.3 (Stage 1)	Details of known surrounding developments and major projects with the potential to interact with the Stage 1 construction work will be identified through consultation with stakeholders and a review of relevant local environmental plans, the Department of Planning, Industry and Environment's Major Projects database and local council development application registers. Potential cumulative impacts arising from the interaction of these projects will be identified and assessed in a qualitative manner. Management and mitigation measures will be proposed, where appropriate.	Chapters 10 to 26

Appendix B

Environmental Planning and Assessment Regulation 2000, Part 3 of Schedule 2 checklist

Appendix B

Environmental Planning and Assessment Regulation 2000, Part 3 of Schedule 2 checklist

This appendix describes the requirements of Schedule 2 (Part 3) of the Environmental Planning and Assessment Regulation 2000 and where they are considered in the assessment.

Table 1: Requirements of Schedule 2 (Part 3) of the Regulation

Clause(s)	Where addressed
6. Form of environmental impact statement	
An environmental impact statement must contain the following information —	
a. the name, address and professional qualifications of the person by whom the statement is prepared	Certification
b. the name and address of the responsible person	Certification
c. the address of the land —	
i. in respect of which the development application is to be made, or	Certification
ii. on which the activity or infrastructure to which the statement relates is to be carried out	Certification
d. a description of the development, activity or infrastructure to which the statement relates	
e. an assessment by the person by whom the statement is prepared of the environmental impact of the development, activity or infrastructure to which the statement relates, dealing with the matters referred to in this Schedule	Certification
f. a declaration by the person by whom the statement is prepared to the effect that —	
i. the statement has been prepared in accordance with this Schedule, and	Certification
ii. the statement contains all available information that is relevant to the environmental assessment of the development, activity or infrastructure to which the statement relates, and	Certification
iii. that the information contained in the statement is neither false nor misleading.	Certification
7. Content of environmental impact statement	
1. An environmental impact statement must also include each of the following —	
a. a summary of the environmental impact statement	Executive summary Chapter 27 – Synthesis of the Environmental Impact Statement
b. a statement of the objectives of the development, activity or infrastructure	Chapter 2 – Strategic need and justification
c. an analysis of any feasible alternatives to the carrying out of the development, activity or infrastructure, having regard to its objectives, including the consequences of not carrying out the development, activity or infrastructure	Chapter 3 - Sydney Metro West development and alternatives
d. an analysis of the development, activity or infrastructure, including —	
i. a full description of the development, activity or infrastructure	Chapter 6 – Concept description Chapter 9 – Stage 1 description
ii. a general description of the environment likely to be affected by the development, activity or infrastructure, together with a detailed description of those aspects of the environment that are likely to be significantly affected	Chapter 8 – Concept environmental assessment Chapters 10 to 26 – Stage 1
iii. the likely impact on the environment of the development, activity or infrastructure	Chapter 8 – Concept environmental assessment Chapters 10 to 26 – Stage 1
iv. a full description of the measures proposed to mitigate any adverse effects of the development, activity or infrastructure on the environment	Chapter 8 – Concept environmental assessment Chapters 10 to 26 – Stage 1
v. a list of any approvals that must be obtained under any other Act or law before the development, activity or infrastructure may lawfully be carried out	Chapter 4 – Planning and assessment process
e. a compilation (in a single section of the environmental impact statement) of the measures referred to in item (d)(iv)	Chapter 27 – Synthesis of the Environmental Impact Statement
f. the reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, economic and social considerations, including the principles of ecologically sustainable development set out in subclause (4).	Chapter 27 – Synthesis of the Environmental Impact Statement Chapter 29 – Project justification and conclusion
2. Subclause (1) is subject to the environmental assessment requirements that relate to the environmental impact statement.	Secretary's Environmental Assessment Requirements are addressed throughout the document. A summary is provided in Appendix A.
3. Not applicable	N/A
4. The principles of ecologically sustainable development.	Chapter 27 – Synthesis of the Environmental Impact Statement

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Appendix C

Stakeholder and community engagement

Appendix C

Stakeholder and community engagement

This appendix describes the stakeholder and community engagement completed during project scope development and preparation of the Environmental Impact Statement for Stage 1 and the projects considered in the assessment.

1.1 Stakeholder and community feedback from project scope consultation

Two rounds of formal stakeholder engagement were carried out over 2017 and 2018 based around the release of:

- First Project Scope in 2017
- Project Overview report in 2018.

In addition, ongoing consultation and engagement has been carried out with government agencies, local government and Precinct Partners (the former Sydney Olympic Park Authority, Infrastructure NSW (formerly UrbanGrowth) in relation to The Bays, and Westmead Alliance).

A summary of the outcomes of the project scope consultation is provided below.

1.1.1 Summary of feedback from local government and stakeholders

Sydney Metro has engaged with local councils situated within the Greater Parramatta to Sydney CBD corridor since 2016. These councils are shown in Figure 1 and include Cumberland City Council, City of Parramatta Council, Municipalities of Strathfield and Burwood, City of Canada Bay Council, Inner West Council and City of Sydney. Table 1 summarises the key aspects of the Concept relevant to each Council area, which has also guided the types of issues discussed with each council (Table 2).

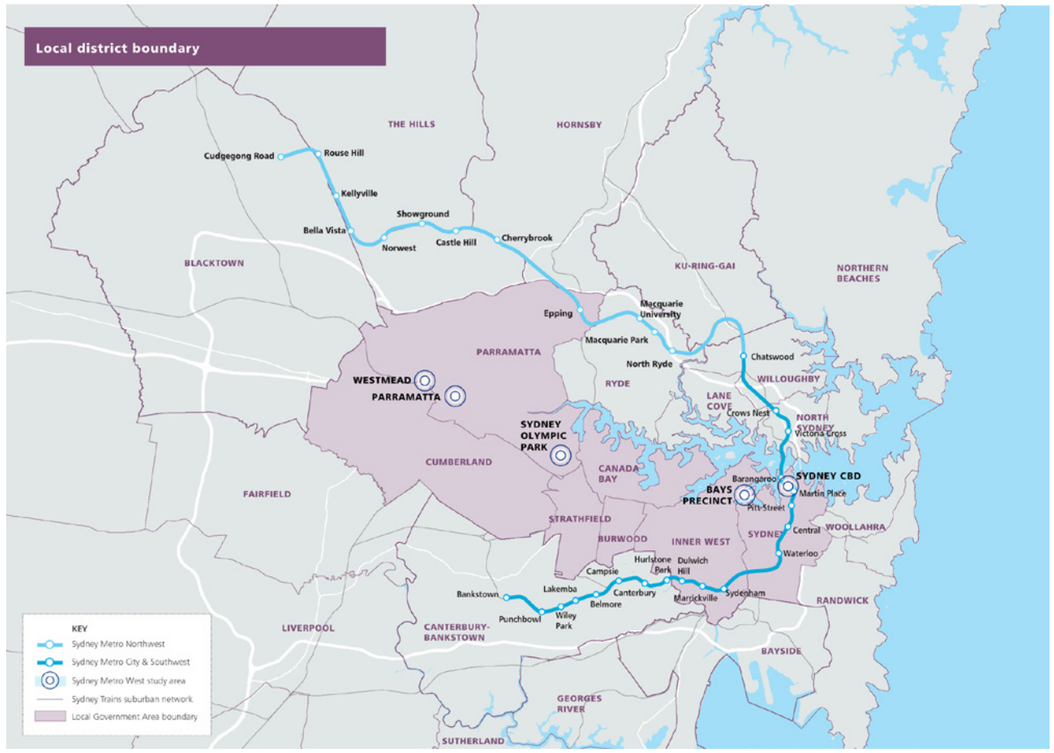

Figure 1: Local councils consulted since 2016

Table 1: Geographical interfaces with local councils

Council	Geographical interface
Cumberland City Council	• Westmead (south of existing rail line)
City of Parramatta Council	• Westmead (north of existing rail line) • Parramatta CBD • Sydney Olympic Park • Investigations of potential intermediate station options in the Greater Parramatta Olympic Peninsula area
Strathfield Council	• Implications of potential intermediate stations (not located in local government area boundary)
Burwood Council	• Implications of Burwood North Station
City of Canada Bay Council	• T9 Northern Line connection at North Strathfield • Intermediate station options investigations including Burwood North, Kings Bay and Five Dock
Inner West Council	• The Bays Precinct • Implications of Five Dock Station (not located in local government area boundary)
City of Sydney Council	• Overall alignment • Potential Sydney CBD station options • Pyrmont as a strategic station option

Table 2: Key issues covered through local council engagement

Theme	Items covered
General project updates	• Updates on project scope, development and milestones • Sydney Metro West Project objectives • Informing of upcoming formal consultation periods • Overview of feedback from previous engagement
Travel time	• Overview of drivers and customer benefits of a travel time target of about 20 minutes between Parramatta and the Sydney CBD
Station optionality	• Overview of station location evaluation processes for stations relevant to each local government area
Station location analysis	• Overview of station options with a geographical interface with the local government area • High level station design, where relevant
Transport integration	• Sydney Metro West transport integration principles • Overview of transport integration opportunities for stations with a geographical interface with the local government area – including active transport and bus integration • Drivers and benefits of rail interchanges – including the T9 Northern Line (City of Canada Bay Council and Municipality of Strathfield); and the T1 Western Line (City of Parramatta Council and Cumberland City Council)
Urban design and place	• Station locality plans and urban design considerations
Local planning	• Council updates on development applications and planning proposals which may impact the Concept • Progress on council-led projects where relevant

Table 3 summarises the feedback from local government from the two rounds of stakeholder engagement and explains how Sydney Metro has considered the feedback received. Table 4 summarises the feedback from peak bodies, representative organisations and groups from the first round of engagement. Table 5 summarises the feedback from Precinct Partners.

Table 3: Summary of feedback from local government stakeholders

Organisation	Summary of feedback – round one	Summary of feedback – round two and from ongoing engagement	Sydney Metro response
City of Parramatta Council	• Identified that the City of Parramatta (as part of the Westmead Alliance) is undertaking a master plan for Westmead that will identify opportunities to coordinate with Sydney Metro West.	NA	• Sydney Metro has consulted with the Westmead Innovation District master planning team in determining the most appropriate location for the Westmead Metro Station This engagement will continue during future development of Sydney Metro West, including consideration of integrated station and precinct development
	• Previously (in a joint submission with the Sydney Business Chamber) recommended a fast train service linking Western Sydney Airport, and the Parramatta and Sydney CBDs.	NA	• Sydney Metro Greater West has been announced. This metro would connect travellers from the new airport to the rest of Sydney's public transport system, with stations at St Marys, Western Sydney Airport and the Aerotropolis.

	• Recommended the following options:
	  • Use of the existing rail corridor
	  • Intermediate stations at Croydon and Lidcombe, and then Pitt Street Station
	  • Intermediate stations at White Bay and Sydney Olympic Park, and then Pitt Street Station
	  • Barangaroo to Parramatta CBD, with intermediate stations at White Bay and Ryde, with a subsequent connection to Western Sydney Airport.
		• Support for connection with T9 Northern Line and T1 Western Line
		• Under 20-minute travel time between Parramatta and the Sydney CBD
		• Strong support for a station at Westmead and an interchange with T1 Western Line, Parramatta Light Rail, T-Way and active transport.
			• The Concept establishes a new corridor to improve the public transport network accessibility to key economic centres across the Greater Parramatta to Sydney CBD corridor. Connections with the T1 Western Line and T9 Northern Line are provided at Westmead and North Strathfield respectively. Connections to Parramatta Light Rail are proposed at Westmead and Sydney Olympic Park.

	NA	• Sydney Metro West is aligned with Council's vision for Parramatta • Support for a metro station close to or on Civic Link and clear legibility with other transport modes • Civic Link Framework Plan and related Development Control Plan needs to be integrated with any future metro station.	• The Parramatta Metro Station is positioned for good connections with the existing and planned civic spaces, including Parramatta Square, Church Street and the proposed Civic Link. The Civic Link Framework Plan and related Development Control Plan will be considered during future development of Sydney Metro West, including integrated station and precinct development.
	NA	• Council requests direct involvement in planning for Metro at Sydney Olympic Park.	• Engagement with Council will continue during future development of Sydney Metro West.
	NA	• Council resolved to advocate a station in the Newington/North Lidcombe area (north of the M4 motorway) • Support for a station at either Camellia or Rydalmere – preference for Camellia • Retain employment lands at Rydalmere.	• A strategic station option at Rydalmere has been identified and is still under investigation.
Canterbury Bankstown Council	• Acknowledged that Sydney Metro West does not directly impact the Canterbury Bankstown area, however requested that the southwest is given the same level of investment and focus to maximise the benefits possible from this new infrastructure.	NA	• Significant investment is proposed as part of Sydney Metro City & Southwest, which includes upgrade and conversion of all 11 stations between Sydenham and Bankstown to metro standards.
Strathfield Council	• Recommended stations within the Strathfield and Homebush priority precincts to support additional dwellings and jobs.	• Support for Sydney Metro West • Connection and integration to North Strathfield supported.	• The Concept includes the opportunity to transfer to and from the T9 Northern Line at North Strathfield.
	NA	• Welcomed further briefing once more information is available including decision on funding • Welcomed continued engagement and briefing with Council staff.	• Sydney Metro will continue to work with Strathfield Council as the Concept and Stage 1 progress.
City of Canada Bay Council	• Support for Kings Bay Station option to serve future development associated with the Parramatta Road Urban Transformation Strategy • Recommended two additional station locations at Burwood and Strathfield/Homebush.	• Support for a connection to the T9 Northern Line at either North Strathfield or Concord West and requests further information.	• The Concept includes metro stations at Five Dock and Burwood North and a connection to the T9 Northern Line at North Strathfield.
	NA	• Endorses Five Dock in addition to Burwood North within the Parramatta Road Corridor Urban Transformation Strategy area.	• With metro stations at North Strathfield, Burwood North and Five Dock, the Concept supports the overall vision for the Parramatta Road Corridor as a high quality multi-use corridor with improved transport choices.
	NA	• Requests community consultation sessions held in Five Dock.	• Community consultation will continue during the preparation and exhibition of the Environmental Impact Statement. This will include community drop-in sessions across the alignment.

Organisation	Summary of feedback – round one	Summary of feedback – round two and from ongoing engagement	Sydney Metro response
Burwood Council	NA	• Support for a metro station at the intersection of Burwood Road and Parramatta Road to serve demand from the north and south.	• The Concept includes Burwood North Station near the intersection of Parramatta Road and Burwood Road.
	NA	• Plan for a connection between Burwood North Station and Burwood Station including a pedestrian-only link across Parramatta Road.	• An entry to the metro station is proposed to be provided on the southern side of Parramatta Road, with a pedestrian underpass.
	NA	• Plan for new bus services to connect Burwood North Station with Burwood Station and Strathfield Station • Restore peak hour suburban rail services stopping at Burwood Station. This should be enabled by decreased pressure on the T1 Western Line with the construction of Sydney Metro West.	• Bus and rail servicing will be discussed with operators during future development of Sydney Metro West.
Inner West Council	NA	• Requests that The Bays Station be located near to the White Bay Power Station site and the Balmain Peninsula.	• The Bays Station would be located at the apex of White Bay between Glebe Island and the White Bay Power Station.
	• Requests involvement in decisions associated with route options, alignment and station locations.	• Requests involvement in the determination of station locations, access arrangements and land use responses to stations.	• Sydney Metro has engaged with stakeholders, including Council, to seek feedback throughout early project development. This engagement with Council will continue during future development of Sydney Metro West.
	NA	• Recommends that Sydney Metro is integrated with the broader transport network, including enhanced bus and active transport connections • Opportunities should be considered to reinstate Glebe Island Bridge for active transport.	• The development of the Concept has considered opportunities for integration with other public and active transport modes • Stations would be designed to integrate with the broader transport network.
	NA	• Requests that opportunities for additional stations within the Inner West local government area be considered to encourage the use of public transport	• Various station options have been considered. Station locations have been informed by a range of factors including travel time between the Sydney and Parramatta CBD, opportunities for land use and transport integration, constructability and community feedback, among other factors. • Stations at Five Dock and The Bays Precinct present opportunities for integration with the bus network in the Inner West area.
	NA	• Requests that the Sydney Metro West project include a comprehensive community consultation program.	• Community consultation will continue during the preparation and exhibition of the Environmental Impact Statement. This will include activities such as community drop-in sessions.
	• Advocates for the protection of industrial land, spaces for creative uses and heritage items. • Future development around stations should support broader strategic planning objectives. • Supports increased supply of open space across the corridor.	• Reiterated previous comments.	• The development of the Concept has been informed by broader strategic planning objectives. • Integrated station and precinct development would be subject to a separate planning approvals process.
City of Sydney Council	• Recommended that Sydney Metro West should connect to Central Station (via a new station at Railway Square) • Recommended additional stations at Pyrmont, Ultimo and Green Square East.	• Strongly supports Pyrmont station. • Supports a station at Central Station to help renew the southern CBD and build upon the education precinct • An interchange at Central could connect to the health and innovation district at Ultimo and Camperdown/ Sydney University.	• The Concept includes a strategic station option at Pyrmont. The Concept includes a station in the Sydney CBD that would enable transfer to and from with existing public transport networks, including Sydney Metro City & Southwest, Sydney Trains, Light Rail and bus networks. Further investigation is currently underway to identify an optimum location within the Sydney CBD.
	• Recommended that opportunities west of Parramatta at Badgerys Creek Airport and east of Green Square at Randwick and Maroubra should be considered.	NA	• Potential station locations beyond the Sydney CBD would be considered as part of planning for a future extension to the south-east • Sydney Metro Greater West has been announced. This metro would connect travellers from the new airport to the rest of Sydney's public transport system, with stations at St Marys, Western Sydney Airport and the Aerotropolis.
	NA	• Supports the broad Sydney Metro West concept • Supports accelerated delivery of Sydney Metro West – no later than 2028.	• Further information on delivery timeframes for Sydney Metro West will be provided as part of the Environmental Impact Statement
Southern Sydney Regional Organisation of Councils (SSROC)	• Recommended a station at Burwood to support its role as a strategic or district centre.		• The Concept includes Burwood North Station near the intersection of Parramatta Road and Burwood Road.

Table 4: Early feedback from peak bodies, representative organisations and groups

Organisation	Summary
10,000 Friends of Greater Sydney (FROGS)	Recommendations include: • Need to augment the capacity of the current heavy rail lines in the western rail corridor • Use of single deck rolling stock • Various station locations • Need for a second station at Parramatta • Need for a fast rail link from Parramatta to Western Sydney Airport, joining to the Sydney CBD with a separate line from Sydney Metro West in the future.
Action for Public Transport (NSW) Inc	• Recommended that metro should provide cross-platform interchange to other rail services and that stations should be not too far apart • Suggested that Sydney Metro West provides an opportunity to transform Parramatta Road • Suggested route alignments and station locations for east, south and south-west of the Sydney CBD.
Australian Rugby Union (ARU)	• Recommended a station at Moore Park to address the need for better public transport connections for sports fans.
Cricket NSW	• Recommended a station at Moore Park to support the multiple sporting events and align with other domestic and international sporting precincts by providing better public transport connectivity.
Kings Bay Partnership	• Supported a Kings Bay Station option.
Liverpool Transport Taskforce	• Recommended four metro tracks between the Sydney CBD and Parramatta to enable both express and all-stops services • Supported a Concord West Station option rather than Strathfield • Suggested station locations for east of the Sydney CBD • Recommended faster and more connected services for Liverpool.
NSW Rugby Union	• Suggested the Moore Park area would benefit from an integrated public transport system.
Royal Agricultural Society	• Recommended that the Olympic Park Station for Sydney Metro West should be located in the south-east of the Sydney Showground site (in or around the existing P6 car park site).
Sydney Cricket and Sports Ground Trust	• Recommended a station at Moore Park to significantly decrease traffic congestion during major events, to the benefit of event attendees, as well as local businesses and residents.
Sydney Swans Ltd	• Supports Sydney Metro West • Recommended a station at Moore Park.
Western Sydney University	• Recommended a station at Westmead to support jobs within the education and health super precinct.

Table 5: Summary of feedback from Precinct Partners

Precinct Partners	
• **Former Sydney Olympic Park Authority** • **Infrastructure NSW (formerly UrbanGrowth)** • **Ports Authority of NSW** • **Westmead Alliance**	• Alignment with master planning processes • Coordination and alignment on staging and implementation of masterplan outcomes and other infrastructure • Joint decision making on station location, design, transport integration and economic benefit realisation.

1.1.2 Summary of feedback from community engagement

Community information and engagement – round one

The "have your say" survey from round one yielded useful information to further inform the development of Sydney Metro West.

Key insights from the 1,000 people that participated in the survey included:

- Top five suggested station locations (apart from the four key precincts announced) included Five Dock, Wentworth Point, Newington, North Strathfield and Westmead
- Thirty-nine per cent requested a metro station in their own suburb, 41 per cent did not request a metro station in their own suburb, and 20 per cent did not state a metro station location preference
- Majority of survey respondents use public transport daily and want a train service that is frequent, with no timetable
- Top five community attributes that are valued (in order) include:
  - parks and recreational facilities
  - cafes restaurants and shops
  - natural environment
  - a sense of community
  - walking and cycling links
- Seventy-four per cent stated they were not concerned about a metro station being built in their suburb, 15 per cent replied they would be concerned, 10 per cent replied that maybe they would be concerned (one per cent did not answer this question).

For the survey respondents that expressed concern about a metro station being built in their suburb (15 per cent), a follow-up question asked for more information. Figure 2 summarises the concerns provided by this group of survey respondents.

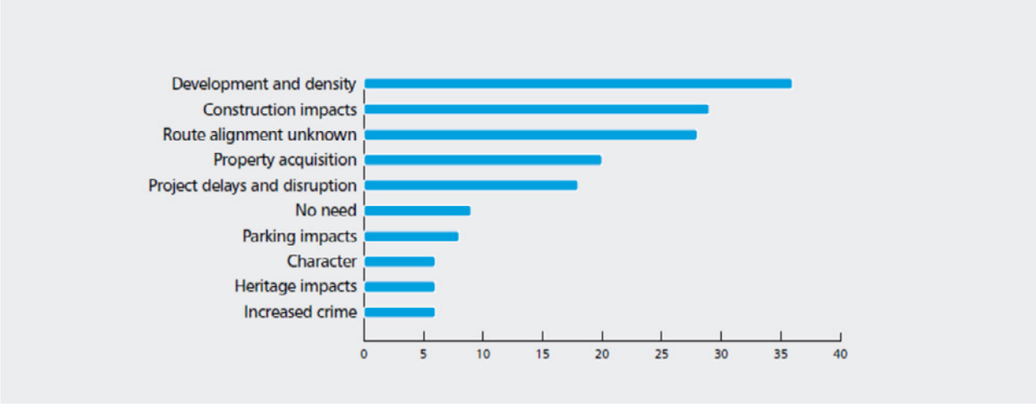

Figure 2: Survey results from question: 'Why are you concerned about a metro station being built in your suburb?'

In addition to the 1,000 "have your say" survey responses, 39 submissions were received from members of the community, with 38 submissions from individuals and one submission from the Save North Strathfield Residents Action Group. Most community submissions were supportive of Sydney Metro West.

A summary of the key themes from 39 community submissions received during round one of the community information and engagement is provided in Table 6.

Table 6: Key themes from round one community information and engagement

Topic	Issue raised	Sydney Metro West response
Strategic objectives and justification	Some submissions felt Sydney Metro West should be delivered earlier than the late 2020s, to support forecast population growth and relieve congestion on the T1 Western Line. It was also felt that consideration should be given to connecting communities that are currently not serviced by rail, while being aware of the impact of high-density development as a result of urban renewal.	Sydney Metro will continue to investigate ways to deliver Sydney Metro West as efficiently as possible. The delivery of Sydney Metro Northwest and Sydney Metro City & Southwest will provide some relief from congestion for the T1 Western Line when it opens in full configuration in 2024. The Concept includes stations in areas not currently serviced by rail (Burwood North, Five Dock and The Bays) and interchange opportunities with the suburban rail network at Westmead, North Strathfield and in the Sydney CBD.
Land use and development	Urban renewal, including employment and higher-density housing, could be associated with Sydney Metro West. Many submissions had a view that effective public transport solutions needed to accompany new developments in the corridor, and that Sydney Metro West should consider these areas in addition to areas marked for growth. There were mixed views on development potential according to the area. As part of its ongoing analysis, Sydney Metro will look at how the existing bus network can be optimised to achieve better customer outcomes, and opportunities presented to optimise the broader public transport network.	A range of station options within the corridor have been considered to determine which would benefit most from a metro service and how to best integrate with land use planning along the corridor.
Project cost and funding	Some submissions expressed concern about the value-capture process and how it would not meet the long-term local and social infrastructure needs of urban renewal locations.	Various funding options including value-capture mechanisms are being considered. This is beyond the scope of the planning approval process.
Project definition – train type, journey times and station frequency	Some submissions felt that service on the new line would need to be frequent, support the population and employment areas, and be significantly less than a 25 to 27 minute journey time to compete with the T1 Western Line. Others felt that the journey time should be between 10 and 20 minutes. There were mixed views about providing a fast- or high-speed rail service versus the number of stations. Submissions wanting greater accessibility for communities west of Parramatta from the Western Sydney Airport to the Sydney CBD wanted a fast service. Submissions from locations between the Parramatta and Sydney CBDs that currently do not have access to a mass-transit solution, generally requested a metro station within their area. It was also mentioned that fewer stations would provide less opportunity for people to use the service.	To achieve the optimum balance, Sydney Metro have looked at a combination of speed of travel, frequency of service, the number of stations, and the reliability of the service. There is also the need to link communities not currently serviced by rail to major job centres. The optimal combination of all these factors to provide the best outcome for most customers informed the development of the Concept.
Transport integration	Many submissions expressed concern about the need to relieve congestion on the T1 Western Line, and also the need to integrate rail lines to create a north–south connection. Other comments included the need to provide connections to ferries and to local bus routes within the corridor. Respondents felt that the new line should not duplicate the current T1 Western Line, even though there was congestion on that line, but should instead service new areas.	The Greater Sydney Service and Infrastructure Plan released as part of the Future Transport 2056 strategy includes several mass transit links for further investigation around Parramatta to expand 30-minute access to education, jobs and services. This includes links from the north to south, including potential links between Parramatta–Epping and Parramatta–Kogarah. Relieving the T1 Western Line is a key objective for Sydney Metro West. All areas within the study area have been investigated, and the Concept would provide new areas with rail services.
Road network performance	Many submissions welcomed Sydney Metro West, as they felt that it would reduce congestion on the roads. They also raised the importance of a metro station within the Parramatta Road Corridor to cater for growth and support the Parramatta Road Urban Transformation Strategy.	The Greater Sydney Service and Infrastructure Plan released as part of the Future Transport 2056 strategy proposes a range of transport initiatives to support growth and improve journey times. This includes Parramatta Road public transport improvements with planning underway. The Concept has been developed with reference to strategic investigations to support broader land use planning within the corridor, such as the Parramatta Road Urban Transformation Strategy, The Bays Urban Transformation Program, the Sydney Olympic Park Masterplan, and the Greater Sydney Commission's vision for the Greater Parramatta and the Olympic Peninsula. Directly relevant to these plans and strategies, the Concept includes new metro stations at Sydney Olympic Park, North Strathfield, Burwood North and The Bays Precinct.
Local amenity, precinct planning and placemaking	Some submissions felt that station locations should be walkable and cycle friendly and include pick-up and drop-off points.	All stations forming part of the Concept would prioritise walking and cycling access, and would provide cycle parking options, to encourage active transport connections. Stations would also be designed to provide easy transfer to other transport services, such as buses, and include kiss-and-ride, ride share and taxi zones.
Project design and construction	One submission provided advice on design and construction considerations to ensure benefits of the new Sydney Metro West and T1 Western Line could both be realised.	All submissions providing technical advice and comments were provided to the project team for consideration.
Options outside study area	Some submissions raised the importance of connecting a north–south line to Sydney Metro West, as well as providing a connection to Western Sydney Airport. One submission suggested using the same branding for metro as heavy rail to avoid confusion for passengers.	The Future Transport Strategy 2056 proposes future initiatives and potential future transport solutions, including rail lines. Sydney Metro Greater West has been announced. This metro would connect travellers from the new airport to the rest of Sydney's public transport system, with stations at St Marys, Western Sydney Airport and the Aerotropolis. For ease of customer information and wayfinding, Sydney Metro and Sydney Trains will continue to have individual branding.
Location specific considerations	Location-specific considerations outlining issues, constraints and opportunities, were provided in submissions for many locations.	Further detail on Sydney Metro West, including proposed and potential station locations was provided to the community as part of the second round of community information and engagement. Location specific considerations were therefore considered in more detail as part of the second round (refer below).

Community information and engagement – round two

The overview document, Sydney Metro West: A new railway for Western Sydney – Project overview (March 2018), provided a summary of Sydney Metro West. This included station locations at Westmead, Parramatta CBD, Sydney Olympic Park, The Bays Precinct and the Sydney CBD.

Sydney Metro West: A new railway for Western Sydney – Project overview (March 2018) also outlined potential intermediate stations that were being investigated at Rydalmere/Camellia, Burwood North/Kings Bay/Five Dock and Pyrmont, as well as a connection to the T9 Northern Line at either North Strathfield or Concord West.

Most submissions received were broadly positive and supportive of Sydney Metro West and/or the metro network, while some others outlined concerns and raised questions.

Fifteen submissions were received from major stakeholders, including local governments, peak bodies, education providers, community groups and others. Many submissions raised multiple issues, resulting in a total greater than the total number of submissions.

An overview of all submission topics, as well as feedback provided through interactive maps, is provided in Figure 3.

Table 7 outlines the feedback received as part of the second phase of consultation regarding Sydney Metro West and how this has been considered in refining the scope of Sydney Metro West or in defining the scope of the Environmental Impact Statement. This table (which was initially provided in the Scoping Report) has been updated to reflect the information that is now provided in the Environmental Impact Statement.

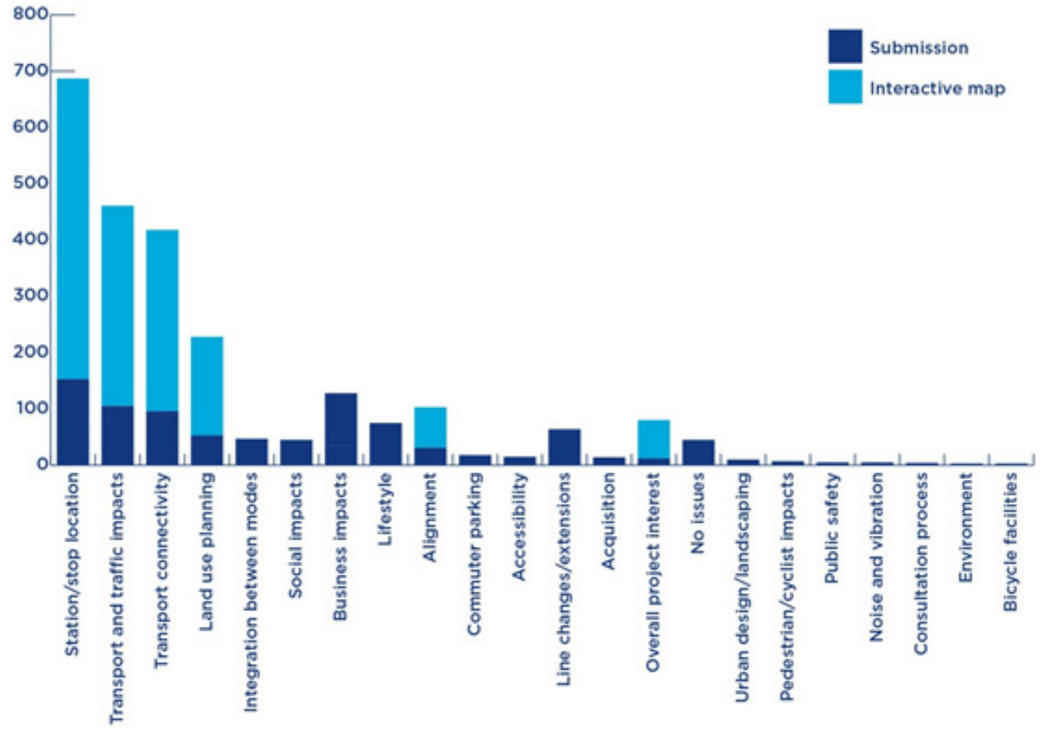

Figure 3: Submission issues raised by category

Table 7: Feedback from round two of community consultation and engagement

Topic	Issue raised	Sydney Metro response	Environmental Impact Statement reference
Confirmed stations			
Westmead metro station	Support for a station at Westmead and an opportunity to create a transport interchange.	Support for a metro station at Westmead is acknowledged.	Chapter 3 (Sydney Metro West development and alternatives)
	Concern about parking availability around Westmead Station.	The Environmental Impact Statement will include an assessment of parking changes around Westmead as a result of the Concept and Stage 1.	Chapter 10 (Transport and traffic – Stage 1)
	Suggestion that the station should be closer to Westmead Hospital. instead of the current proposed station location.	The proposed metro station at Westmead Metro Station would be located at the existing Westmead Station to provide opportunity for transfer to and from the T1 Western Line. Connections to the hospital precinct would be available via the proposed Parramatta Light Rail.	Chapter 3 (Sydney Metro West development and alternatives)
Parramatta metro station	Support for a station at Parramatta with some comments supporting an interchange and other comments supporting a new location.	Support for a station at Parramatta is acknowledged. The proposed Parramatta Metro Station would be located to the north of the existing station within the Parramatta CBD.	Chapter 3 (Sydney Metro West development and alternatives)
Sydney Olympic Park metro station	Concern about the similarities with the current train line and light rail.	The need for Sydney Metro West is identified in Chapter 2 (Strategic need and justification). The planned Parramatta Light Rail Stage 2 would provide complimentary services to Sydney Metro West. Light rail brings customers to and disperses them from the major transport hubs served by higher capacity suburban and metro rail services.	Chapter 2 (Strategic need and justification) Chapter 3 (Sydney Metro West development and alternatives)
	Recommendation for transport planning to identify interchanges with light rail and bus services.	Interchange between Sydney Metro West and both the planned Parramatta Light Rail Stage 2 and buses is proposed at Sydney Olympic Park. The Environmental Impact Statement includes principles to guide service and interchange planning for Sydney Metro West. Details of interchange provision at each station will form part of the assessment of future stages of Sydney Metro West.	Chapter 7 (Placemaking)

Topic	Issue raised	Sydney Metro response	Environmental Impact Statement reference
The Bays Station	Support for a station at The Bays Precinct, particularly near the White Bay Power Station and the development of a multi modal transport plan to facilitate transport to surrounding areas.	The support for The Bays Station is acknowledged. The Environmental Impact Statement includes principles to guide service and interchange planning for Sydney Metro West. Details of interchange provision at each station will form part of the assessment of future stages of Sydney Metro West.	Chapter 7 (Placemaking)
Potential intermediate stations			
Rydalmere	Support for a station at Rydalmere to service the Western Sydney University campus and provide an interchange between metro, light rail and ferries.	The preferred location for a station between Parramatta and Sydney Olympic Park is at Rydalmere. Rydalmere has been included as a strategic station option.	Chapter 3 (Sydney Metro West development and alternatives)
Camellia	Support for a station at Camellia to facilitate expected growth related to the draft Camellia Town Centre Master Plan and to include interchange with a light rail stop.	A station at Camellia is not proposed.	Chapter 3 (Sydney Metro West development and alternatives)
Burwood North	Mixed response to a station at Burwood North with some support.	Sydney Metro West includes a proposed station at Burwood North. The proposed station would provide a more frequent, reliable and fast mass transit service. It would also support the development of the Burwood strategic centre and would create an opportunity to integrate with the existing bus networks along Burwood Road and Parramatta Road, providing an efficient interchange for customers.	Chapter 3 (Sydney Metro West development and alternatives) Chapter 6 (Concept description)
Kings Bay	Small amount of support for a station at Kings Bay which could complement the Kings Bay precinct plan that is part of the Parramatta Road Urban Transformation Strategy.	A station at Kings Bay is not proposed.	Chapter 3 (Sydney Metro West development and alternatives)
Five Dock	Support for a station at Five Dock as the area needed better public transport connections with current long journey times to the CBD, compared to Burwood.	The Concept includes proposed stations at both Burwood North and Five Dock.	Chapter 3 (Sydney Metro West development and alternatives) Chapter 6 (Concept description)
Pyrmont	Support for a station at Pyrmont due to limited capacity and reliability with existing transport modes.	Sydney Metro is continuing to investigate the potential for a station at Pyrmont.	Chapter 3 (Sydney Metro West development and alternatives)
T9 Northern Line connection	More support for a station at North Strathfield rather than a station at Concord West.	The proposed location for a T9 Northern Line connection is North Strathfield.	Chapter 3 (Sydney Metro West development and alternatives) Chapter 6 (Concept description)
North Strathfield	Support included relieving congestion on the T9 Northern Line.	The Concept includes a proposed station at North Strathfield.	Chapter 3 (Sydney Metro West development and alternatives)
	Qualified support due to concerns about property acquisitions.	The support for a metro station at North Strathfield is acknowledged. Property acquisition requirements and processes for North Strathfield metro station are identified in Chapter 14 (Property and land use – Stage 1) and the need for private property acquisition has been minimised.	Chapter 14 (Property and land use – Stage 1)
	Concerns about changing the character of the area, potential to worsen the constricted road network and concerns about increasing the density of the suburb.	Land use change around the proposed North Strathfield metro station is planned as part of the Parramatta Road Urban Transformation Plan. The Environmental Impact Statement considers potential land use, character and congestion impacts associated with the construction of Stage 1 of Sydney Metro West. Operation will be considered as part of the assessment of future stages of Sydney Metro West.	Chapter 7 (Placemaking) Chapter 8 (Concept environmental assessment) Chapter 10 (Transport and traffic – Stage 1) Chapter 14 (Property and land use – Stage 1)
Concord West	Support for a station at Concord West due to easing traffic congestion, revitalising the area and providing access to cultural and recreational facilities.	A station at Concord West is not proposed.	Chapter 3 (Sydney Metro West development and alternatives)
	Not supportive of a station due to potential heritage impacts and there is fewer growth opportunities.	A station at Concord West is not proposed.	Chapter 3 (Sydney Metro West development and alternatives)
Alternative Stations			
Support for other potential station locations	Support for a station at either Silverwater or Newington, with Newington receiving almost twice the amount of support.	The preferred location for a station between Parramatta and Sydney Olympic Park is at Rydalmere. Rydalmere has been included as a strategic station option.	Chapter 3 (Sydney Metro West development and alternatives)

Topic	Issue raised	Sydney Metro response	Environmental Impact Statement reference
Other issues			
Transport and traffic impacts	Concern about the transport and traffic impacts during construction.	The Environmental Impact Statement provides an assessment of potential construction transport and traffic impacts.	Chapter 10 (Transport and traffic – Stage 1)
	Concern about additional growth within planned precincts and the need for Metro to support existing and future development.	Sydney Metro West is needed to support already planned growth. The Environmental Impact Statement includes further information on Sydney Metro's role in creating places and integrated station/precinct development.	Chapter 2 (Strategic need and justification) Chapter 7 (Placemaking) Chapter 14 (Property and land use – Stage 1)
	The Concept would take cars off the road, reduce future car need and reduce road congestion.	The support for the benefits of Sydney Metro West is acknowledged. The Environmental Impact Statement provides additional information regarding the traffic and transport benefits of Sydney Metro West.	Chapter 2 (Strategic need and justification)
Transport connectivity	Suggestions outlined alternative connections to existing networks, such as Sydney Metro Northwest, Sydney Metro City & Southwest and Dulwich Hill Line light rail.	The Concept includes opportunity to interchange with the Sydney Metro City & Southwest line in the Sydney CBD. Further detail will be provided as part of future stages of Sydney Metro West.	Chapter 3 (Sydney Metro West development and alternatives) Chapter 6 (Concept description)
	Concerns about ensuring integration with other modes of transport.	The Environmental Impact Statement includes principles to guide service and interchange planning for Sydney Metro West. Details of interchange provision at each station will form part of the assessment of future stages of Sydney Metro West.	Chapter 3 (Sydney Metro West development and alternatives) Chapter 7 (Placemaking)
	Strong desire for placemaking and good design outcomes at interchanges.	The Environmental Impact Statement outlines the Sydney Metro approach to placemaking and sets place and design principles for each station location.	Chapter 7 (Placemaking)
Land use planning	Concern that Sydney Metro West would lead to an increase in residential densities near the stations.	Sydney Metro West is needed to support already planned growth. The Environmental Impact Statement includes further information on Sydney Metro's role in creating places and integrated station/precinct development.	Chapter 2 (Strategic need and justification) Chapter 7 (Placemaking) Chapter 14 (Property and land use – Stage 1)
	Resulting high-rise developments would add to congestion and make street parking more difficult.	Sydney Metro West is needed to support already planned growth. The Environmental Impact Statement includes further information on Sydney Metro's role in creating places and integrated station/precinct development.	Chapter 2 (Strategic need and justification) Chapter 7 (Placemaking) Chapter 14 (Property and land use – Stage 1)
	Concerns about increased land use without a mass transit solution as there are constraints on the existing road and rail networks.	Sydney Metro West is needed to support already planned growth. The Environmental Impact Statement includes further information on Sydney Metro's role in creating places and integrated station/precinct development.	Chapter 2 (Strategic need and justification) Chapter 7 (Placemaking) Chapter 14 (Property and land use – Stage 1)
Social impacts	Support for the positive social impacts of Sydney Metro West, including providing connections to services, businesses, education and medical facilities.	The Environmental Impact Statement includes information on the connectivity benefits of Sydney Metro West.	Chapter 2 (Strategic need and justification)
	Benefits due to reduced commuting times and increasing family and social time.	The Environmental Impact Statement includes information on the benefits of Sydney Metro West.	Chapter 2 (Strategic need and justification)
	Project would reduce congestion and increase amenity in many areas.	The Environmental Impact Statement includes information on the benefits of Sydney Metro West, including placemaking opportunities.	Chapter 2 (Strategic need and justification) Chapter 7 (Placemaking)
	Propose an active transport (walking and cycling) corridor to improve the Inner West cycling network.	Environmental Impact Statement includes transport integration principles for Sydney Metro West. Details of connections to existing transport networks at each station will form part of the assessment of future stages of Sydney Metro West.	Chapter 7 (Placemaking)
Business impacts	Support for increased access to businesses for employees and customers which would increase the productivity and economic output of the area.	The Environmental Impact Statement includes information on the benefits of Sydney Metro West.	Chapter 2 (Strategic need and justification)
	Support for stations to be near business, retail and employment centres instead of being near residential areas.	Sydney Metro West is being planned to provide a balance of station types. Stations servicing business and employment centres are required as destination stations and to provide economic benefits. Stations servicing residential areas are also required as origin stations and to provide land use and housing benefits.	Chapter 3 (Sydney Metro West development and alternatives) Chapter 7 (Placemaking)

Topic	Issue raised	Sydney Metro response	Environmental Impact Statement reference
Business impacts cont.	Concern about the negative impact of businesses near stations during construction.	The Environmental Impact Statement considers local business impacts around construction sites.	Chapter 16 (Business impacts – Stage 1)
Alignment and network	Many submissions suggested alternative alignments or extensions which are outside of the scope of Sydney Metro West, with some people outlining complete rail networks for Greater Sydney and regional NSW.	The Environmental Impact Statement provides information on alternative alignments considered. Extensions to the Concept are not within the current scope of Sydney Metro West.	Chapter 3 (Sydney Metro West development and alternatives)
Commuter parking	Concern about the need for commuter car parking at stations, particularly at Westmead, North Strathfield and Concord West Stations.	Based on the proximity of the proposed stations to CBD locations, commuter parking is not proposed at any stations. The Environmental Impact Statement includes transport integration principles for Sydney Metro West.	Chapter 7 (Placemaking)
Accessibility	Concern about accessibility at stations.	All Sydney Metro West stations would be fully accessible.	Chapter 6 (Concept description)
	Concern about decrease in seating on metro train compared to Sydney Trains.	All trains would be new, single-deck metro trains similar to those in operation on the Metro North West Line. Metro trains have seating and standing room designed to maximise personal space.	Chapter 6 (Concept description)
	Concern there would be insufficient time for people to board or exit the train in the peak period of trains every four minutes.	Sydney Metro West would provide level access between the platform and train, reduced gaps between the platform and train and at least three double doors per side per carriage. These features would allow efficient and safe boarding and alighting including for customers with special needs.	Chapter 6 (Concept description)
Acquisition			
	Concern about property acquisition associated with Sydney Metro West. Concern about property acquisition and suggestions that stations be placed on or under land that is open space, industrial or community use.	Sydney Metro would only acquire properties necessary to facilitate construction or operation of Sydney Metro West. Sydney Metro has minimised the need for private property acquisition using existing Government owned land where possible. Sydney Metro has contacted those property owners whose properties will need to be acquired and has appointed Personal Managers to offer residents support throughout the acquisition process.	Chapter 14 (Property and land use – Stage 1)
	Questions about when residents will be advised about the type of development (higher density housing, retail, commercial) that will accompany stations.	The Concept supports already planned growth. Future stages of Sydney Metro West will provide opportunity for Council and community engagement and input into the types of development Council and residents would like to access in their station precincts. Any proposed future development associated with station precincts will be subject to separate planning assessment processes and approvals.	Chapter 7 (Placemaking)
Urban design and landscaping	Support for public spaces such as squares and parks at station entrances.	The Environmental Impact Statement identifies preliminary place and design principles for each station precinct. Strategies to implement these principles would be developed in collaboration with key stakeholders – including relevant local and state government agencies.	Chapter 7 (Placemaking)
	Support for safeguarding extensions within station design.	The support for safeguarding extensions is acknowledged. Provision for integrated station and precinct developments would be made at Westmead, Parramatta, Sydney Olympic Park, Burwood North, Five Dock, The Bays and Sydney CBD. Sydney Metro West stations would be designed to provide for requirements associated with integrated station and precinct development.	Chapter 6 (Concept description) Chapter 7 (Placemaking)
	No support for over station development outside of the core CBD area.	Several of the Sydney Metro West stations would provide opportunity for integrated station and precinct development – whether this is directly above the station, integrated with the station entry, or adjacent to station entries on residual sites available following construction. Integrating a mix of uses and development into the station precinct would contribute to the success of these places. Any developments proposed to be integrated with new metro stations would be subject to a separate planning approvals process. in accordance with the Environmental Planning and Assessment Act 1979.	Chapter 7 (Placemaking)
Pedestrians and cyclists	Stations should be planned to ensure the largest number of people possible can walk or cycle to stations.	The Environmental Impact Statement includes principles to guide service and interchange planning for Sydney Metro West. This includes consideration of access for pedestrians and cyclists.	Chapter 7 (Placemaking)Chapter 10 Transport and traffic – Stage 1
	Support for bicycle parking facilities or bicycle transport areas.	The Environmental Impact Statement includes principles to guide service and interchange planning for Sydney Metro West. This includes consideration of access for pedestrians and cyclists. Further detail on provision for bicycles will be provided as part of the assessment of future stages of Sydney Metro West.	Chapter 7 (Placemaking) Chapter 10 (Transport and traffic – Stage 1)

Topic	Issue raised	Sydney Metro response	Environmental Impact Statement reference
Public safety	Concern about public safety.	The Environmental Impact Statement identifies preliminary place and design principles for each station precinct. Strategies to implement these principles would be developed in collaboration with key stakeholders – including relevant local and state government agencies. Consideration of public safety would form part of this process.	Chapter 7 (Placemaking)
	Suggestions that all stations include a police station.		
	Concern that a metro would increase crime.		
Nosie and vibration	Concern about noise and vibration, mainly from construction tunnelling.	The Environmental Impact Statement provides an assessment of potential construction noise and vibration impacts, including those from tunnelling.	Chapter 11 (Noise and vibration – Stage 1)
	Concern that properties would be impacted by the construction of tunnels and during operation of the metro.	The Environmental Impact Statement provides an assessment of potential noise and vibration impacts on nearby properties during construction and operation.	Chapter 11 (Noise and vibration – Stage 1)
	Suggestion that Sydney Metro fund dilapidation reports for properties above the tunnel.	The Environmental Impact Statement provides an assessment of potential impacts to properties including identification of mitigation measures such as existing condition surveys.	Chapter 11 (Noise and vibration – Stage 1)
Consultation	Concern about the consultation process for Sydney Metro West and requests that detailed communication for the entire design and construction phases be provided.	Sydney Metro is committed to consulting with the community through all phases of the project. The Environmental Impact Statement provides further details regarding consultation undertaken to date and proposed future consultation.	Chapter 5 (Stakeholder and community engagement)
	Concern that it is difficult to comment without decision on station locations, design and integration.	The Environmental Impact Statement provides information on the station locations. There will be more opportunities provided through the planning assessment process and ongoing community and stakeholder feedback to provide comment input into station design and integration.	Chapter 6 (Concept description)
	Request for transparency for the project at every stage.	Sydney Metro is committed to consulting with the community through all phases of the project. The Environmental Impact Statement provides further details regarding consultation undertaken to date and proposed future consultation.	Chapter 5 (Stakeholder and community engagement)
	Request for a clear and understandable explanation of the cost-benefit of Sydney Metro West.	The Environmental Impact Statement provides further details regarding the potential impacts and benefits of Sydney Metro West.	Chapter 2 (Strategic need and justification) Chapter 8 (Concept environmental assessment) Chapters 10 to 26.
Environment	Support environmental benefits of public transport.	The support for the benefits of Sydney Metro West is acknowledged.	Chapter 2 (Strategic need and justification)
	Importance of trees, to make place liveable, provide shade and reduce carbon dioxide.	The Environmental Impact Statement identifies preliminary place and design principles for each station precinct. Strategies to implement these principles would be developed in collaboration with key stakeholders – including relevant local and state government agencies.	Chapter 7 (Placemaking)
	Concern about what would happen to the spoil from the tunnelling process.	The Environmental Impact Statement includes information regarding the management of spoil.	Chapter 24 (Spoil, waste management and resource use – Stage 1)
	Concern about existing construction impacts in Parramatta causing poor noise and air quality. Sydney Metro West should consider this and not contribute further impacts.	The Environmental Impact Statement provides an assessment of potential cumulative construction impacts, including those related to noise and air quality.	Chapter 11 (Noise and vibration – Stage 1) Chapter 23 (Air quality – Stage 1)
Timeframe/ staging	Request for the project to be delivered faster.	The Environmental Impact Statement provides information on staging and an indicative delivery timeframe for Stage 1.	Chapter 6 (Concept description) Chapter 9 (Stage 1 description)

1.2 Stakeholder and community feedback during preparation of the Environmental Impact Statement

1.2.1 Summary of feedback from local government and stakeholders

The issues raised during preparation of the Environmental Impact Statement (between October 2019 and April 2020), and a response to those issues, is provided in Table 8.

Table 8: Summary of feedback from local government stakeholders

Topic	Issue raised	Response and Environmental Impact Statement reference
Cumberland City Council		
Traffic and transport	• Service patterns and capacity • Road constraints around construction sites • Consider corridor preservation to the west • Noted plans for a road bridge upgrade at Bridge Road and presence of existing roundabout • Proposed temporary diversions around the construction site • Impacts on buses during construction and at completion • Cumulative traffic impacts in the surrounding area • Query about permanent road modifications • Management of truck movements during school hours.	Transport and traffic impacts associated with Stage 1, including cumulative impacts, are considered in Chapter 10 (Transport and traffic – Stage 1). Indicative road network modifications required for Stage 1 are considered in Chapter 9 (Stage 1 description).
Integrated station development	• Proposal for integrated station development.	Provision for integrated station and precinct developments would be made at several Sydney Metro West stations (including Westmead). All future integrated station and precinct developments would be subject to a separate planning approvals process. Refer to Chapter 6 (Concept description) and Chapter 7 (Placemaking).
Construction staging	• Proposed construction staging including timeframes for Westmead station.	An indicative construction program for Stage one (including individual stations) is provided in Chapter 9 (Stage 1 description).
Planning and placemaking	• Council would like to work with Sydney Metro to develop placemaking and activation opportunities • Support for an integrated approach to North/South Westmead including integration with Department of Planning, Industry and Environment precinct plan • Support for activation of Hawkesbury Road.	The Environmental Impact Statement identifies preliminary place and design principles for each station precinct. Strategies to implement these principles would be developed in collaboration with key stakeholders – including relevant local and state government agencies.
Station naming	• Query whether Westmead station could be renamed and how Council could be involved with the process.	The final naming of station would be determined in consultation with the Geographic Names Board of NSW.
Cumulative impacts	• Potential cumulative traffic impacts due to multiple developments in close proximity to Westmead station • Traffic management in relation to the hospital precinct and the Public School.	The Environmental Impact Statement considers potential cumulative impacts. Refer to Chapters 10 to 25 and to the cumulative impact assessment methodology included in Appendix G (Cumulative impacts assessment methodology - Stage 1).
Spoil management	• Council requested spoil be extracted from Sydney Olympic Park • Council noted spoil could potentially be used for capping of Council waste sites.	Options for the tunnelling strategy are considered in Chapter 3 (Sydney Metro West development and alternatives). Spoil generation and management is considered in Chapter 24 (Spoil, waste management and resource use – Stage 1). Transport and traffic impacts associated with the removal of spoil at Westmead are considered in Chapter 10 (Transport and traffic – Stage 1).
Site access	• Access agreements to undertake temporary and permanent works on Council land.	Consultation would continue with Council including appropriate forms of agreement in relation to Council assets.
Parking	• Inclusion of commuter car parking as part of station design • Management of construction worker street-parking during construction.	Based on the proximity of the proposed stations to CBD locations, commuter parking is not proposed at any stations. Construction sites would be managed to minimise the number of construction workers parking on surrounding streets – refer to Chapter 10 (Transport and traffic – Stage 1).
Active transport	• Importance of a North-South active transport link • Council plans for cycle routes across rail corridor • Request that active transport be included in the design principles.	The Environmental Impact Statement includes principles to guide service and interchange planning for Sydney Metro West. This includes consideration of access for pedestrians and cyclists. Refer to Chapter 7 (Placemaking).
Consultation and engagement	• Council noted importance of including stakeholders and the community in design development.	Sydney Metro is committed to consulting with the community and stakeholders through all phases of the project. The Environmental Impact Statement provides further details regarding consultation undertaken to date and proposed future consultation. Refer to Chapter 5 (Stakeholder and community engagement).
City of Parramatta Council		
Site selection, connectivity, planning and placemaking	• Rationale for the station location at Westmead South versus Westmead North • Need for an additional station between Sydney Olympic Park and Parramatta • Is there provision for a future north-south connection at Parramatta station? Query whether corridor protection work is occurring • Bus interchange with Metro station • Noted planned development in the area • Integration with the future Parramatta Light Rail (Stage 1) and the planned Parramatta Light Rail (Stage 2) • Opportunities for future green space. • Location of Clyde stabling and maintenance facility.	The justification for the preferred station and other metro infrastructure locations is discussed in Chapter 3 (Sydney Metro West development and alternatives). A north-south rail line through Parramatta is not within the scope of Sydney Metro West. Chapter 7 (Placemaking) includes principles to guide service and interchange planning for Sydney Metro West. Details of interchange provision at each station will form part of the assessment of future stages of Sydney Metro West. Property acquisition requirements and processes are discussed in Chapter 14 (Property and land use – Stage 1).

Topic	Issue raised	Response and Environmental Impact Statement reference
Civic Link	• Noted the importance of realising the Civic Link • Requirement for access to new and existing developments via Macquarie Street • Opportunity to achieve better precinct outcomes if Council, Parramatta Light Rail and Sydney Metro are coordinated.	Chapter 7 (Placemaking) identifies preliminary place and design principles for each station precinct which includes supporting the Civic Link. Strategies to implement these principles would be developed in collaboration with key stakeholders – including relevant local and state government agencies.
Design	• Queries regarding the construction site at Parramatta • Provision for access to adjacent buildings in design and during construction • Queried availability and use of surplus land surrounding the Rosehill Dive Structure • Will on-site stormwater detention be provided as part of station design?	Construction site footprints were developed considering expected future operational requirements for the stations, as well as the key construction requirements for the tunnel and stations. Refer to Chapter 3 (Sydney Metro West development and alternatives). Access to existing properties and buildings would be maintained in consultation with property owners. The future use of any residual land would be determined in subsequent stages. Detailed stormwater management arrangements for stations would be determined as part of the design for future stages. On-site stormwater detention would be provided for the Clyde stabling and maintenance facility construction due to increased imperviousness of the site.
Traffic and transport	• Local transport links and local access to Sydney Olympic Park • Existing congestion on Homebush Bay Drive • Alexandra Avenue/Bridge Road bridge at Westmead identified as a key consideration • Impacts to the cycle link if Horwood Place is closed, noting it is the only north-south cycle route • Identified lack of commuter parking as a social issue.	Transport, traffic and parking impacts are considered in Chapter 10 (Transport and traffic – Stage 1).
Consultation	• Timeframe for Stage 2 Environmental Impact Statement inputs • Query about when final design information will become available and request that it show application of design principles • Requested for continued consultation with Sydney Metro.	The City of Parramatta Council will be consulted regarding future planning approval stages of Sydney Metro West. Chapter 7 (Placemaking) identifies place and design principles for each station location. The application of these principles will be considered during the design and assessment of future stages of Sydney Metro West.
Construction impacts	• Council noted that local community was sensitive to change • Construction will have impacts on local amenity • Management of construction traffic impacts including local accesses and worker parking • Construction duration • Cumulative construction noise and vibration impacts • Management of vibration impacts on heritage buildings and other sensitive structures • Major event considerations at Sydney Olympic Park including the Royal Easter Show • Spoil transport strategies.	Construction impacts associated with Stage 1, including cumulative impacts, are discussed Chapters 10 to 26 of the environmental impact statement. Options for spoil transport are reviewed in Chapter 3 (Sydney Metro West development and alternatives).
Environmental impacts	• Ecological and flooding issues at the Clyde stabling and maintenance facility.	Biodiversity impacts are considered in Chapter 22 (Biodiversity – Stage 1). Flooding is considered in Chapter 21 (Hydrology and flooding – Stage 1).
City of Canada Bay Council		
General	• Council is supportive of the project and happy to receive the news of the planning commencement.	Support is noted.
Station naming	• Burwood North Station naming not appropriate.	The final naming of station would be determined in consultation with the Geographic Names Board of NSW.
Active transport and pedestrian connections	• Consider connectivity to Concord Oval • Planned installation of new bike routes on Queen Street nearby station precinct.	Chapter 7 (Placemaking) includes principles to guide service and interchange planning for Sydney Metro West. Details of interchange provision at each station, including provision for pedestrians and cyclists, will form part of the assessment of future stages of Sydney Metro West.
Property impacts	• Timing of proposed Council carpark impacts • Integration with Council's strategic plans • Importance of Fred Kelly Place as a community asset • Process for acquisition of Council property • Council ownership and leases over land around the proposed North Strathfield station.	Property acquisition requirements and processes are discussed in Chapter 14 (Property and land use). Sydney Metro will continue to consult the City of Canada Bay regarding property acquisition. The importance of Fred Kelly Place as a community asset is acknowledged. There would be no direct impacts on Fred Kelly Place, its proximity to the western construction site would potentially affect the level of comfort and amenity enjoyed by users and pedestrians. Mitigation measures have been proposed to minimise these impacts. Refer to Chapter 15 (Landscape character and visual amenity – Stage 1). Condition surveys of buildings and structures near to the tunnel and construction sites would be undertaken prior to the start of works at each site, where appropriate.
Placemaking	• Requested ongoing engagement with Council regarding placemaking • Need for a plaza accessible outside the paid station area as part of the design.	Chapter 7 (Placemaking) identifies preliminary place and design principles for each station precinct. Strategies to implement these principles would be developed in consultation with key stakeholders – including relevant local and state government agencies.

Topic	Issue raised	Response and Environmental Impact Statement reference
Traffic and transport	• North/south road access across Pomeroy and George Streets is constrained • Need to reconsider roundabout at Pomeroy and Queen Street – low performance currently • Widening of Pomeroy Street Bridge may be required to ease traffic build up • Access to the station for the west is generally constrained • A signalised intersection may be required to address constraints at Burwood Road/ Burton Street.	Chapter 7 (Placemaking) identifies preliminary place and design principles for each station precinct. Strategies to implement these principles would be developed in consultation with key stakeholders – including relevant local and state government agencies. Transport and traffic impacts of Stage 1 are discussed in Chapter 10 (Transport and traffic – Stage 1).
Potential tunnelling impacts	• Query regarding tunnel depths and potential for any impacts on properties above • Queried where dilapidation surveys are undertaken • Questioned sub-stratum acquisition • Will harvest base flow from canal near Cintra Park for sport field and golf course irrigation be impacted by tunnelling?	Tunnel depths are identified in Chapter 9 (Stage 1 description). Condition surveys of buildings and structures near to the tunnel and construction sites would be undertaken prior to the start of works at each site, where appropriate. Substratum acquisition is discussed in Chapter 14 (Property and land use). Groundwater, including surface and groundwater interaction, is discussed in Chapter 18 (Groundwater and ground movement – Stage 1).
Interchange access	• Noted importance of interchange for Five Dock Station • Query about how east-west regional routes and shared path east of Concord Oval would connect to the station.	Chapter 7 (Placemaking) includes principles to guide service and interchange planning for Sydney Metro West. Details of interchange provision at each station will form part of the assessment of future stages of Sydney Metro West.
Local amenity	• Consider existing council plans to include new open space at Fred Kelly Place and pedestrian link at Second Avenue • Management of local amenity during managed during construction • Councils existing proposals for local amenity including the Five Dock Town centre upgrade.	Chapter 7 (Placemaking) identifies preliminary place and design principles for each station precinct. Strategies to implement these principles would be developed in collaboration with key stakeholders – including relevant local and state government agencies. Mitigation measures have been proposed in the relevant chapters of this Environmental Impact Statement to minimise local amenity impacts during construction.
Planning	• Consistency with Parramatta Road Corridor Urban Transformation strategy and Five Dock Town Centre Revitalisation.	The Parramatta Road Corridor Urban Transformation strategy and Five Dock Town Centre Revitalisation are addressed in Chapter 7 (Placemaking).
Construction traffic	• Turning constraint for heavy vehicles at Queen Street/Wellbank Street intersection • Heavy pedestrian use at Queen Street/Wellbank Street intersection and potential safety issues • Construction stage traffic solutions or benefits • Heavy weekend traffic congestion around the station site including Parramatta Road/Burwood Road intersection • Configuration of traffic signals may be needed to accommodate construction traffic movements • Worker parking and potential impact on street parking and local events during construction. Provision for a tuck marshalling yard • Requested for an agreed parking solution at the western side of Queen Street • Waterview Street is narrow and may require removal of parking.	Transport and traffic impacts of Stage 1 are discussed in Chapter 10 (Transport and Traffic – Stage 1). Sydney Metro is continuing to investigate potential solutions to manage construction traffic movements, including at North Strathfield metro station and Five Dock Station construction sites. Sydney Metro is committed to continued consultation with the City of Canada Bay regarding traffic and parking issues.
Construction noise and vibration	• Respite strategy and community notifications.	Construction noise impacts and proposed mitigation are discussed in Chapter 11 (Noise and vibration – Stage 1).
Burwood Council		
Planning	• Local government area masterplan and traffic and transport study underway. Multiple other studies also underway including housing, open space and resilience • Council has developed a vision for Burwood town centre beautification to join the park and the main street (Burwood North, Park Precinct, Central Precinct and Southern Precinct) • Questioned tunnel depth and ventilation • Nearby RSL upgrade including a hotel and 1,500 basement car spaces should be considered.	Chapter 7 (Placemaking) identifies preliminary place and design principles for each station precinct. Strategies to implement these principles would be developed in consultation with key stakeholders – including relevant local and state government agencies. Tunnel depths and ventilation are addressed in Chapter 9 (Stage 1 description).
Traffic and transport	• Questioned interchange planning and noted interchange access plan • Council plans to partially pedestrianize sections of Burwood Road south of Parramatta Road intersection. Bus access to be maintained • Discussion of bus priority and existing bus stops • Discussed proposed improvements at Parramatta Road/Shaftsbury Road and Parramatta Road/Loftus Street intersections.	Chapter 7 (Placemaking) identifies preliminary place and design principles for each station precinct. Strategies to implement these principles would be developed in consultation with key stakeholders – including relevant local and state government agencies. Transport and traffic impacts associated with Stage 1 are considered in Chapter 10 (Transport and traffic – Stage 1). Indicative road network modifications required for Stage 1 are considered in Chapter 9 (Stage 1 description).

Topic	Issue raised	Response and Environmental Impact Statement reference
Placemaking	• Parramatta Road amenity – there are opportunities for shade, public seating and public art on hoardings etc which will improve the current amenity. Council would welcome revitalisation of Parramatta Road • If tree planting is proposed, Council could adopt similar planting further around the area.	Chapter 7 (Placemaking) identifies preliminary place and design principles for each station precinct. Strategies to implement these principles would be developed in consultation with key stakeholders – including relevant local and state government agencies.
Parking	• Questioned if the project includes commuter parking and noted Burwood Road parking changes • Questioned proposed parking arrangements for construction workers.	Based on the proximity of the proposed stations to CBD locations, commuter parking is not proposed at any stations. Construction sites would be managed to minimise the number of construction workers parking on surrounding streets – refer to Chapter 10 (Transport and traffic – Stage 1).
Construction traffic	• Noted road widening on Esher Lane may be required • Test right turn phase to Burwood Road from Parramatta Road (west) after hours.	Transport and traffic impacts associated with Stage 1 are considered in Chapter 10 (Transport and traffic – Stage 1).
Noise and vibration	• Query regarding potential vibration impacts on nearby buildings • Parramatta Road is calmer due to WestConnex opening, however heavy vehicle noise is still present.	Noise and vibration impacts associated with Stage 1 are discussed in Chapter 11 (Noise and vibration – Stage 1).
Inner West Council		
Active transport	• Access to The Bays Station via Victoria Road cycle path and City West cycle link.	Chapter 7 (Placemaking) includes principles to guide service and interchange planning for Sydney Metro West, including provision for pedestrians and cyclists. Details of interchange provision at each station will form part of the assessment of future stages of Sydney Metro West.
Traffic and transport	• Request that potential operational impacts are clear and accurate. • Noted congestion point at Roberts/Mullens Street and Victoria Road.	Chapter 7 (Placemaking) includes principles to guide service and interchange planning for Sydney Metro West, including provision for pedestrians and cyclists. Details of interchange provision at each station will form part of the assessment of future stages of Sydney Metro West. Traffic and transport impacts associated with Stage 1 are discussed in Chapter 10 (Transport and traffic – Stage 1).
Cumulative impacts	• Noted the importance of considering cruise passenger terminal operations.	Traffic and transport impacts associated with Stage 1, including special events and cumulative impacts, are considered in Chapter 10 (Transport and traffic – Stage 1).
Parking	• Worker parking needs during construction.	Construction sites would be managed to minimise the number of construction workers parking on surrounding streets. Refer to Chapter 10 (Transport and traffic – Stage 1).
Hydrology/ flooding	• Potential coastal and overland flood impacts.	Potential flooding impacts associated with Stage 1 are discussed in Chapter 21 (Hydrology and flooding – Stage 1).
Site selection for services facility	• Expressed concerns regarding the potential impacts of a services facility between Five Dock and The Bays.	Sydney Metro is continuing to investigate the preferred location of a service facility between Five Dock and The Bays. An assessment of the types of impacts anticipated from such a facility is provided in Chapter 9 (Stage 1 description).
Construction impacts	• Out-of-hours work • Expected size of the construction workforce • Construction management and potential respite periods to limit peak impacts.	Details regarding working hours and the construction workforce are provided in Chapter 9 (Stage 1 description). Noise and vibration impacts associated with Stage 1 and mitigation are discussed in Chapter 11 (Noise and vibration – Stage 1).

1.2.2 Summary of feedback from community engagement

A survey ('SwipEngage') was open to the community along the proposed corridor between 6 November and 16 December 2019, with 135 people taking the survey. Half of those who took the survey lived in Five Dock, Burwood North, and North Strathfield. The largest first preference for getting around was by train. More than 85 per cent of those surveyed had a strong attachment to their suburb. Almost 80 per cent thought their area had a strong sense of community. Over 85 per cent highly valued their open space and community spaces. Almost 60 per cent of people were concerned about construction impacts. More than 85 per cent of people looked forward to having a metro station in their suburb. Around half of those surveyed spoke more than one language at home.

Seven survey responses identified that they used local services including the harbour and surrounding estuary (for work, sport and recreation), walkways, cycle paths, churches, or they work in the area.

Seven responses noted the following expected benefits of Sydney Metro West once operational:

- Improved public transport options (2)
- Access to employment (2)
- Rezoning and redevelopment opportunities (2)
- Business benefits (access for customers) (1)
- Increased local amenity (1)
- Increased property value (1).

A summary of the key issues raised by survey comments and Sydney Metro responses is provided in Table 9.

Table 9: Summary of feedback from community along the proposed Sydney Metro West corridor

Issue raised[1]	Environmental Impact Statement reference
Potential construction impacts	
• **Traffic, trucks and parking (36)** • **Disruption to business (6)** • **Loss of amenity (visual impacts) (2)**	Chapter 10 (Transport and traffic – Stage 1) Chapter 16 (Business impacts – Stage 1) Chapter 7 (Placemaking) Chapter 15 (Landscape character and visual amenity – Stage 1)
• **Noise and vibration (30)**	Chapter 11 (Noise and vibration - Stage 1)
• **Damage to properties (and tunnelling) (18)**	Chapter 11 (Noise and vibration – Stage 1)
• **Air quality (dust) (12)**	Chapter 23 (Air quality – Stage 1)
• **Property acquisition (2)**	Chapter 14 (Property and land use – Stage 1)
• **Safety and security (3)**	Chapter 7 (Placemaking) Chapter 17 (Social impacts – Stage 1)
• **Lack of information provided. Would like more information about tunnel routes and expected construction timeframe. (4)**	Chapter 6 (Concept description) Chapter 9 (Stage 1 description)
Potential operational impacts and general feedback	
• **A metro station will greatly improve access to the area, property values and business opportunities (2)** • **Appreciate the consultation process and looking forward to the benefits of the project. Pleased to have improved public transport for Sydney (13)**	Chapter 7 (Placemaking) Chapter 5 (Stakeholder and community engagement) Chapter 6 (Concept description) Chapter 9 (Stage 1 description)
• **Against the project (undefined) (3)** • **Against the project – Parramatta station is sufficient (1)**	Chapter 2 (Strategic need and justification) Chapter 3 (Sydney Metro West development and alternatives)
• **Traffic and parking concerns around stations once operational (commuter parking facilities) (2)**	Chapter 10 (Transport and traffic – Stage 1)
• **Should connect with Parramatta Light Rail Stage 2. This infrastructure is necessary given the amount of urban growth in the area (1)**	Chapter 3 (Sydney Metro West development and alternatives) Chapter 6 (Concept description)
• **There was a lack of project information and transparency during consultation (4)**	Chapter 5 (Stakeholder and community engagement)
• **Support rezoning to better suit housing and business opportunities introduced by a metro station (4)**	Chapter 2 (Strategic need and justification) Chapter 7 (Placemaking)
• **Concerned about zoning changes and overdevelopment diminishing place (7)**	Chapter 2 (Strategic need and justification) Chapter 7 (Placemaking)
• **The project should consider existing communities transport demands rather than prioritising those of new developments (1)** • **There should be stations at Rydalmere, Newington/ Silverwater and Bella Vista (3)**	Chapter 3 (Sydney Metro West development and alternatives) Chapter 6 (Concept description)
• **Wayfinding and appropriate signage are vital for public transport, especially those with a pram or wheelchair and for the elderly and those with limited mobility (1)**	Chapter 6 (Concept description) Chapter 7 (Placemaking)
• **Westmead's metro station should have been on the north side of Westmead railway station rather than south. The north side is closer to health, education and business premises (1)** • **The Bays station is isolated and should be closer to existing homes and businesses (1)**	Chapter 3 (Sydney Metro West development and alternatives)
• **Loss of green space and heritage, diminished amenity and neighbourhood security (3)**	Chapter 7 Placemaking Chapter 11 (Non-Aboriginal heritage – Stage 1) Chapter 12 (Aboriginal heritage – Stage 1) Chapter 15 (Landscape character and visual amenity – Stage 1) Chapter 17 (Social impacts – Stage 1)
• **Concerned about ventilation emissions (1)**	Chapter 8 (Concept Environmental Assessment)
• **Disappointed with property acquisition outcomes (4)**	Chapter 14 (Property and land use – Stage 1)

Note: 1 Number in brackets denotes number of responses identifying this issue.

1.2.3 Rydalmere and Pyrmont strategic station options consultation

In November 2019, Sydney Metro asked the community and stakeholders for feedback on Rydalmere and Pyrmont as strategic station options. Feedback was received via online survey, at stakeholder meetings or via emailed submissions. The feedback received will form part of the project team's assessment on Rydalmere and Pyrmont as station options. This will be subject to a separate assessment process and is not included as part of this Environmental Impact Statement.

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Appendix D

Sydney Metro Construction Environmental Management Framework

CONSTRUCTION ENVIRONMENTAL MANAGEMENT FRAMEWORK

APRIL 2020

Transport for NSW

MAKING IT HAPPEN

Contents

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1. Introduction

1.1 Purpose and Scope

This Construction Environmental Management Framework (CEMF) is a Sydney Metro project framework which sets out the environmental, stakeholder and community management requirements for construction. It provides a linking document between the planning approval documentation and the construction environmental management documentation to be developed by the Principal Contractors relevant to their scope of works.

Sydney Metro Principal Contractors will be required to implement and adhere to the requirements of this CEMF.

1.2 Status

This is a controlled document, please refer to the version register below which is updated as required.

Version	Description	Date
1.0	EIS 1 – Northwest Rail Link	4 April 2012
1.1	EIS 1 Submissions Report – Northwest Rail link	26 July 2012
1.2	EIS 2 and the Rapid Transit Rail Facility (RTRF) – Northwest Rail Link	31 October 2012
1.3	Updated to incorporate all planning approvals, including ECRL conversion Part 5 approvals	11 July 2014
3.0	Updated to encompass the scope of Sydney Metro – Chatswood to Sydenham EIS	16 February 2016
3.1	Updated for - Chatswood to Sydenham Submissions Report and Preferred Infrastructure Report	15 August 2016
3.2	Updated for – Sydenham to Bankstown EIS	25 August 2017
4.0	Updated for inclusion in Sydney Metro West EIS	23 January 2020

1.3 Environment and Sustainability Policy

Sydney Metro has developed an Environment and Sustainability Policy (Appendix A) which applies to Sydney Metro projects. Principal Contractors are required to undertake their works in accordance with this policy. The policy reflects a commitment in the delivery of the project to:

- Optimise sustainability outcomes, transport service quality, and cost effectiveness.
- Develop effective and appropriate responses to the challenges of climate change, carbon management, resource and waste management, land use integration, customer and community expectation, and heritage and biodiversity conservation.
- Be environmentally responsible, by avoiding pollution, enhancing the natural environment and reducing the project ecological footprint, while complying with all applicable environmental laws, regulations and statutory obligations.
- Be socially responsible by delivering a workforce legacy which benefits individuals, communities, the project and industry, and is achieved through collaboration and partnerships.

2. Legislative and Other Requirements

Table 1.1 below identifies key NSW environmental legislative requirements and their application to SM construction works, current as at the date of this document. Sydney Metro and its Contractors must regularly review their legislative and other requirements.

Table 1.1 NSW Legislative Requirements

Legislation and Administering Authority	Requirements	Application to Sydney Metro
Biosecurity Act 2015	Under this Act, all plants are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.	Control weeds as required on land under the management of the Contractor.
Contaminated Land Management Act 1997 NSW Environment Protection Authority (EPA)	The Act provides a process for the investigation and remediation of land where contamination presents a significant risk of harm to human health or some other aspect of the environment. The Act also outlines the circumstances in which notification to the Environment Protection Authority is required in relation to the contamination of land.	Follow the legislative process where contaminated land is identified.
Dangerous Goods (Road and Rail Transport) Act 2008 EPA / SafeWork NSW	A licence is required for the storage (SafeWork NSW) and /or transport (EPA) of prescribed quantities of dangerous goods.	Obtain a licence where storage of dangerous goods would exceed licensable quantities.
Environmental Planning and Assessment Act 1979 Department of Planning and Environment (DPI&E)	Encourages proper environmental impact assessment and management of development areas for the purpose of promoting the social and economic welfare of the community and a better environment.	Adhere to mitigation measures and conditions within the planning approval documentation. The proponent and their contractors must endeavour to deliver in a consistent manner within the assessed scope of works.

Legislation and Administering Authority	Requirements	Application to Sydney Metro
Heritage Act 1977 NSW Department of Premier and Cabinet	The Act aims to encourage the conservation of the State's heritage and provides for the identification and registration of items of State heritage significance. The Heritage Council must be notified 'of the location of the relic, unless he or she believes on reasonable grounds that the Heritage Council is aware of the location of the relic'.	Projects assessed under Part 5, Division 5.2 of the Environmental Planning and Assessment Act 1979 (EP&A Act) are exempt from approvals required under Part 4 and permits required under section 139.
Marine Pollution Act 2012	This Act includes provisions to protect the sea and waters from pollution by oil and other noxious substances discharged from vessels.	Any construction activities requiring the use of a vessel (e.g. a barge) must comply with the requirements of this Act and the Marine Pollution Regulation 2014.
National Parks and Wildlife Act 1974 OEH	The objectives of the Act are for the conservation of nature and the conservation of objects, places or features (including biological diversity) of cultural value within the landscape.	Projects assessed under Part 5, Division 5.2 of the Environmental Planning and Assessment Act 1979 (EP&A Act) are exempt from obtaining an Aboriginal Heritage Impact Permit required under section 90.
Biodiversity Conservation Act 2016 OEH	The relevant purpose of the Act is to conserve biodiversity and maintain the diversity and quality of ecosystems.	Projects assessed under Part 5, Division 5.2 of the Environmental Planning and Assessment Act 1979 (EP&A Act) are exempt from an order or direction under Part 11 of the Act. The Act also established that other permits and approvals are not required for projects assessed and determined under Part 5, Division 5.2 of the EP&A Act.
Protection of the Environment Operations Act 1997 EPA	The relevant objective of the Act is to prevent environmental pollution.	Where Sydney Metro projects are scheduled activities under Schedule 1 of the Act an Environment Protection Licence (EPL) must be obtained. Further details on the requirements to obtain an EPL are provided in Section 2.3.

Legislation and Administering Authority	Requirements	Application to Sydney Metro
Roads Act 1993 Roads and Maritime Service	The relevant objective of the Act is to regulate the carrying out of various activities on public roads.	Obtain consent under Section 138 for carrying out work in, on or over a public road, or digging up or disturbance of the surface of the road. Under Section 38N of the *Transport Administration Act 1988*, Section 138 of the *Roads Act 1993* does not apply to Sydney Metro activities in relation to classified roads for which a council is the roads authority. However, consent from Transport for New South Wales is still required under Section 38N(2) of the *Transport Administration Act 1988* for those activities described in Section 138(1) of the *Roads Act 1993*, when carried out in relation to a classified road.
Waste Avoidance and Resource Recovery Act 2001 EPA	The objectives of the Act are to reduce environmental harm, provide for the reduction in waste generation and the efficient use of resources.	Implement strategies to reduce waste volumes and report on waste generated.
Water Management Act 2000 NSW Office of Water	The relevant objective of the Act is to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality.	Sydney Metro projects assessed under Part 5, Division 5.2 of the Environmental Planning and Assessment Act 1979 (EP&A Act) are exempt from obtaining water use approval under section 89, a water management work approval under section 90 or an activity approval (other than an aquifer interference approval) under section 91.

Table 1.2 identifies key Commonwealth environmental legislative requirements and their application to SM construction works, current as at the date of this document. Sydney Metro and its Contractors should regularly review their legislative requirements.

Table 1.2 Commonwealth Legislative Requirements

Legislation and Administering Authority	Requirements	Application to Sydney Metro
Environment Protection and Biodiversity Conservation Act 1999 Department of the Environment	The relevant objective of the Act is to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance.	A project may be defined as a controlled action under the Act due to impacts on matters of national environmental significance. If an approval under the Environment Protection and Biodiversity Conservation Act is required for the project, Sydney Metro Principal Contractors must comply with any relevant conditions of the approval.
National Greenhouse and Energy Reporting Act 2007 Department of Climate Change and Energy Efficiency	The Act established a framework for reporting of greenhouse gas emissions, abatement actions, energy consumption and production data.	Report on greenhouse gas and energy usage data as required by the Act.

2.1 Environmental Approvals

All Sydney Metro projects require a planning approval under the *Environmental Planning and Assessment Act 1979*. For infrastructure components, this may take the form of:

- State significant infrastructure or critical State significant infrastructure under Part 5, Division 5.2 of the Act, with Department of Planning, Industry and Environment as the determining authority
- An approval under Part 5 of the Act, with Sydney Metro as the determining authority
- Exempt development under Section 1.6 of the Act and in accordance with a relevant State Environmental Planning Policy

For development components, this may take the form of:

- State significant development under Part 4, Division 4.7 of the Act
- A local development application under Part 4 of the Act.

The requirements of the relevant approval are required to be complied with by Sydney Metro. Responsibility for implementing mitigation measures and conditions of approval will be allocated between Sydney Metro and Principal Contractors as appropriate. Typically Sydney Metro will produce a Staging Report which sets out the applicability and allocation of approval requirements within the project's program of works.

2.2 Environment Protection Licence Requirements

Sydney Metro projects can meet the definition of a number of scheduled activities under Schedule 1 of the *Protection of the Environmental Operation Act 1997* (POEO Act). Contractors need to review the applicability of Scheduled Activities and assess the need to obtain an Environment Protection Licence (EPL). In other circumstances work may be undertaken the existing EPL held by Sydney Trains.

Where required, Sydney Metro Principal Contractors will:

- Apply for and be granted an EPL from the EPA.
- Hold an EPL which covers their scope of works as necessary under the POEO Act.
- Undertake their scope of works in accordance with the conditions of the applicable EPLs as issued by the EPA.
- Work under the existing Sydney Trains EPL.

2.3 Standards and Guidelines

Numerous environmental publications, standards, codes of practice and guidelines are relevant to Sydney Metro construction and are referenced throughout this Construction Environmental Management Framework. A summary of key applicable standards and guidelines is provided in Table 1.3.

Table 1.3 Environmental Standards and Guidelines

Standard / Guideline	Relevant Authority	CEMF Reference
ISO14001 Environmental Management System – Requirements with Guidelines for Use	DPIE	Section 3.1
Interim Construction Noise Guidelines (Department of Environment and Climate Change, 2009)	EPA	Section 8.2
Managing Urban Stormwater: Soil and Construction (Landcom, 2008)	EPA	Section 12.2
AS4282:1997 Control of the Obtrusive Effect of Outdoor Lighting	DPIE	Section 11.2
Waste Classification Guidelines (Department of Environment, Climate Change and Water, 2008)	EPA	Section 14.2
Australian and New Zealand Guidelines for Fresh and Marine Water Quality	ANZECC	Section 12.2

3. Environmental Management Requirements

3.1 Environmental and Sustainability Management System

a. Principal Contractors are required to have a corporate Environmental Management System certified under AS/NZS ISO 14001:2015.

b. Principal Contractors are required to develop a project based Environment and Sustainability Management System (E&SMS). The E&SMS will:

i. Be consistent with the Principal Contractors corporate Environmental Management System and AS/NZS ISO 14001:2015;

ii. Be supported by a process for identifying and responding to changing legislative or other requirements;

iii. Include processes for assessing design or construction methodology changes for consistency against the planning approvals;

iv. Include processes for tracking and reporting performance against sustainability and compliance targets;

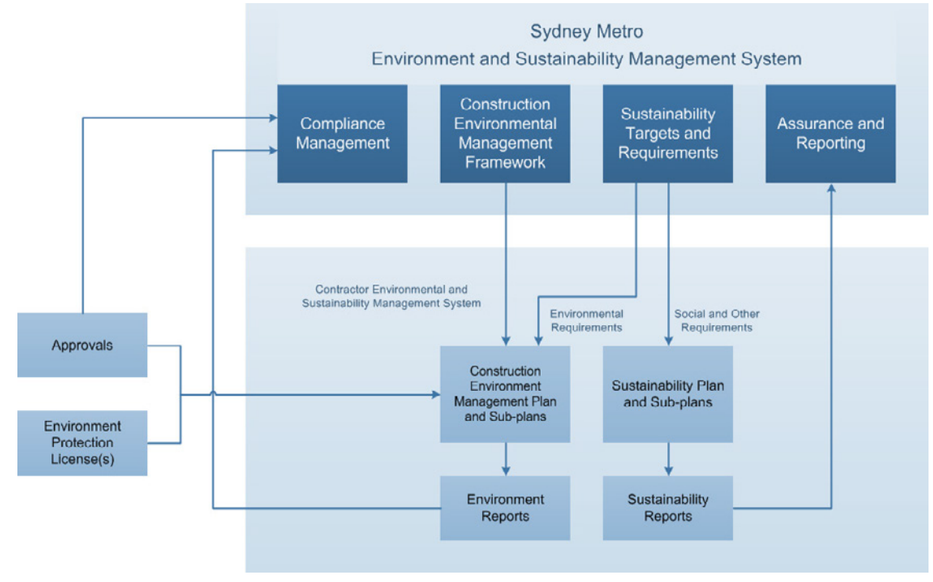
v. Include a procedure for the identification and management of project specific environmental risks and appropriate control measures; and

vi. Be consistent with the SM C&SW Sustainability Strategy and Sydney Metro Environment and Sustainability Policy.

c. All sub-contractors engaged by the Principal Contractor will be required to work under the Principal Contractor's Environment and Sustainability Management System.

d. The relationship between the Sydney Metro Environment and Sustainability Management System and the Principal Contractor's Environment and Sustainability Management System is shown in Figure 2.

Figure 2 - Environmental Management and Sustainability Structure



3.2 Sustainability Management Plan

a. Principal Contractors are required to prepare and implement a Sustainability Management Plan (SMP) relevant to the scale and nature of the Project Works.

b. The SMP must, as a minimum, address and detail:

Reference	SMP Requirements	Design	Construction
SMP1	The relevant requirements of the Sydney Metro Environment and Sustainability Policy	•	•
SMP2	A sustainability policy statement	•	•
SMP3	The sustainability management team structure, including key personnel authority and roles of key personnel, lines of responsibility and communication, minimum skill levels of each role and interfaces with the overall project organisation structure	•	•
SMP4	How sustainability initiatives will be identified and integrated into the design of the Project Works	•	

Reference	SMP Requirements	Design	Construction
SMP5	The carbon and energy mitigation measures as detailed in the environmental approval documentation that are applicable to the Project Works	•	•
SMP6	The low carbon strategies and initiatives that will be implemented to minimise the carbon emissions	•	•
SMP7	The energy efficiency strategies and initiatives that will be implemented to minimise energy use	•	•
SMP8	Support innovative and cost effective approaches to energy efficiency, low carbon / renewable energy sources and energy procurement	•	•
SMP9	The strategies and initiatives that will be implemented to enhance the biodiversity	•	
SMP10	The processes and methodologies for assurance, monitoring, auditing, corrective action, continuous improvement and reporting on sustainability performance		•
SMP11	Process (or Processes) for compliance record generation and management		•
SMP12	The processes and methodologies which will be used to achieve the required scores under rating systems identified in General Specification Section 11 – Sustainability	•	•
SMP13	The strategy and methodology for incorporating climate change adaption in designs that respond to the climate change risks and baseline adaptation measures allocated to the Project Works	•	
SMP14	The strategies and initiatives that will be implemented to minimise overall water use, maximise the availability and use of non-potable water sources	•	•
SMP15	Estimates of the quantity of potable water which will be consumed during construction	•	
SMP16	Estimates of the quantity of water from non-potable sources which will be consumed during construction	•	
SMP17	The strategy to reduce material use throughout the project life-cycle	•	•
SMP18	The strategies and initiatives that will be implemented to maximise the use of recycled materials	•	•
SMP19	The strategies and initiatives to recycle and reuse materials onsite	•	•
SMP20	The strategies and initiatives to prioritise the use of materials with a lower embodied impact	•	•
SMP21	Estimates of the Portland cement reduction which will be achieved in concrete (averaged across all mixes) compared to a reference case	•	

Reference	SMP Requirements	Design	Construction
SMP22	The strategies and initiatives to prioritise the use of low-VOC, low emission materials	•	•
SMP23	The use of sustainably sourced and certified timber and wood products	•	•
SMP24	The development of a deconstruction plans to enable recycling and reuse at end-of-life	•	
SMP25	Estimates of fuel consumption	•	
SMP26	Estimates of electricity consumption	•	
SMP27	Estimates of 'Scope 1', 'Scope 2', 'Scope 3' and total carbon emissions (Carbon Emission Targets) that incorporates direct and indirect emissions associated with electricity and fuel consumption, on-site process emissions and embodied emissions for all main materials used	•	•
SMP28	Reporting of carbon and energy will be undertaken in accordance with the National Greenhouse and Energy Reporting Act 2007.		•
SMP29	The strategy and initiatives to influence subcontractors and materials suppliers to adopt sustainability objectives in their works and procurement		•
SMP30	A Sustainable Procurement Policy that must, as a minimum, include: ▪ The processes and procedures that will be used to provide environmental and social improvement ▪ The responsibilities of key project personnel with respect to the implementation of the policy ▪ Compliance record generation and management ▪ The processes and environmental and social criteria that will be used for the selection of Subcontractors ▪ The processes that will be used to ensure ethical sourcing of labour and materials ▪ Local sourcing ▪ Where equipment, materials or labour are procured from locations outside Australia, the processes that will be used to ensure human rights impacts and risks are identified and mitigated as well as processes to ensure compliance with modern slavery, and modern slavery reporting		•
SMP31	The retention of records detailing the consideration of sustainability in the procurement of all materials		•

3.3 Construction Workforce Development and Industry Participation Plan

a. The Workforce Development and Industry Participation Plan will address and detail:

i. *The proposed response to policies related to skills, apprenticeships, diversity, small business and Aboriginal Participation which will be delivered on the project*;

ii. *Proposed appropriately skilled key personnel to support delivery of the workforce development and industry participation requirements*;

iii. *Implementation approach, processes and systems to ensure delivery and reporting of workforce development and industry participation priority areas*:

- *Jobs and Industry Participation*;
- *Skills Development*;
- *Diversity and Inclusion*; and
- *Inspiring Future Talent*.

3.4 Construction Environmental Management Plan

a. Principal Contractors are required to prepare and implement a Construction Environmental Management Plan (CEMP) relevant to the scale and nature of their scope of works. The CEMP shall comprise of a main CEMP document, issue specific sub plans, activity specific procedures and site based control maps. The CEMP shall illustrate the relationship between other plans required by the contract, in particular those that relate to design management.

b. Depending on the scope and scale of the works, Sydney Metro may decide to streamline the CEMP and sub-plan requirements. For example, depending on the risk associated with particular environmental issues it may be appropriate to remove the need for a sub plan, or replace with a procedure as part of the CEMP.

c. The CEMP will cover the requirements of the relevant planning approval documentation, the conditions of all other permits and licences, the Principal Contractor's corporate EMS, the environmental provisions of the contract documentation and this Construction Environmental Management Framework.

d. As a minimum the CEMP will:

i. Include a contract specific environmental policy;

ii. Include a description of activities to be undertaken during construction;

iii. For each plan under the CEMP include a matrix of the relevant Conditions of Approval or Consent referencing where each requirement is addressed;

iv. For each plan under the CEMP, set objectives and targets, and identify measurable key performance indicators in relation to these;

v. For each role that has environmental accountabilities or responsibilities, including key personnel, provide a tabulated description of the authority and roles of key personnel, lines of responsibility and communication, minimum skill level requirements and their interface with the overall project organisation structure;

vi. Assign the responsibility for the implementation of the CEMP to the Environment Manager, who will have appropriate experience. The Principal Contractor's Project Director will be accountable for the implementation of the CEMP;

vii. Identify communication requirements, including liaison with stakeholders and the community;

viii. Include induction and training requirements and a summary of the Training Needs Analysis required in Section 3.10(b);

ix. Management strategies for environmental compliance and review of the performance of environmental controls;

x. Procedures for environmental inspections and monitoring, auditing and review, and reporting on environmental performance including environmental compliance tracking;

xi. Include an annual schedule for auditing the CEMP and Sub-Plans that is updated at least monthly;

xii. Include procedures for emergency and incident management, non-compliance management, and corrective and preventative action; and

xiii. Include procedures for the control of environmental records.

e. The CEMP and associated sub-plans will be reviewed by Sydney Metro and/or an independent environmental representative (see Section 3.12) prior to any construction works commencing. Depending on the Conditions of Approval, the CEMP and certain sub-plans may also require the approval of the Department of Planning, Industry and Environment (DPIE).

f. Where a corresponding systems document exists within the Sydney Metro Integrated Management System, the Principal Contractor's procedures will be required to be consistent with any requirements in those documents.

3.5 Construction Environmental Management Sub-Plans

a. Subject to Section 3.4(b) the Principal Contractor will prepare issue-specific environmental sub plans to the CEMP which address each of the relevant environmental impacts at a particular site or stage of the project. Issue specific sub plans will include:

i. Spoil management;

ii. Groundwater management;

iii. Noise and vibration management;

iv. Heritage management;

v. Flora and fauna management;

vi. Visual amenity management;

vii. Soil and water management;

viii. Air quality management; and

ix. Waste management.

b. Additional detail on the minimum requirements for these sub plans is provided in Sections 6-17 of this CEMF.

3.6 Environmental Procedures and Control Maps

a. The Principal Contractor will prepare and implement activity specific environmental procedures. These procedures should supplement environmental management sub plans, but may substitute for sub plans in agreement with Sydney Metro if a reasonable risk based justification can be made and the sub plan is not a requirement of any approval.

b. The procedures will include:

i. A breakdown of the work tasks relevant to the specific activity and indicate responsibility for each task;

ii. Potential impacts associated with each task;

iii. A risk rating for each of the identified potential impacts;

iv. Mitigation measures relevant to each of the work tasks; and

v. Responsibility to ensure the implementation of the mitigation measures.

c. The Principal Contractor will prepare and implement site based progressive Environmental Control Maps (ECM's) which as a minimum:

i. Depicts the current representation of the site;

ii. Indicate which environmental procedures, environmental approvals, or licences are applicable;

iii. Illustrate the site, showing significant structures, work areas and boundaries;

iv. Illustrate the environmental control measures and environmentally sensitive receivers;

v. Is endorsed by the Principal Contractors Environmental Manager or delegate;

vi. Include all the training and competency requirements for relevant workers; and

vii. Be communicated to relevant workers, including sign-off for the appropriate procedures prior to commencing works on the specific site and / or activity.

3.7 Additional Environmental Assessments

a. Where the requirement for an additional environmental assessment is identified, this will be undertaken prior to undertaking any construction activities. The environmental assessment will include:

i. A description of the existing surrounding environment;

ii. Details of the ancillary works and construction activities required to be carried out including the hours of works;

iii. An assessment of the environmental impacts of the works, including, but not necessarily limited to, traffic, noise and vibration, air quality, soil and water, ecology and heritage;

iv. Details of mitigation measures and monitoring specific to the works that would be implemented to minimise environmental impacts; and

v. Identification of the timing for completion of the construction works, and how the sites would be reinstated (including any necessary rehabilitation).

3.8 Condition Surveys

a. Prior to the commencement of construction the Principal Contractors are to offer Pre-construction Building Condition Surveys, in writing, to the owners of buildings where there is a potential for construction activities to cause damage regardless of severity. If accepted, the Principal Contractor will produce a comprehensive written and photographic condition report produced by an appropriate professional prior to relevant works commencing.

b. Prior to the commencement of construction the Principal Contractor will prepare a Road Dilapidation Report for all local public roads proposed to be used by heavy vehicles. Dilapidation reports are to include other road infrastructure such as signs, curbs, applicable driveways and pedestrian paths.

3.9 Register of Hold Points

a. Principal Contractors will identify hold points, beyond which approval is required to proceed with a certain activity. These hold points will be documented in relevant CEMP or relevant sub-plans. Example activities include vegetation removal and water discharge.

b. Table 1.4 provides the structure for these hold points to be included in the CEMP as well as an initial list of hold points which will be implemented.

Table 1.4 Initial Register of Hold Points

Hold Point	Release of Hold Point	By Who
Prior to Vegetation Clearing / Ground Disturbance	Pre-clearing inspection Erosion and sediment control plan	Qualified Ecologist Contractor's Environmental Manager or delegate
Discharge of water	Water tested to verify compliance and approval to discharge	Contractor's Environment Manager or delegate
Out of hours works	Noise Assessment	Contractor's Environment Manager
Use of local roads by heavy vehicles	Road Dilapidation Report	Appropriate Professional nominated by Principal Contractor
Construction identified as affecting buildings	Building Condition Survey	Appropriate Professional nominated by Principal Contractor

3.10 Training, Awareness and Competence

a. Principal Contractors are responsible for determining the training needs of their personnel. As a minimum this will include site induction, regular toolbox talks and topic specific environmental training as follows:

i. The site induction will be provided to all site personnel and will include, as a minimum:

- Training purpose, objectives and key issues;
- Contractor's environmental and sustainability policy(s) and key performance indicators;

- Due diligence, duty of care and responsibilities;
- Relevant conditions of any environmental licence and/or the relevant conditions of approval;
- Site specific issues and controls including those described in the environmental procedures;
- Reporting procedure(s) for environmental hazards and incidents; and
- Communication protocols for interactions with community and stakeholders.

ii. Toolbox talks will be held on a regular basis in order to provide a project or site wide update, including any key or recurring environmental issues; and

iii. Topic specific environmental training should be based upon, but is not limited to, Issue specific sub-plans required under Section 3.5 (a) (i-xi).

b. Principal Contractors will conduct a Training Needs Analysis which:

i. Identifies that all staff are to receive environmental training;

ii. Identifies the competency requirements of staff that hold environmental roles and responsibilities documented within the Construction Environmental Management Plan and sub-plans;

iii. Identifies appropriate training courses/events and the frequency of training to achieve and/or maintain these competency requirements; and

iv. Implements and documents as part of the CEMP a training schedule that plans attendance at environmental training events, provides mechanisms to notify staff of their training requirements, and identifies staff who do not attend scheduled training events or who have overdue training requirements.

3.11 Emergency and Incident Response

a. Principal Contractors undertaking work in accordance with an EPL must develop and implement a Pollution Incident Response Management Plan, in accordance with the requirements of the POEO Act. Contractors' emergency and incident response procedures will also be consistent with any relevant Sydney Metro procedures and will include:

i. Categories for environmental emergencies and incidents;

ii. Notification protocols for each category of environmental emergency or incident, including notification to Sydney Metro and notification to owners / occupiers in the vicinity of the incident. This is to include relevant contact details;

iii. Identification of personnel who have the authority to take immediate action to shut down any activity, or to affect any environmental control measure (including as directed by an authorised officer of any regulator or government department);

iv. A process for undertaking appropriate levels of investigation for all incidents and the identification, implementation and assessment of corrective and preventative actions; and

v. Notification protocols of incidents to relevant regulators and stakeholders including (but not limited to) the EPA or DPIE that are made by the Contractor or Sydney Metro.

b. The Contractor will make all personnel aware of the plan and their responsibilities.

3.12 Independent Environmental Representatives

a. Sydney Metro will engage Independent Environmental Representatives (ERs) as required under the CSSI approval to undertake the following, along with any additional roles as required:

i. Review, provide comment on and endorse (where required) any relevant environmental documentation to verify it is prepared in accordance with relevant environmental legislation, planning approval conditions, Environment Protection Licences, relevant standards and this CEMF;

ii. Monitor and report on the implementation and performance of the above mentioned documentation and other relevant documentation;

iii. Provide independent guidance and advice to Sydney Metro and the Contractors in relation to environmental compliance issues and the interpretation of planning approval conditions;

iv. Be the principal point of advice for the DP&E in relation to all questions and complaints concerning the environmental performance of the project;

v. Ensure that environmental auditing is undertaken in accordance with all relevant project requirements; and

vi. Recommend reasonable steps, including 'stop works', to be taken to avoid or minimise adverse environmental impacts.

3.13 Roles and Responsibilities

a. In relation to Roles and Responsibilities the CEMP will:

i. Describe the relationship between the Principal Contractor, Sydney Metro, key regulatory stakeholders, the independent environmental representative and the independent certifier;

ii. For each role that has environmental accountabilities or responsibilities, including key personnel, provide a tabulated description of the authority and roles of key personnel, lines of responsibility and communication, minimum skill level requirements and their interface with the overall project organisation structure;

iii. Provide details of each specialist environment, sustainability or planning consultant who is employed by the Principal Contractor including the scope of their work; and

iv. Provide an overview of the role and responsibilities of the Independent Environmental Representative, the Independent Certifier and other regulatory stakeholders.

b. All sub-contractors engaged by the Principal Contractor will be required to operate within the EMS documentation of that Principal Contractor.

3.14 Environmental Monitoring, Inspections and Auditing

a. Issue specific environmental monitoring will be undertaken as required or as additionally required by any approval, permit or licence conditions.

b. The results of any monitoring undertaken as a requirement of a licence or permit that is required to be published will be published on the Principal Contractor's, or a project specific, website within 14 days of obtaining the results.

c. Environmental inspections will include:

i. Surveillance of environmental mitigation measures by the Site Foreman; and

ii. Periodic inspections by the Principal Contractor's Environmental Manager (or delegate) to verify the adequacy of all environmental mitigation measures. This will be documented in a formal inspection record.

d. Regular site inspections by the ERs and Sydney Metro representatives at a frequency to be agreed with the Principal Contractor.

e. Principal Contractors must undertake internal environmental audits. The scope will include:

i. Compliance with any approval, permit or licence conditions;

ii. Compliance with the E&SMS, CEMP, SMP, sub-plans and procedures;

iii. Community consultation and complaint response;

iv. Environmental training records; and

v. Environmental monitoring and inspection results.

f. Sydney Metro (or an independent environmental auditor) will also undertake periodic audits of the Principal Contractor's E&SMS, including this Construction Environmental Management Framework.

3.15 Environmental Non-compliances

a. Principal Contractors will document and detail any non-compliances with the requirements of any legislative or other requirements. Sydney Metro will be made aware of all non-compliances in a timely manner.

b. Principal Contractors will develop and implement corrective actions to rectify the non-compliances in order to prevent a re-occurrence of the non-compliance. Contractors will also maintain a register of non-compliances and associated corrective actions.

c. Sydney Metro or the Environmental Representative may raise non-compliances against environmental requirements. In these circumstances the Principal Contractor must abide by any requirements of Sydney Metro's procedure for managing non-compliances.

3.16 Environmental Records and Compliance Reporting

a. Principal Contractors will maintain appropriate records of the following:

i. Site inspections, audits, monitoring, reviews or remedial actions;

ii. Documentation as required by performance conditions, approvals, licences and legislation;

iii. Modifications to site environmental documentation (eg CEMP, sub-plans and procedures); and

iv. Other records as required by this Construction Environmental Management Framework.

b. Records must be accessible onsite for the duration of works.

c. Additionally records will be retained by the Principal Contractor for a period of no less than 7 years. Records will be made available in a timely manner to Sydney Metro (or their representative) upon request.

d. Compliance reports detailing the outcome of any environmental surveillance activity including internal and external audits (refer to Section 3.14) will be produced by the Principal Contractors Environmental Manager or delegate. These reports will be submitted to Sydney Metro at an agreed frequency.

3.17 Review and Improvement of the Environment and Sustainability Management System

a. Principal Contractors will ensure the continual review and improvement of the management systems. This will generally occur in response to:

i. Issues raised during environmental surveillance and monitoring;

ii. Expanded scope of works;

iii. Environmental incidents; and

iv. Environmental non-conformances.

b. A formal review of the management systems by the Principal Contractor's Senior Management Team will also occur on an annual basis, as a minimum. This review shall generate actions for the continual improvement of the systems and supporting management plans.

4. Stakeholder and Community Involvement

4.1 Overview

a. Throughout construction, Sydney Metro and the Principal Contractors will work closely with stakeholders and the community to ensure they are well informed regarding the construction works.

b. Stakeholders and the community will be informed of significant events or changes that affect or may affect individual properties, residences and businesses. These will include:

i. Significant milestones;

ii. Design changes;

iii. Changes to traffic conditions and access arrangements for road users and the affected public; and

iv. Construction operations which will have a direct impact on stakeholders and the community including noisy works, interruptions to utility services or construction work outside of normal work hours.

4.2 Community Communication Strategy

a. A Community Communication Strategy will be developed by each Sydney Metro Principal Contractor.

b. Key elements of the Community Communication Strategy, which will be implemented at appropriate times in the construction process, will include:

i. Notification (including targeted letterbox drops and email) of any works that may disturb local residents and businesses (such as noisy activities and night works) at least seven days prior to those works commencing;

ii. Notification (including targeted letterbox drops and email) of works that may affect transport (such as road closures, changes to pedestrian routes and changes to bus stops);

iii. Traffic alerts (via email) to all key traffic and transport stakeholders advising of any changes to access and local traffic arrangements (at least seven days prior to significant events);

iv. Print and radio advertisements regarding major traffic changes;

v. 24-hour toll-free community project information phone line;

vi. Complaints management process;

vii. Community information sessions, as required;

viii. Regular updates to the Sydney Metro website (sydneymetro.info), including uploading of all relevant documents, and contact details for the stakeholder and community relations team;

ix. Provision of information to the Sydney Metro Community Information Centre including community newsletters, information brochures and fact sheets and interactive web-based activities;

x. Clear signage at the construction sites;

xi. Regular newspaper advertisements in local and metropolitan papers;

xii. Regular inter-agency group meetings;

xiii. Community, business and stakeholder satisfaction surveys and feedback forms;

xiv. Translator and interpreter services; and

xv. The Principal Contractor's Community Relations Team will liaise with the Sydney Metro Project Communications team as the point of contact for the community.

4.3 Complaint Handling

a. Community liaison and complaints handling will be undertaken in accordance with the Construction Complaints Management System and will include:

i. Principal Contractors will deal with complaints in a responsive manner so that stakeholders' concerns are managed effectively and promptly; and

ii. A verbal response will be provided to the complainant as soon as possible and within a maximum of two hours from the time of the complaint (unless the complainant requests otherwise). A detailed written response will then be provided, if required, to the complainant within one week.

4.4 Urban Design of Temporary Works

a. Principal Contractors will ensure as a minimum:

i. Temporary construction works consider urban design and visual impacts, including:

- Artwork, graphics and images to enhance the visual appearance of temporary works in high visibility locations;
- Project information to raise awareness on benefits, explain the proposed works at each site and provide updates on construction progress;
- Community information, including contact numbers for enquiries / complaints;
- Signage and information to mitigate impacts on local businesses which may be obscured by the construction site;
- Sydney Metro advertising / public awareness campaigns; and
- Logos / branding, including Sydney Metro, NSW Government, and Contractor branding.

ii. The design of all temporary works will require Sydney Metro approval in relation to urban design and visual impacts and Sydney Metro will stipulate the design of hording artwork, including:

- Sydney Metro advertising / public awareness campaigns; and
- Logos / branding, including Sydney Metro, NSW Government, and Contractor branding.

b. Construction hoardings, scaffolding and acoustic sheds will be regularly inspected and kept clean and free of dust build up. Graffiti on construction hoardings, scaffolding or acoustic sheds will be removed or painted over promptly.

c. The principles of Crime Prevention Through Environmental Design will be applied to all works, including temporary works, that have a public interface.

4.5 Business and Property Impacts

a. Principal Contractors will proactively work with potentially affected stakeholders to identify the likely impacts and put in place measures to minimise impacts.

b. Construction works will be undertaken to meet the following objectives:

i. Minimise the potential impact of the project to businesses affected by construction works;

ii. Ensure businesses are kept informed of the project and consulted in advance of major works or factors that are likely to have a direct impact;

iii. Consult with all business directly affected by changes to access arrangements regarding specific requirements at least two weeks prior to those changes coming into effect; and

iv. Ensure that business stakeholder enquiries and complaints regarding the project are managed and resolved effectively.

c. Principal Contractors will document in the Community Communication Strategy (Section 4.2) key issues relating to business impacts by locality with a particular focus on proactive consultation with affected businesses. Including:

i. Identification of specific businesses which are sensitive to construction activity disturbances;

ii. Summary of the commercial character of the locality, its general trading profile (daily and annually) and information gained from the business profiling such as:

- Operating hours;
- Main delivery times;
- Reliance on foot traffic;
- Any signage or advertising that may be impacted;
- Customer origin; and
- Other information specific to the business that will need to be considered in construction planning.

iii. Define the roles and responsibilities in relation to the control and monitoring of business disturbances;

iv. Identification of locality specific standard business mitigation measures which would be implemented;

v. Maps and diagrams to illustrate the information for easy identification of measures which would be implemented;

vi. Description of the monitoring, auditing and reporting procedures;

vii. Procedure for reviewing performance and implementing corrective actions;

viii. Description of the complaints handling process; and

ix. Procedure for community consultation and liaison.

5. General Site Works

Figure 3 - Aerial View of the Sydney Metro Norwest Station Site

5.1 Working Hours

a. Standard working hours are between 7am – 6pm on weekdays and 8am – 1pm on Saturdays.

b. Works which can be undertaken outside of standard construction hours without any further approval include:

i. Those which have been described in respective environmental assessments as being required to take place 24/7. For example, tunnelling and underground excavations and supporting activities will be required 24/7;

ii. Works which are determined to comply with the relevant Noise Management Level at sensitive receivers;

iii. The delivery of materials outside of approved hours as required by the Police or other authorities (including Sydney Roads) for safety reasons;

iv. Where it is required to avoid the loss of lives, property and / or to prevent environmental harm in an emergency; and

v. Where written agreement is reached with all affected receivers.

c. Principal Contractors may apply for EPA approval to undertake works outside of normal working hours under their respective Environment Protection Licences.

5.2 Construction Traffic Management

a. The management of traffic impacts due to construction is addressed in the Construction Traffic Management Framework (CTMF) which sets out system requirements for management plans and other associated documentation. Requirements in the CTMF must be followed by Principal Contractors.

b. The Construction Traffic Management Framework (CTMF) sets out the approach to managing traffic impacts during the construction of the Sydney Metro projects. The CTMF also outlines contractor requirements, with reference to third party agreements. Principal Contractors are required to produce these documents in accordance with the CTMF.

5.3 Site Layout

a. Principal Contractors will consider the following in the layout of construction sites:

i. The location of noise intensive works and 24 hour activities in relation to noise sensitive receivers;

ii. The location of site access and egress points in relation to noise and light sensitive receivers, especially for sites proposed to be utilised 24 hours per day;

iii. The use of site buildings to shield noisy activities from receivers;

iv. The use of noise barriers and / or acoustic sheds where feasible and reasonable for sites proposed to be regularly used outside of daytime hours;

v. Aim to minimise the requirement for reversing, especially of heavy vehicles; and

vi. Any applicable requirements of the Construction Traffic Management Framework (CTMF).

5.4 Reinstatement

a. Mitigation measures required for reinstatement will be incorporated into the CEMP and will include as a minimum:

i. Principal Contractors will clear and clean all working areas and accesses at project completion;

ii. At the completion of construction all plant, temporary buildings or vehicles not required for the subsequent stage of construction will be removed from the site;

iii. All land, including roadways, footpaths, loading facilities or other land having been occupied temporarily will be returned to their pre-existing condition or better; and

iv. Reinstatement of community spaces, infrastructure and services will occur as soon as possible after completion of construction.

6. Spoil Management

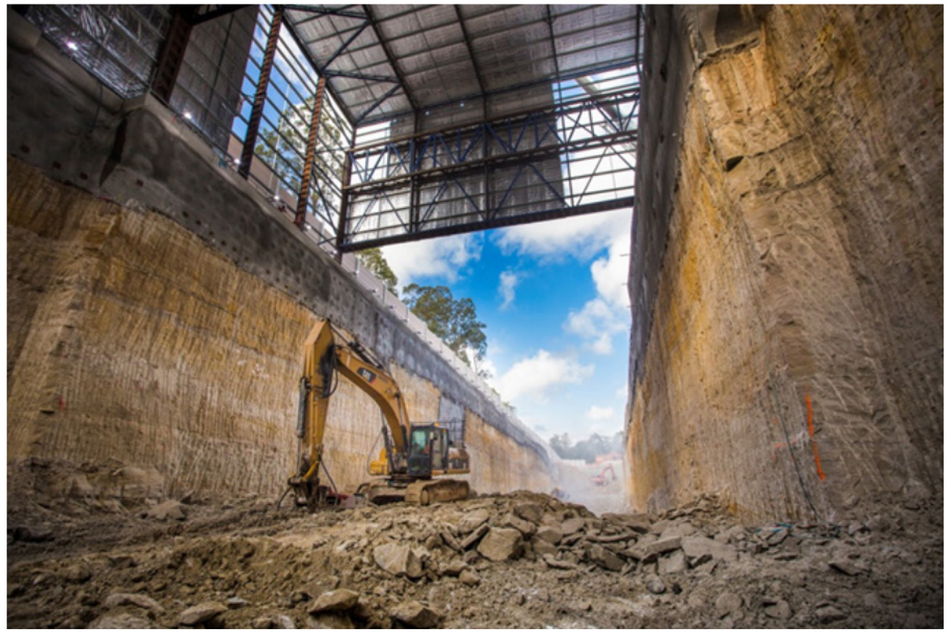


Figure 4 - Spoil and Excavation Works at the Showground Station Site

6.1 Spoil Management Objectives

a. The following spoil management objectives will apply to the construction of the project:

i. Minimise spoil generation where possible;

ii. The project will mandate 100% reuse or recycling (on or off-site) of usable spoil;

iii. Spoil will be managed with consideration to minimising adverse traffic and transport related issues;

iv. Spoil will be managed to avoid contamination of land or water;

v. Spoil will be managed with consideration of the impacts on residents and other sensitive receivers; and

vi. Site contamination will be effectively managed to limit the potential risk to human health and the environment.

6.2 Spoil Management Implementation

a. Principal Contractors will develop and implement a Spoil Management Plan for their scope of works. The Spoil Management Plan will include as a minimum:

i. The spoil mitigation measures as detailed in the environmental approval documentation;

ii. The responsibilities of key project personnel with respect to the implementation of the plan;

iii. Procedures and methodologies for the haulage and disposal locations, storage and stockpiling arrangements, including those for virgin excavated natural material, contaminated and unsuitable material;

iv. Procedures for the testing, excavation, classification, handling and reuse of spoil;

v. measures that will be implemented to both reduce spoil quantities and maximise the beneficial reuse of spoil which will be generated during the performance of the TSE Contractor's Activities, including how spoil generation is minimised through the design development process;

vi. Details, links or references to where traffic movements in relation to spoil are described, and measures that will be implemented to minimise traffic and noise impacts associated with haulage and disposal of spoil;

vii. quantities for reuse of spoil within the Construction Site, for beneficial reuse of spoil off site and for spoil disposal;

viii. Processes and procedures for the management of the environmental and social impacts of spoil transfer and reuse;

ix. A register of spoil receipt sites that includes the site or project name, location, capacity, site owner and which tier the site is classified as under the spoil reuse hierarchy;

x. Spoil management monitoring requirements; and

xi. Compliance record generation and management.

b. Spoil management measures will be included in regular inspections undertaken by the Contractor, and compliance records will be retained. These will include:

i. Records detailing the beneficial re-use of spoil either within the project or at off-site locations; and

ii. Waste dockets for any spoil disposed of to landfill sites.

6.3 Spoil Mitigation

a. Examples of spoil mitigation measures include:

i. Implementing the spoil re-use hierarchy;

ii. Handling spoil to minimise potential for air or water pollution; and

iii. Minimise traffic impacts associated with spoil removal.

7. Groundwater Management

7.1 Groundwater Management Objectives

a. The following groundwater management objectives will apply to construction:

i. Reduce the potential for drawdown of surrounding groundwater resources;

ii. Prevent the pollution of groundwater through appropriate controls; and

iii. Reduce the potential impacts of groundwater dependent ecosystems.

7.2 Groundwater Management Implementation

a. The following content may be provided within other sub plans such as the Soil and Water Management Plan and Flora and Fauna Management Plan.

b. Principal Contractors will develop and implement a Groundwater Management Plan for their scope of works. The Groundwater Management Plan will include as a minimum:

i. The groundwater mitigation measures as detailed in the environmental approval documentation;

ii. The requirements of any applicable licence conditions;

iii. Details of proposed extraction, use and disposal of groundwater, and measures to mitigate potential impacts to groundwater sources, incorporating monitoring, impact trigger definition and response actions for all groundwater sources potentially impacted by the SSI;

iv. Evidence of consultation with relevant government agencies;

v. The responsibilities of key project personnel with respect to the implementation of the plan;

vi. Procedures for the treatment, testing and discharge of groundwater from the site;

vii. Compliance record generation and management; and

viii. Details of groundwater monitoring if required.

7.3 Groundwater Mitigation

a. Examples of groundwater mitigation measures include:

i. Implementing all feasible and reasonable measures to limit groundwater inflows to stations and crossovers; and

ii. Undertaking groundwater monitoring during construction (levels and quality) in areas identified as 'likely' and 'potential' groundwater dependent ecosystems.

8. Construction Noise and Vibration Management

Figure 6 - Hebel Wall Noise Barrier at the Cheltenham Services Facility Site

8.1 Construction Noise and Vibration Management Objectives

a. The following noise and vibration management objectives will apply to construction:

i. Minimise unreasonable noise and vibration impacts on residents and businesses;

ii. Avoid structural damage to buildings or heritage items as a result of construction vibration;

iii. Undertake active community consultation; and

iv. Maintain positive, cooperative relationships with schools, childcare centres, local residents and building owners.

8.2 Construction Noise and Vibration Management Implementation

a. Principal Contractors will develop and implement a Construction Noise and Vibration Management Plan for their scope of works consistent with the Interim Construction Noise Guidelines (Department of Environment and Climate Change, 2009). The Construction Noise and Vibration Management Plan will include as a minimum:

i. Identification of work areas, site compounds and access points;

ii. Identification of sensitive receivers and relevant construction noise and vibration goals;

iii. Be consistent with, and include the requirements of the noise and vibration mitigation measures as detailed in, the environmental approval documentation and the Sydney Metro Construction Noise and Vibration Strategy (CNVS);

iv. Details of construction activities and an indicative schedule for construction works, including the identification of key noise and/or vibration generating construction activities (based on representative construction scenarios) that have the potential to generate noise or vibration impacts on surrounding sensitive receivers, in particular residential areas;

v. Identification of feasible and reasonable procedures and mitigation measures to ensure relevant vibrations and blasting criteria are achieved, including a suitable blast program;

vi. Community consultation requirements and Community notification provisions specifically in relation to blasting;

vii. The requirements of any applicable licence or approval (for example EPL);

viii. Additional requirements in relation to activities undertaken 24 hours of the day, 7 days per week;

ix. Pre-construction compliance requirements and hold points;

x. The responsibilities of key project personnel with respect to the implementation of the plan;

xi. Noise monitoring requirements;

xii. Compliance record generation and management; and

xiii. An Out of Hours Works Protocol applicable to all construction methods and sites.

b. Detailed Construction Noise and Vibration Impact Statements will be prepared for noise-intensive construction sites and or activities, to ensure the adequacy of the noise and vibration mitigation measures. Specifically, Construction Noise and Vibration Impact Statements will be prepared for works proposed to be undertaken outside of standard construction hours and to support applications to undertake out of hours works (this includes variations of EPL's and applications to relevant agencies).

c. Noise and vibration monitoring would be undertaken for construction as specified in the CNVS.

d. The following compliance records would be kept by Principal Contractors:

i. Records of noise and vibration monitoring results against appropriate NMLs and vibration criteria; and

ii. Records of community enquiries and complaints, and the Contractor's response.

8.3 Construction Noise and Vibration Mitigation

a. All feasible and reasonable mitigation measures would be implemented in accordance with the CNVS. Examples of noise and vibration mitigation measures include:

i. Construction hours will be in accordance with the working hours specified in Section 5.1;

ii. Hoarding and enclosures will be implemented where required to minimise airborne noise impacts; and

iii. The layout of construction sites will aim to minimise airborne noise impacts to surrounding receivers.

9. Heritage Management

Figure 7 –White Hart Inn Excavation Site

9.1 Heritage Management Objectives

a. The following heritage management objectives will apply to construction:

i. Embed significant heritage values through any architectural design, education or physical interpretation;

ii. Minimise impacts on items or places of heritage value;

iii. Avoid accidental impacts on heritage items; and

iv. Maximise worker's awareness of indigenous and non-indigenous heritage.

9.2 Heritage Management Implementation

a. Principal Contractors will develop and implement a Heritage Management Plan which will include as a minimum:

i. Evidence of consultation with Registered Aboriginal Parties and the NSW Heritage Council;

ii. Identify initiatives that will be implemented for the enhancement of heritage values and minimisation of heritage impacts, including procedures and processes that will be used to implement and document heritage management initiatives;

iii. The heritage mitigation measures as detailed in the environmental approval documentation;

iv. The responsibilities of key project personnel with respect to the implementation of the plan;

v. Procedures for interpretation of heritage values uncovered through salvage or excavation during detailed design;

vi. Procedures for undertaking salvage or excavation of heritage relics or sites (where relevant), consistent with and any recordings of heritage relics prior to works commencing that would affect them;

vii. Details for the short and / or long term management of artefacts or movable heritage;

viii. Details of management measures to be implemented to prevent and minimise impacts on heritage items (including further heritage investigations, archival recordings and/or measures to protect unaffected sites during construction works in the vicinity);

ix. Procedures for unexpected heritage finds, including procedures for dealing with human remains;

x. Heritage monitoring requirements; and

xi. Compliance record generation and management.

b. The Contractor's regular inspections will include checking of heritage mitigation measures.

c. Compliance records will be retained by the Contractor. These will include:

i. Inspections undertaken in relation to heritage management measures;

ii. Archival recordings undertaken of any heritage item;

iii. Unexpected finds and stop work orders; and

iv. Records of any impacts avoided or minimised through design or construction methods.

9.3 Heritage Mitigation

a. Examples of heritage mitigation measures include:

i. Induction courses for site workers will include training in the identification of Aboriginal artefacts and management of Aboriginal heritage values.

ii. Any heritage item not affected by the works will be retained and protected throughout construction;

iii. During construction undertake professional archaeological investigation, excavation, and reporting of any historical Indigenous heritage sites of state significance which will be affected. Reporting may be completed as construction progresses;

iv. Undertake archival recordings of all non-Indigenous heritage items affected by the works prior to commencement of works; and

v. Implement unexpected heritage find procedures for Indigenous and non-Indigenous heritage items.

10. Flora and Fauna Management

Figure 8 - Demarcation of Retained Flora

10.1 Flora and Fauna Management Objectives

a. The following flora and fauna management objectives will apply to construction:

i. Minimise impacts on flora and fauna;

ii. Design waterway modifications and crossings to incorporate best practice principles;

iii. Retain and enhance existing flora and fauna habitat wherever possible; and

iv. Appropriately manage the spread of weeds and plant pathogens.

10.2 Flora and Fauna Management Implementation

a. Principal Contractors will develop and implement a Flora and Fauna Management Plan which will include as a minimum:

i. The ecological mitigation measures as detailed in the environmental approval documentation;

ii. The responsibilities of key project personnel with respect to the implementation of the plan;

iii. Procedures for the clearing of vegetation and the relocation of flora and fauna;

iv. Details on the locations, monitoring program and use of nest boxes by fauna;

v. Procedures for the demarcation and protection of retained vegetation, including all vegetation outside and adjacent to the construction footprint;

vi. Plans for impacted and adjoining areas showing vegetation communities; important flora and fauna habitat areas; locations where threatened species, populations or ecological communities have been recorded;

vii. Vegetation management plan(s) for sites where native vegetation is proposed to be retained;

viii. Identification of measures to reduce disturbance to sensitive fauna;

ix. Rehabilitation details, including identification of flora species and sources, and measures for the management and maintenance of rehabilitated areas (including duration of the implementation of such measures);

x. Weed management measures focusing on early identification of invasive weeds and effective management controls;

xi. A procedure for dealing with unexpected EEC threatened species identified during construction, including cessation of work and notification of the Department, determination of appropriate mitigation measures in consultation with the OEH (including relevant relocation measures) and updating of ecological monitoring or off-set requirements;

xii. Details on the methodology for vegetation mapping and survey;

xiii. Ecological monitoring requirements; and

xiv. Compliance record generation and management.

b. Principal Contractors would undertake the following ecological monitoring as a minimum:

i. A pre-clearing inspection will be undertaken prior to any native vegetation clearing by a suitable qualified ecologist and the Contractor's Environmental Manager (or delegate). The pre-clearing inspection will include, as a minimum:

- Identification of hollow bearing trees or other habitat features;
- Identification of any threatened flora and fauna;
- A check on the physical demarcation of the limit of clearing;
- An approved erosion and sediment control plan for the worksite; and
- The completion of any other pre-clearing requirements required by any project approvals, permits or licences.

ii. The completion of the pre-clearing inspection will form a HOLD POINT requiring sign-off from the Contractor's Environmental Manager (or delegate) and a qualified ecologist; and

iii. A post clearance report, including any relevant Geographical Information System files, will be produced that validates the type and area of vegetation cleared including confirmation of the number of hollows impacted and the corresponding nest box requirements to offset these impacts.

c. The Principal Contractor's regular inspections will include a check on the ecological mitigation measures and project boundary fencing.

d. The following compliance records would be kept by the Principal Contractor:

i. Records of pre-clearing inspections undertaken;

ii. Records of the release of the pre-clearing hold point; and

iii. Records of ecological inspections undertaken.

10.3 Flora and Fauna Mitigation

a. Examples of flora and fauna mitigation measures include:

i. Areas to be retained and adjacent habitat areas will be fenced off prior to works to prevent damage or accidental over clearing;

ii. Clearing will follow a two-stage process as follows:

- Non-habitat trees will be cleared first after sign-off of the pre-clearing inspection; and
- Habitat trees will be cleared no sooner than 48 hours after non-habitat trees have been cleared. A suitably qualified ecologist will be present on site during the clearing of habitat trees. Felled habitat trees will be left on the ground for 24 hours or inspected by the ecologist prior to further processing.

iii. Weed management is to be undertaken in areas affected by construction prior to any clearing works in accordance with the Noxious Weeds Act 1993.

11. Visual Amenity Management

11.1 Visual Amenity Management Objectives

a. The following visual and landscape management objectives will apply to the construction of the project:

i. Minimise impacts on existing landscape features as far as feasible and reasonable;

ii. Ensure the successful implementation of the Landscape Design; and

iii. Reduce visual impact of construction to surrounding community.

11.2 Visual Amenity Management Implementation

a. Principal Contractors will develop and implement a Visual Amenity Management Plan for temporary works which will include as a minimum:

i. The visual mitigation measures as detailed in the environmental approval documentation for construction;

ii. Input from an experienced Landscape or Urban Designer;

iii. The maintenance of outward facing elements of site hoarding or noise barriers, including the removal of graffiti and weeds;

iv. Apply the principles of Australian Standard 4282-1997 Control of the obtrusive effects of outdoor lighting and relevant safety design requirements and detail mitigation measures to minimise lighting impacts on sensitive receivers for all permanent, temporary and mobile light sources;

v. Identify the processes and procedures that will be used for the incorporation of the principles of Crime Prevention Through Environmental Design (CPTED) in the design and construction of any temporary site facilities; and

vi. Compliance record generation and management.

b. Visual and landscape measures will be incorporated into the Principal Contractor's regular inspections including checking the health of retained vegetation around site boundaries, checking the condition of any site hoarding and acoustic sheds, and checking the position and direction of any sight lighting.

c. The Contractor will retain compliance records of any inspections undertaken in relation to visual and landscape measures.

11.3 Visual Amenity Mitigation

a. Examples of visual amenity mitigation measures include:

i. Wherever feasible and reasonable, vegetation around the perimeter of the construction sites will be maintained;

ii. Temporary construction works will be designed with consideration of urban design and visual amenity as per Section 4.4; and

iii. Temporary site lighting, for security purposes or night works will be installed and operated in accordance with AS4282:1997 Control of the Obtrusive Effect of Outdoor Lighting.

12. Soil and Water Management

Figure 10 - Erosion and Sediment Controls at the Cudgegong Rd Site

12.1 Soil and Water Management Objectives

a. The following soil and water management objectives will apply to construction:

i. Minimise pollution of surface water through appropriate erosion and sediment control;

ii. Minimise leaks and spills from construction activities;

iii. Maintain existing water quality of surrounding surface watercourses; and

iv. Source construction water from non-potable sources, where feasible and reasonable.

12.2 Soil and Water Implementation

a. Principal Contractors will develop and implement a Soil and Water Management Plan for their scope of works. The Soil and Water Management Plan will include as a minimum:

i. The surface water and flooding mitigation measures as detailed in the environmental approval documentation;

ii. Details of construction activities and their locations, which have the potential to impact on water courses, storage facilities, stormwater flows, and groundwater;

iii. Surface water and ground water impact assessment criteria consistent with the principles of the Australian and New Zealand Environment Conservation Council (ANZECC) guidelines;

iv. Management measures to be used to minimise surface and groundwater impacts, including identification of water treatment measures and discharge points, details of how spoil and fill material required by the project will be sourced, handled, stockpiled, reused and managed; erosion and sediment control measures; salinity control measures and the consideration of flood events;

v. A contingency plan, consistent with the NSW Acid Sulphate Soils Manual (EPA 1998), to deal with the unexpected discovery of actual or potential acid sulphate soils, including procedures for the investigation, handling, treatment and management of such soils and water seepage;

vi. Management measures for contaminated material (soils, water and building materials) and a contingency plan to be implemented in the case of unanticipated discovery of contaminated material, including asbestos, during construction;

vii. A description of how the effectiveness of these actions and measures would be monitored during the proposed works, clearly indicating how often this monitoring would be undertaken, the locations where monitoring would take place, how the results of the monitoring would be recorded and reported, and, if any exceedance of the criteria is detected how any non-compliance can be rectified;

viii. The requirements of any applicable licence conditions;

ix. The responsibilities of key project personnel with respect to the implementation of the plan;

x. Procedures for the development and implementation of Progressive Erosion and Sediment Control Plans;

xi. Identification of locations where site specific Stormwater and Flooding Management Plans are required; and

xii. Compliance record generation and management.

b. Principal Contractors will develop and implement Progressive Erosion and Sediment Control Plans (ESCPs) for all active worksites in accordance with Managing Urban Stormwater: Soils & Construction Volume 1 (Landcom, 2004) (known as the “Blue Book”). The ESCPs will be approved by the Contractor’s Environmental Manager (or delegate) prior to any works commencing (including vegetation clearing) on a particular site. Copies of the approved ESCP will be held by the relevant Contractor personnel including the Engineer and the Site Foreman.

c. ESCPs will detail all required erosion and sediment control measures for the particular site at the particular point in time and be progressively updated to reflect the current site conditions. Any amendments to the ESCP will be approved by the Contractor’s Environmental Manager (or delegate).

d. Principal Contractors will develop and implement Stormwater and Flooding Management Plans for the relevant construction sites. These plans will identify the appropriate design standard for flood mitigation based on the duration of construction, proposed activities and flood risks. The plan will develop procedures to ensure that threats to human safety and damage to infrastructure are not exacerbated during the construction period.

e. Principal Contractors will undertake the following soil and water monitoring as a minimum:

i. Weekly inspections of the erosion and sediment control measures. Issues identified would be rectified as soon as practicable;

ii. Additional inspections will be undertaken following significant rainfall events (greater than 20 mm in 24 hours); and

iii. All water will be tested (and treated if required) prior to discharge from the site in order to determine compliance with relevant approvals and licence requirements. No water will be discharged from the site without written approval of the Contractor’s Environmental Manager (or delegate). This is to form a HOLD POINT.

f. The following compliance records will be kept by the Principal Contractors:

i. Copies of current ESCPs for all active construction sites;

ii. Records of soil and water inspections undertaken;

iii. Records of testing of any water prior to discharge; and

iv. Records of the release of the hold point to discharge water from the construction site to the receiving environment.

g. The following water resources management objectives will apply to the construction of the project:

i. Minimise demand for, and use of potable water;

ii. Maximise opportunities for water re-use from captured stormwater, wastewater and groundwater;

iii. Examples of measures to minimise potable water consumption include:

- Water efficient controls, fixtures and fittings in temporary facilities;
- Collecting, treating and reusing water generated in tunnelling operations, concrete batching and casting facility processes;
- Using recycled water or treated water from onsite sources in the formulation of concrete;
- Harvesting and reusing rainwater from roofs of temporary facilities;
- Using water from recycled water networks;
- Collecting, treating and reusing groundwater and stormwater;
- Using water efficient construction methods and equipment; and
- Providing designated sealed areas for equipment wash down.

12.3 Soil and Water Mitigation

a. Examples of surface water and flooding mitigation measures include:

i. Clean water will be diverted around disturbed site areas, stockpiles and contaminated areas;

ii. Control measures will be installed downstream of works, stockpiles and other disturbed areas;

iii. Exposed surfaces will be minimised, and stabilised / revegetated as soon feasible and reasonable upon completion of construction;

iv. Dangerous good and hazardous materials storage will be within bunded areas with a capacity of 110 per cent of the maximum single stored volume;

v. Chemicals will be stored and handled in accordance with relevant Australian standards such as:

- AS 1940-2004 The storage and handling of flammable and combustible liquids
- AS/NZS 4452:1997 The storage and handling of toxic substances
- AS/NZS 5026:2012 The storage and handling of Class 4 dangerous goods
- AS/NZS 1547:2012 On-site domestic wastewater management

vi. Spill kits will be provided at the batch plants, storage areas and main work sites;

vii. A protocol will be developed and implemented to respond to and remedy leaks or spills.

viii. A remedial action plan and unexpected finds protocol would be established to facilitate the quarantining, isolation and remediation of contamination identified throughout the construction programme. Any asbestos identified on site would be managed in accordance with applicable regulatory requirements.

13. Air Quality

Figure 11 - Dust Mitigation at Norwest Station Site

13.1 Air Quality Management Objectives

a. The following air quality management objectives will apply to construction:

i. Minimise gaseous and particulate pollutant emissions from construction activities as far as feasible and reasonable; and

ii. Identify and control potential dust and air pollutant sources.

13.2 Air Quality Management Implementation

a. Principal Contractors will develop and implement an Air Quality Management Plan which will include, as a minimum:

i. The air quality mitigation measures as detailed in the environmental approval documentation;

ii. The requirements of any approval and applicable licence conditions;

iii. Site plans or maps indicating locations of sensitive receivers and key air quality / dust controls;

iv. The responsibilities of key project personnel with respect to the implementation of the plan;

v. Air quality and dust monitoring requirements; and

vi. Compliance record generation and management.

b. Air quality and dust monitoring will involve the following as a minimum:

i. Meteorological conditions will be monitored and appropriate responses will be organised and undertaken periodically by the Principal Contractor;

ii. Regular visual monitoring of dust generation from work zones; and

iii. Monitoring emissions from plant and construction vehicles to ensure they have appropriate emission controls and are being maintained correctly.

c. The following compliance records will be kept by the Principal Contractor:

i. Records of any meteorological condition monitoring;

ii. Records of any management measures implemented as a result of adverse, windy weather conditions; and

iii. Records of air quality and dust inspections undertaken.

13.3 Air Quality Mitigation

a. Examples of air quality mitigation measures include:

i. Plant and equipment will be serviced and maintained in good working order to reduce unnecessary emissions from exhaust fumes;

ii. Water suppression will be used for active earthwork areas, stockpiles, unsurfaced haul roads and loads of soil being transported to reduce wind-blown dust emissions;

iii. Wheel-wash facilities or rumble grids will be provided and used near the site exit points, as appropriate; and

iv. Dust extraction and filtration systems will be installed for tunnel excavation works and deep excavation with limited surface exposure.

14. Waste Management

14.1 Waste Objectives

a. The following waste objectives will apply to construction:

i. Minimise waste throughout the project life-cycle; and

ii. Waste management strategies will be implemented in accordance with the *Waste Avoidance and Resource Recovery Act 2001* management hierarchy as follows:

- Avoidance of unnecessary resource consumption;
- Resource recovery (including reuse, reprocessing, recycling and energy recovery); and
- Disposal.

b. Targets for the recovery, recycling or reuse of construction waste, and beneficial reuse of spoil will be provided by the Principal Contractor.

14.2 Waste Implementation

a. Principal Contractors will develop and implement a Waste Management Plan which will include as a minimum:

i. The waste management mitigation measures as detailed in the environmental approval documentation;

ii. The responsibilities of key project personnel with respect to the implementation of the plan;

iii. Waste management monitoring requirements;

iv. A procedure for the assessment, classification, management and disposal of waste in accordance with Waste Classification Guidelines; and

v. Compliance record generation and management.

b. Principal Contractors will undertake the following waste monitoring as a minimum:

i. Weekly inspections will include checking on the waste storage facilities on site; and

ii. All waste removed from the site will be appropriately tracked from ‘cradle to grave’ using waste tracking dockets.

c. Principal Contractors will report all necessary waste and purchasing information to Sydney Metro as required for Sydney Metro to fulfil their WRAPP reporting requirements.

d. Compliance records will be retained by the Principal Contractors in relation to waste management including records of inspections and waste dockets for all waste removed from the site.

14.3 Waste Mitigation

a. Examples of waste management mitigation measures include:

i. All waste materials removed from the sites will be directed to an appropriately licensed waste management facility;

ii. The use of raw materials (noise hoarding, site fencing, etc...) will be reused or shared, between sites and between construction contractors where feasible and reasonable; and

iii. Recyclable wastes, including paper at site offices, will be stored separately from other wastes.

15. Acronyms

Acronym	
CEMP	Construction Environmental Management Plan
CNVS	Construction Noise and Vibration Strategy
DP&E	Department of Planning and Environment (Formerly Department of Planning and Infrastructure)
EIS	Environmental Impact Statement
EMF	Environmental Management Framework
EMS	Environmental Management System
EPA	Environment Protection Authority
EP&A Act	Environmental Planning and Assessment Act 1979
EPL	Environment Protection Licence (issued by EPA under the POEO Act)
ER	Environmental Representative
ESCP	Erosion and Sediment Control Plan
NOHSC	National Occupational Health and Safety Commission
OEH	Office of Environment and Heritage (Formerly DECCW)
POEO Act	Protection of the Environment Operation Act 1997
RMS	Roads and Maritime Service (Formerly RTA)
TBM	Tunnel Boring Machine
TfNSW	Transport for NSW

Appendix A – Environment and Sustainability Policy

NSW GOVERNMENT

Transport Environment and Sustainability Policy

Transport is a key enabler of economic and social activity. We are committed to delivering transport which contributes to economic prosperity and social inclusion in an environmentally responsible and sustainable manner, consistent with the Future Transport Strategy 2056.

Transport for NSW's activities cover the whole State and its infrastructure will last for generations to come. We have a duty to undertake our activities in the interest of the greater good, moving beyond compliance, and being a genuine leader in environment and sustainability performance.

We will work towards achieving this for NSW by:

- Leadership – contributing to and influencing the strategic environment and sustainability agenda of the NSW Government
- Environmental protection – being accountable for addressing and minimising the environmental impacts of our activities to satisfy the expectations and legislative requirements of the NSW Government and community
- Energy and carbon – improving energy efficiency and working towards net zero carbon emissions
- Resilience – embedding climate risk and resilience considerations in our activities
- Sustainable procurement – procuring and delivering sustainable, efficient and cost effective transport options, including responsible supply chains
- Whole of life – considering whole of life benefits and impacts from our activities across all life cycle stages - demand/need, plan, acquire, operate/maintain and disposal
- Social – recognising the social impacts and benefits of our activities, and working for healthy liveable communities
- Awareness – raising the awareness and capacity of our workforce to be accountable for implementing the Policy through their activities to achieve enhanced environmental outcomes and a culture of environmental responsibility
- Communication – communicating openly, responsively and empathetically with our customers, partners and stakeholders on environmental matters and report on our performance

This Policy applies to the agencies listed below:

- Transport for NSW
- Department of Transport
- Sydney Trains
- NSW Trains
- RailCorp
- State Transit Authority
- Sydney Metro

This Policy applies to permanent, temporary and casual staff of the above agencies, staff seconded from another organisation and contingent workers including labour hire, professional services contractors and consultants.

Rodd Staples
Secretary
13 January 2020

Transport for NSW T 8202 2200 | F 8202 2209
18 Lee Street, Chippendale NSW 2008 | PO Box K659, Haymarket NSW 1240

CP20000

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Appendix E

Sydney Metro Construction Noise and Vibration Strategy

Integrated Management System

Sydney Metro Construction Noise and Vibration Standard

Report No 610.14213-R3

Sydney Metro Integrated Management System (IMS)

Applicable to:	Sydney Metro West
Author:	Sydney Metro
System owner:	Sydney Metro
Status:	Final
Version:	4.0
Date of issue:	16/03/2020
Security classification:	Open Access

Table of Contents

1. PURPOSE AND SCOPE

This Standard applies to all Sydney Metro projects and covers all elements of the project lifecycle with the exception of operational activities. Additionally, this standard only applies to design activities insofar as design decisions affect construction-related noise and vibration impacts (such as route selection, at-grade or underground rail systems and tunnel depth).

1.1. Distribution and Use

This document may be used in the development of, or referred to in:

- Environmental Impact Assessment documents;
- Design and construction environmental management documents;
- Contract documents; or
- Approvals and licences (subject to the agreement of the relevant regulatory authority).

1.2. Strategic Objectives

Sydney Metro recognise that sources of Noise and Vibration originating from our activities have a significant impact to local communities. We have adopted several strategic objectives to understand and manage these impacts:

- Applying a risk-based approach and implementing an appropriate hierarchy of controls at each stage of the project lifecycle to minimise impacts.
- Building an approach to reducing Noise and Vibration risks within each stage of the project lifecycle through active collaboration with internal and external stakeholders.
- Developing a clear understanding of our Construction Noise and Vibration Impacts and applying best practice management techniques.
- Valuing genuine community engagement that is sensitive to the needs and expectations of local communities and businesses.
- Committing to the continual improvement of Noise and Vibration management.

1.3. Construction Noise and Vibration Terminology

Decibel (dB): Decibel, often expressed as an 'A – weighted' sound pressure level, which has been found to correlate well with human subjective reactions to moderate noise levels. For steady, broadband noise, an increase or decrease of approximately 10 dB corresponds to a subjective doubling or halving of the loudness and a change of 2 to 3 dB is subjectively barely perceptible.

Sound Pressure Level (SPL or L_p): Expressed in dB, it is the level of noise measured by a standard sound level meter. It must be accompanied by a description of the measurement distance from the source, if used in any noise predictions or calculations. In a free field (eg outside on flat ground), each doubling of distance results in approximately 6dB reduction in airborne sound pressure level due to distance attenuation.

Sound Power Level (SWL or L_w): Expressed in dB, it is the total acoustic energy radiated by a plant or equipment to the environment. Sound power level is independent of distance from the source of the noise.

Rating Background Level (RBL): Rating background level is the overall single-figure background level representing each assessment period (day/evening/night) over a measurement period. As defined in the EPA "Noise Policy for Industry" dated October 2017.

Vibration: Vibration may be expressed in terms of displacement, velocity and acceleration. Velocity (mm/s), acceleration (m/s^2) and Vibration Dose Value (VDV, m/s$^{1.75}$) are most commonly used when assessing human comfort issues respectively. Peak Particle Velocity (PPV, mm/s) is typically used to assess impacts on structures.

Ground borne noise and Structure-borne noise: The transmission of noise energy as vibration travelling through the ground and / or structures and re-radiated as audible noise.

The three primary noise metrics used to describe construction noise emissions in the modelling and assessments are:

$L_{A1(1minute)}$ The typical 'maximum noise level for an event', used in the assessment of potential sleep disturbance during night-time periods. Alternatively, assessment may be conducted using the L_{Amax} or maximum noise level

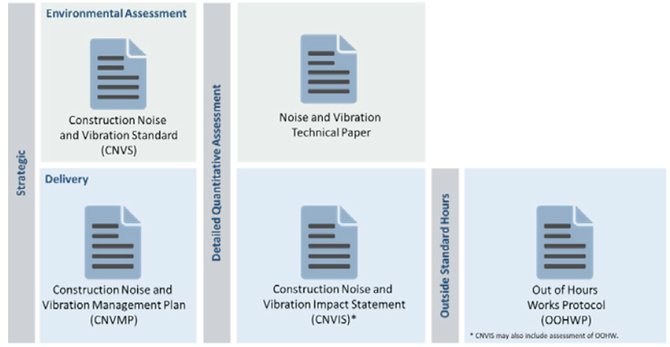
$L_{Aeq(15minute)}$ The 'energy average noise level' evaluated over a 15-minute period. This parameter is used to assess the potential construction noise impacts.

L_{A90} The 'background noise level' in the absence of construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods respectively. The $L_{Aeq(15minute)}$ construction noise management levels are based on the L_{A90} background noise levels.

1.4. Documentation Framework

There are five main documents (**Figure 1**) which comprise the noise and vibration documentation framework. Together they provide a comprehensive approach to the assessment and delivery of works which generate noise and vibration while mitigating the impacts.

Figure 1 - Noise and Vibration Documentation Framework



1.4.1. Construction Noise and Vibration Standard (CNVS)

The CNVS (this document) establishes a consistent strategy for the assessment, mitigation and monitoring of noise and vibration generated by construction activities. It defines a minimum standard for managing noise and vibration impacts that considers currently best practice guidelines and other regulatory requirements. It is included in all Sydney Metro Environmental Assessments.

1.4.2. Construction Noise and Vibration Management Plan (CNVMP)

Where works will cause significant noise and vibration impacts upon sensitive receivers Principal Contractors will be required to prepare and implement CNVMP's. These documents form part of the CEMP suite of documentation.

The function of the CNVMP is to provide a strategic overview of how the requirements of the CNVS will be applied to activities or locations under the control of the Principal Contractor. This overview includes an outline of how quantitative noise and vibration assessments will be undertaken across worksites and/or activities, and an indicative construction schedule.

The CNVMP also links to Community and Stakeholder consultation processes and explains how commercial and residential receivers will be consulted throughout the construction phase with regard to mitigating impacts upon them.

Further detail on the requirements for CNVMP's can be found in Chapter 8 of the Construction Environmental Management Framework.

1.4.3. Noise and Vibration Technical Paper

The Noise and Vibration Technical Paper is produced as part of the Environmental Assessment carried out in the planning phase of Sydney Metro projects. This document is a Quantitative Noise Assessment based upon the information known at the time the assessment is undertaken and makes recommendations for mitigation.

Typically it will include a range of assumptions on equipment lists and construction methodologies on the basis of which the impact upon sensitive receivers will be determined. As such, these Quantitative Assessments are generally conservative and may over predict actual impacts during construction. Where noise and vibration impacts are anticipated to be minor, this document may be used to set Noise Management Levels and mitigation measures during delivery without the need for secondary Construction Noise and Vibration Impact Statements (**Section 1.4.4**).

1.4.4. Construction Noise and Vibration Impact Statements (CNVIS)

While quantitative noise assessments are documented in environmental assessments, Principal Contractors will have a better understanding of the exact equipment list and construction methodology to be used in carrying out their works. As a result, certain assumptions made in the Noise and Vibration Technical Paper can be clarified in a secondary quantitative assessment undertaken by the Principal Contractor. These documents are called Construction Noise and Vibration Impact Statements.

They are typically written with a focus on specific activities or locations and consider works carried out inside and outside of standard working hours.

Where 24/7 works are approved under an SSI approval, a separate CNVIS should be carried out specifically for these activities.

Work described in a CNVIS's cannot proceed until the CNVIS is approved by an Acoustic Advisor appointed under an SSI approval, or where there is no SSI approval, approved by Sydney Metro. Should the scope of work or the timing of works change, the Principal contractor must update the CNVIS and subsequent approval for the new version. See **Section 3.2** for more detail on CNVIS's.

1.4.5. Out of Hours Works Protocols (OOHW)

In the event that work needs to occur outside standard working hours, and the activity is not already approved to be carried out during the proposed timeframe in a CNVIS, the OOHW Protocol may be used to assess the impact and approve the activity.

2. NOISE AND VIBRATION GUIDELINES

2.1. Construction Hours

Where possible, works will be completed during the standard day time construction hours of Monday to Friday 7.00 am to 6.00 pm and Saturdays 8.00 am to 1.00 pm. However, the nature of infrastructure projects means evening and night works are likely to be required throughout construction due to various considerations including avoiding sensitive periods for sensitive receivers, delivery of oversized plant or structures, emergency works, or other activities that require the temporary closure of roads. In these situations the impacts of works outside standard construction hours will be approved via the Out of Hours Works Protocol (OOHW).

These assessments are usually carried out during construction as the need arises and supplementary to other quantitative noise assessments which are documented in either the project's Environmental Assessment, or a Construction Noise & Vibration Impact Statement (CNVIS).

In other cases there may be a need to assess activities that require 24 hour working for a significant portion of the construction period. Examples of construction scenarios that will require 24/7 works include:

- Excavation of station shafts;
- Truck movements to manage spoil;
- Excavation of the station caverns;
- Operation of tunnel boring machines; or
- Spoil removal and transport from site.

Where the need for 24 hours works arises post approval, a consistency assessment would be undertaken to determine if a modification to the planning approval is required.

2.2. Construction Noise Management Levels (NML)

Construction Noise Management Levels (NML) for all Sydney Metro projects will be determined in accordance with the DECCW's "Interim Construction Noise Guideline" dated July 2009 (ICNG, 2009). The following sections supplement this guideline with respect to Sydney Metro projects.

2.2.1. Residences and Other Sensitive Land Uses

Noise management levels and how they are applied is set out in **Table 1.** This approach is intended to provide respite for residents exposed to excessive construction noise outside the recommended standard hours whilst allowing construction to occur without undue constraints during the recommended standard hours.

The rating background level (RBL) is used when determining the management level and is the overall single-figure background noise level measured in each relevant assessment period (as defined in the EPA "Noise policy for Industry" dated January 2017).

Sydney Metro – Integrated Management System (IMS)
(Uncontrolled when printed)

Table 1: Noise Management Levels for different times of day and considerations on their application

Time of Day	Noise Management Level $L_{Aeq\ (15minute)}$[1]	Management Considerations
Recommended standard hours: Monday to Friday 7.00 am to 6.00 pm Saturday 8.00 am to 1.00 pm	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent would apply all feasible and reasonable work practices to minimise noise. The proponent would also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the proponent would consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent would communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent would apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dBA above the noise affected level, the proponent would negotiate with the community. For guidance on negotiating agreements see Section 7.2.2 of the ICNG.

Note 1: Noise levels apply at the property boundary that is most exposed to construction noise. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence.

Management levels for noise near properties which are sensitive to Noise Impacts are presented in **Table 2.** These values are set and based on the principle that the characteristic activities for each would not be unduly disturbed. The noise management levels apply only when the property is being used, for example, classrooms during school hours. Internal noise levels are to be assessed at the centre of the occupied room. External noise levels are to be assessed at the most-affected point within 50 m of the area boundary.

Table 2: Noise Management Levels for certain sensitive receivers

Land Use	Management Level, $L_{Aeq(15minute)}$ (Applies When Land Use is being Utilised)
Classrooms at schools and other educational institutions	Internal noise level 45 dB
Hospital wards and operating theatres	Internal noise level 45 dB
Places of worship	Internal noise level 45 dB
Active recreation areas (such as parks and sports grounds or playgrounds)	External noise level 65 dB
Passive recreation areas (such as outdoor grounds used for teaching, outdoor cafes or restaurants)	External noise level 60 dB

Other noise-sensitive businesses require separate specific noise goals and it is suggested in the ICNG that the internal construction noise levels at these premises are to be referenced to the 'maximum' internal levels presented in AS 2107. Recommended 'maximum' internal noise levels from AS 2107 are reproduced in **Table 3** for other sensitive receiver types.

However, the ICNG and AS 2107 do not provide specific criteria for childcare centres. Childcare centres generally have internal play areas and sleep areas. The Association of Australian Acoustical Consultants (AAAC) Technical Guideline on Child Care Centre Noise Assessments provides criteria for these land uses. Based on this guideline an $L_{Aeq\ (1hour)}$ of 55 dBA for external play areas and $L_{Aeq\ (1hour)}$ of 40 dBA for indoor play areas and sleeping areas would be adopted.

Table 3 AS 2107 Recommended Maximum Internal Noise Levels

Land Use	Time Period	AS 2107 Classification	Recommended "Maximum" Internal LAeq (dBA)
Hotel	Daytime & Evening	Bars and Lounges	50 dB
	Night-time	Sleeping Areas: - Hotels near major roads	40 dB
Café	When in use	Coffee bar	50 dB
Bar/Restaurant	When in use	Bars and Lounges / Restaurant	50 dB
Library	When in use	Reading Areas	45 dB
Recording Studio	When in use	Music Recording Studios	25 dB
Theatre / Auditorium	When in use	Drama Theatres	30 dB

2.2.2. Commercial and Industrial Premises

Due to the broad range of sensitivities that commercial or industrial land can have to noise from construction, the process of defining Noise Management Levels is separated into three categories. The external noise levels would be assessed at the most-affected occupied point of the premises:

- Industrial premises (external): 75 dB $L_{Aeq(15minute)}$
- Offices, retail outlets (external): 70 dB $L_{Aeq(15minute)}$
- Other businesses that may be very sensitive to noise, where the noise level is project specific as discussed below.

Examples of other noise-sensitive businesses are theatres, studios and child care centres. The proponent would undertake a special investigation to determine suitable noise levels on a project-by-project basis; the recommended internal noise levels presented in Table 1 of AS 2107 "Acoustics - Recommended design sound levels and reverberation times for building interiors" (Standards Australia 2000) may assist in determining relevant noise levels; however, an acoustic consultant would be engaged in order to determine corresponding external noise levels based on the published internal noise levels. The proponent would assess construction noise levels for the project, and consult with occupants of commercial and industrial premises prior to lodging an application where required. During construction, the proponent would regularly update the occupants of the commercial and industrial premises regarding noise levels and hours of work.

2.3. Ground-Borne Vibration

The effects of vibration in buildings can be divided into three main categories; those in which the occupants or users of the building are inconvenienced or possibly disturbed, those where the building contents may be affected and those in which the integrity of the building or the structure itself may be prejudiced.

2.3.1. Human Comfort Vibration

The DECCW's "Assessing Vibration: a technical guideline" dated February 2006 (DEC, 2006) recommends the use of BS 6472-1992 for the purpose of assessing vibration in relation to human comfort.

British Standard 6472-1992 "*Guide to evaluation of human exposure to vibration in building*" nominates guideline values for various categories of disturbance, the most stringent of which are the levels of building vibration associated with a "low probability of adverse comment" from occupants.

BS 6472-1992 provides guideline values for continuous, transient and intermittent events that are based on a Vibration Dose Value (VDV), rather than a continuous vibration level. The vibration dose value is dependent upon the level and duration of the short term vibration event, as well as the number of events occurring during the daytime or night-time period.

The vibration dose values recommended in BS 6472-1992 for which various levels of adverse comment from occupants may be expected are presented in **Table 4**.

Table 4: Vibration Dose Value Ranges which Might Result in Various Probabilities of Adverse Comment within Residential Buildings

Place and Time	Low Probability of Adverse Comment ($m/s^{1.75}$)	Adverse Comment Possible ($m/s^{1.75}$)	Adverse Comment Probable ($m/s^{1.75}$)
Residential buildings 16 hr day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hr night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

Note: For offices and workshops, multiplying factors of 2 and 4 respectively would be applied to the above vibration dose value ranges for a 16 hr day.

2.3.2. Structural Damage Vibration

Most commonly specified 'safe' structural vibration limits are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have potential to cause damage to the main structure.

In terms of the most recent relevant vibration damage goals, Australian Standard AS 2187: Part 2-2006 'Explosives - Storage and Use - Part 2: Use of Explosives' recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 'Evaluation and measurement for vibration in buildings Part 2' as they "are applicable to Australian conditions".

The Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration that are considered in the standard include demolition, blasting (carried out during mineral extraction or construction excavation), piling, ground treatments (e.g. compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

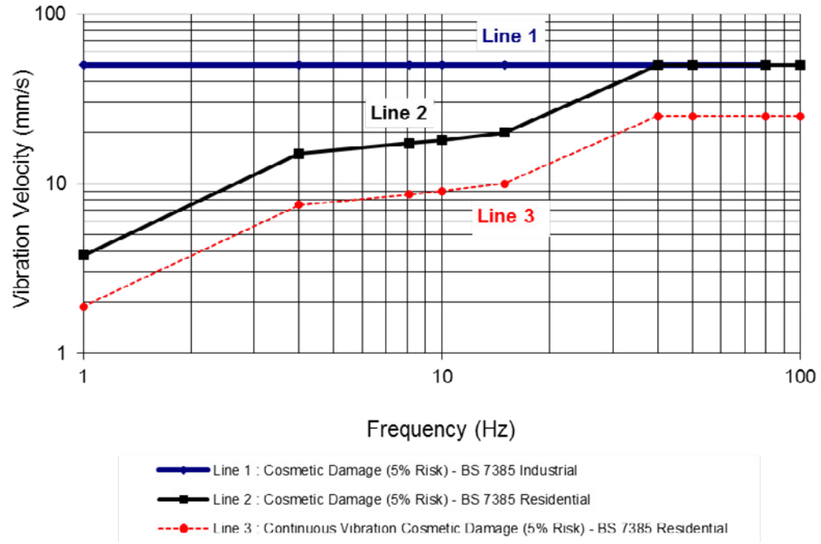
2.3.3. Cosmetic Damage Vibration

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in **Table 5** and graphically in **Figure 2**.

Table 5: Transient Vibration Guide Values - Minimal Risk of Cosmetic Damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Figure 2: Graph of Transient Vibration Guide Values for Cosmetic Damage



The Standard goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in **Table 5**, and major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in the Standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in **Table 5** would not be reduced for fatigue considerations.

In order to assess the likelihood of cosmetic damage due to vibration, AS2187 specifies that vibration measured would be undertaken at the base of the building and the highest of the orthogonal vibration components (transverse, longitudinal and vertical directions) would be compared with the guidance curves presented in **Figure 2**.

It is noteworthy that extra to the guide values nominated in **Table 5**, the standard states that:

> *"Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."*

Also that:

> *"A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive."*

2.4. General Vibration Screening Criterion

The Standard states that the guide values in **Table 5** relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings.

Where the dynamic loading caused by continuous vibration may give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in **Table 5** may need to be reduced by up to 50%.

Note: rock breaking/hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures (e.g. residences) and it may therefore be appropriate to reduce the transient values by 50%.

Therefore for most construction activities involving intermittent vibration sources such as rock breakers, piling rigs, vibratory rollers, excavators and the like, the predominant vibration energy occurs at frequencies greater than 4 Hz (and usually in the 10 Hz to 100 Hz range). On this basis, a conservative vibration damage screening level per receiver type is given below:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s

At locations where the predicted and/or measured vibration levels are greater than shown above (peak component particle velocity), a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure would be required to determine the applicable safe vibration level.

2.5. Guidelines for Vibration Sensitive and Special Structures

2.5.1. Heritage

Heritage buildings and structures would be assessed as per the screening criteria in **Section 2.4** as they should not be assumed to be more sensitive to vibration unless they are found to be structurally unsound. If a heritage building or structure is found to be structurally unsound (following inspection) a more conservative cosmetic damage criteria of 2.5 mm/s peak component particle velocity (from DIN 4150) would be considered.

2.5.2. Sensitive Scientific and Medical Equipment

Some scientific equipment (e.g. electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort.

Where it has been identified that vibration sensitive scientific and/or medical instruments are likely to be in use inside the premises of an identified vibration sensitive receiver, objectives for the satisfactory operation of the instrument would be sourced from manufacturer's data. Where manufacturer's data is not available, generic vibration criterion (VC) curves as published by the Society of Photo-Optical Instrumentation Engineers (Colin G. Gordon - 28 September 1999) may be adopted as vibration goals. These generic VC curves are presented below in **Table 6** and **Figure 3**.

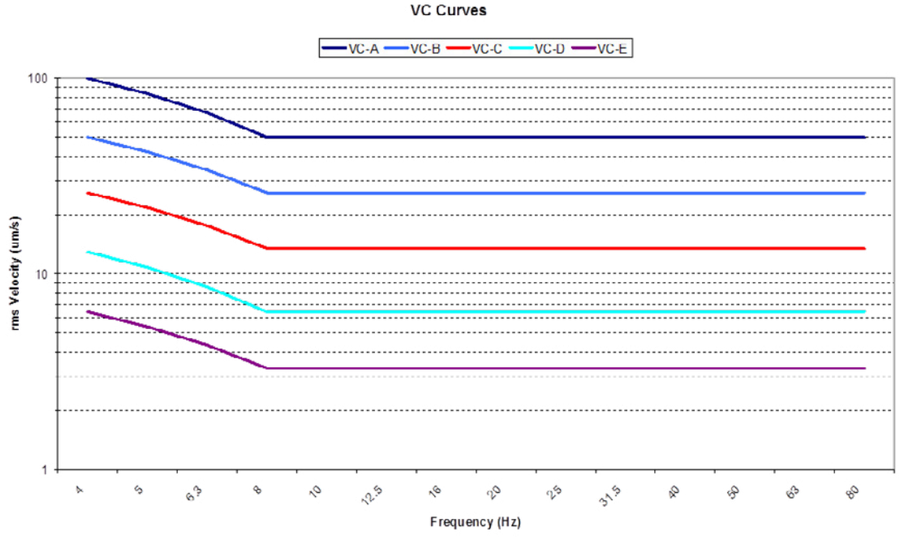
Table 6: Application and Interpretation of the Generic Vibration Criterion (VC) Curves (as shown in Figure 3)

Criterion Curve	Max Level (µm/sec, rms)[1]	Detail Size (microns)[2]	Description of Use
VC-A	50	8	Adequate in most instances for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc.
VC-B	25	3	An appropriate standard for optical microscopes to 1000X, inspection and lithography equipment (including steppers) to 3 micron line widths.
VC-C	12.5	1	A good standard for most lithography and inspection equipment to 1 micron detail size.
VC-D	6	0.3	Suitable in most instances for the most demanding equipment including electron microscopes (TEMs and SEMs) and E-Beam systems, operating to the limits of their capability.
VC-E	3	0.1	A difficult criterion to achieve in most instances. Assumed to be adequate for the most demanding of sensitive systems including long path, laser-based, small target systems and other systems requiring extraordinary dynamic stability.

Note 1: As measured in one-third octave bands of frequency over the frequency range 8 to 100 Hz.

Note 2: The detail size refers to the line widths for microelectronics fabrication, the particle (cell) size for medical and pharmaceutical research, etc. The values given take into account the observation requirements of many items depend upon the detail size of the process.

Figure 3: Vibration Criterion (VC) Curves



2.5.3. Other Vibration Sensitive Structures and Utilities

Where structures and utilities are encountered which may be considered to be particularly sensitive to vibration, a vibration goal which is more stringent than structural damage goals presented in **Section 2.4** may need to be adopted. Examples of such structures and utilities include:

- Tunnels
- Gas pipelines
- Fibre optic cables

Specific vibration goals would be determined on a case-by-case basis. An acoustic consultant would be engaged by the construction contractor and would liaise with the structure or utility's owner in order to determine acceptable vibration levels.

2.6. Vibration and Overpressure from Blasting

The DECCW's ICNG recommends that vibration and overpressure from blasting be assessed against the levels presented in the Australian and New Zealand Environment Council's (ANZECC) Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZECC, 1990).

The criteria set by this standard are targeted at operations that occur for long periods of time such as those at mining sites and hence are targeted at protecting human comfort vibration levels. As a result the vibration levels are conservative and can introduce unnecessary constraints when applied to construction projects which typically occur for much shorter time periods. Recent NSW infrastructure project approvals have recognised the restrictive nature of these blasting criteria when applied to construction projects and have therefore allowed the following vibration and overpressure limits:

- Vibration (PPV): 25 mm/s
- Overpressure: 125 dBL

These upper limits are deemed acceptable where the proponent has a written agreement with the relevant landowner to exceed the criteria and the Secretary has approved the terms of the written agreement. These upper limits to vibration and overpressure are intended to target the protection of building structures from cosmetic damage rather than human comfort criteria as construction works are considered short-term.

2.7. Ground-Borne (Regenerated) Noise

Ground-borne (regenerated) noise is noise generated by vibration transmitted through the ground into a structure. Ground-borne noise caused, for example by underground works such as tunnelling, can be more noticeable than airborne noise. The following ground-borne noise levels for residences are nominated in the ICNG and indicate when management actions would be implemented. These levels recognise the temporary nature of construction and are only applicable when ground-borne noise levels are higher than airborne noise levels.

The ground-borne noise management levels are given below:

- Day (7.00 am to 6.00pm)
  Internal Residential: 45 dB $L_{Aeq(15minute)}$
  Internal Commercial: 50 dB $L_{Aeq(15minute)}$
- Evening (6.00 pm to 10.00 pm)
  Internal Residential: 40 dB $L_{Aeq(15minute)}$
- Night-time (10.00 pm to 7.00 am)
  Internal Residential: 35 dB $L_{Aeq(15minute)}$

The daytime criteria are applicable to both residential and commercial receivers, whereas the evening and night-time criteria are only applicable to residential receivers.

The internal noise levels are to be assessed at the centre of the most-affected habitable room. For a limited number of discrete, ongoing ground-borne noise events, such as drilling or rock-hammering, The L_{Amax} noise descriptor using a slow response on the sound level meter may be better than the L_{Aeq} noise descriptor (15 min) in describing the noise impacts. The level of mitigation of ground-borne noise would depend on the extent of impacts and also on the scale and duration of works. Any restriction on the days when construction work is allowed would take into account whether the community:

- Has identified times of day when they are more sensitive to noise (for example Sundays or public holidays).
- Is prepared to accept a longer construction duration in exchange for days of respite.

2.8. Traffic Noise Assessment Goals

When trucks and other vehicles are operating within the boundaries of the various construction sites, road vehicle noise contributions are included in the overall predicted $L_{Aeq(15minute)}$ construction site noise emissions. When construction related traffic moves onto the public road network a different noise assessment methodology is appropriate, as vehicle movements would be regarded as 'additional road traffic' rather than as part of the construction site.

The ICNG does not provide specific guidance in relation to acceptable noise levels associated with construction traffic. For assessment purposes, guidance is taken from the RNP.

One of the objectives of the RNP is to apply relevant permissible noise increase criteria to protect sensitive receivers against excessive decreases in amenity as the result of a proposal. In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

On this basis, construction traffic NMLs set at 2 dB above the existing road traffic noise levels during the daytime and night-time periods are considered appropriate to identify the onset of potential noise impacts. Where the road traffic noise levels are predicted to increase by more than 2 dB as a result of construction traffic, consideration would be given to applying feasible and reasonable noise mitigation measures to reduce the potential noise impacts and preserve acoustic amenity.

In considering feasible and reasonable mitigation measures where the relevant noise increase is greater than 2 dB, consideration would also be given to the actual noise levels associated with construction traffic and whether or not these levels comply with the following road traffic noise criteria in the RNP:

- 60 dB $L_{Aeq(15hour)}$ day and 55 dB $L_{Aeq(9hour)}$ night for existing freeway/ arterial/ sub-arterial roads.

- 55 dB $L_{Aeq(1hour)}$ day and 50 dB $L_{Aeq(1hour)}$ night for existing local roads.

2.8.1. Sleep Disturbance and Maximum Noise Events

In addition to the current legislative guidance on potential sleep disturbance outlined in Section 5.10 the RNP refers to Practice Note 3 of the ENMM for specific impacts from road traffic. The ENMM recommends an evaluation of the number and distribution of night-time pass by events where the L_{AFmax} - $L_{Aeq(1hour)}$ difference is greater than 15 dB, and the maximum noise level of that event is greater than 65 dB L_{Amax}.

On the basis of the current guidance:

- External sleep disturbance screening criterion of RBL + 15 dB
- External sleep disturbance criterion of 65 dB L_{Amax} (assuming open windows).

2.9. Sleep Disturbance and Maximum Noise Level Events

The DECCW's ECRTN and the Road and Traffic Authority's (RTA's) 'Environmental Noise Management Manual' (ENMM) provide guidance as to the likelihood of sleep disturbance resulting from maximum noise level events (mainly associated with heavy vehicle movements). The ECRTN points out the following:

"There are no universally accepted criteria governing the likelihood of sleep disturbance. In other words, at the current level of understanding, it is not possible to establish absolute noise levels that correlate to levels of sleep disturbance (for all or even a majority of people)."

Notwithstanding the ECRTN/ENMM suggests that:

- Maximum internal noise levels below 50 dB to 55 dB L_{Amax} are unlikely to cause awakening reactions.
- One or two events per night, with maximum internal noise levels of 65 dB to 70 dB LAmax, are not likely to affect health and wellbeing significantly.
- At locations where road traffic is continuous rather than intermittent, the L_{Aeq}(9hour) target noise level should sufficiently account for sleep disturbance impacts.
- Where the emergence of LAmax noise levels over the ambient L_{Aeq} noise level is greater than 15 dB, the L_{Aeq} criterion may not sufficiently account for sleep disturbance impacts.

A maximum noise event can be defined as any pass by for which the difference in the L_{Amax} and L_{Aeq}(1Hour) noise levels is greater than 15 dB. Furthermore, the ECRTN recommends that the assessment of sleep disturbance should include a consideration of the maximum noise level exceedances occurring during the night-time period and the emergence of these exceedances above the ambient noise level.

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3. CONSTRUCTION NOISE & VIBRATION ASSESSMENT METHODOLOGY

3.1. General Assessment Procedure

There are planning processes at all levels of government that may apply to works carried out by Sydney Metro, some of these processes (particularly State and Federal planning processes) require a detailed Environmental Assessment of the construction phases for the proposal be completed. As construction contractors are not typically appointed until later in a project's timeline, the exact construction methodology they will use for a particular project may not be known when the Environmental Assessment is being carried out.

It is expected that conservative assumptions would be incorporated at early stages of the project approval process and these must not unduly restrict innovation (e.g. low noise and vibration construction methods or innovative technologies) at later design stages.

For construction works approved under Division 5.2 of the EP&A Act, further quantitative noise and vibration assessments will be undertaken for activities and/or locations where work will occur. These further assessments are called Construction Noise and Vibration Impact Statements (CNVIS) and works subject to these assessments will not proceed until they have been approved by an Acoustic Advisor appointed under an SSI approval, or where there is no SSI approval, approved by Sydney Metro.

The purpose of a CNVIS is to provide relatively accurate predictions of noise and vibration impacts in comparison to potential construction scenarios identified in Environmental Assessments. To achieve this they are undertaken immediately prior to construction by construction teams who are in control of the activity or location. The CNVIS's ensure that accurate impacts are defined, noise management levels are achieved wherever possible, works scheduling is considered, and sensitive receivers are aware of the approach to minimising impacts upon them.

Other works such as non-construction works approved under Division 5.2 of the EP&A Act, or works approved through alternative approval pathways will by default rely upon the Noise and Vibration assessment in the relevant Environmental Assessment documentation. Where the Environmental Assessment determines that noise or vibration impacts are high for works approved under Division 5.1 of the EP&A Act the Environmental Assessment will require a CNVIS to be carried out prior to the commencement of works for the relevant activity or location.

In all cases the overriding objective is to reduce noise and vibration impacts to, or below, Noise Management Levels using Standard Mitigation techniques so that the reliance upon additional mitigation measures (refer to **Section 5)** is minimised.

Table 7: Summary of Assessment Detail Required During the Various Stages of the Project

Assessment Input	Environmental Impact Statement / Environmental Assessment	In Delivery
Construction Scenarios / Equipment List	Construction scenarios defined by project team, based on potential construction methodologies known at the time	Construction scenarios defined by construction team. These are expected to include finalised equipment lists, itemising the realistic worst-case plant proposed to be used at any one time, and in any one location

Assessment Input	Environmental Impact Statement / Environmental Assessment	In Delivery
Modelled works location	Works location by scenario (or group of scenarios) i.e. different locations for different works	Works location by works scenario i.e. specific locations for each works
Background noise monitoring	Background noise monitoring required to determine RBL at locations representative of worst-affected receiver areas adjacent to the works areas	Supplementary noise monitoring required to determine RBL at locations representative of worst-affected receiver areas adjacent to the works areas where noise survey data is not current (i.e. more than 5 years old)
Study Area	The study area must, as a minimum, include receivers subjected to predicted $L_{Aeq(15minute)}$ ≥ RBL+5dB for the applicable time period. Vibration level predictions up to 100 m	Predict noise and vibration levels to the sensitive receivers within the area surrounding the works, to include all receivers where the $L_{Aeq(15minute)}$ ≥ RBL +5dB and the vibration screening criteria are exceeded during the applicable time periods.
Assessment of mitigation	Demonstration that assessment of this stage includes reasonable and feasible mitigation measures	Based on these predictions the Construction Noise and Vibration Management Plan (CNVMP) shall identify all reasonable and feasible mitigation measures to minimise noise and vibration from construction. Sections 4 and 5 identify the standard and additional mitigation measures to be included where applicable in the CNVMP. Eg. Detailed vibration assessments to include dilapidation surveys, continuous vibration monitoring and accurate vibration transfer measurements (site law measurements) for all buildings with the potential to exceed the screening criteria for vibration.
Documentation	Environmental Assessment and associated documentation	Activity or location specific Construction Noise Impact Statements Construction Noise and Vibration Management Plans OOHW Applications

3.2. Construction Noise and Vibration Impact Statements

In order to develop an accurate and comprehensive CNVIS for works associated with the project, specific detail of the construction methodology, including the size and type of equipment is required. Detailed design, construction and engineering solutions are progressively developed and applied throughout the life-span of the project. Consequently, CNVIS reports that cover the key construction activities/components are to be developed to reflect the progressive nature of design and construction of the project. There are to be two (2) different types of CNVIS report to be developed throughout the project:

- General Construction Activity CNVIS for construction scenarios that are consistently the same and progressively move along the project alignment e.g. tunnelling, retaining walls.
- Location Specific CNVIS for construction scenarios that are specific to a location.

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For all CNVIS reports the noise impacts are to be assessed based on construction scenarios. A construction scenario relating to noise impact is essentially a construction activity which is made up of the required plant and equipment. A number of construction scenarios will make up any one CNVIS report. In undertaking an assessment of the noise impact from a construction scenario(s) including the development of CNVIS report, the following steps are to be taken:

- Identify all noise and/or vibration sensitive receivers (NSRs) which may be affected by the project.
- Conduct background noise monitoring at representative NSRs to determine the rating background noise levels (RBLs) in accordance with the procedures presented in the NSW Industrial Noise Policy, where RBLs have not been established in previous project stages.
- Determine the appropriate noise and vibration management levels of each NSR.
- Determine the source noise levels (Sound Power Levels) of each noise generating plant and equipment item required to undertake the construction scenario. Note: Sound Power Levels for each plant and equipment would be less than the maximum allowable levels found in Table 11 and Table 12.
- Clearly indicate which mitigation measures identified in Section 4 have been/are to be incorporated into the noise assessment. Noise mitigation measures to be implemented will vary for reasons such as safety and space constraints, these are to be identified and the calculations adjusted accordingly.
- For Location Specific construction scenarios and where applicable for Generic scenarios, include the effects of noise shielding provided by site offices, residential fences, noise barriers or natural topographic features.
- Where applicable include the effects of noise reflections and ground attenuation.
- Calculate the L_{Aeq} noise or range of levels from construction scenarios at sensitive receiver groups, with the use of noise contour maps where appropriate and/or at 10 m, 25 m, 50 m, 75 m,100 m and 200 m for more general construction activities.
- Compare these against the goals identified for each NSR and identify predicted exceedances.
- For night-time activities, calculate the $L_{A1(60second)}$ noise levels and compare with the DECCW's RBL + 15 dB sleep disturbance screening criterion. On the basis of the ambient noise environment during the night-time period, the predicted L_{A1} noise levels and the number of expected L_{A1} noise events would be assessed. From this assessment determine the likelihood of potential sleep disturbance. Note: the L_{Amax} noise level can be used to estimate the L_{A1} noise level.
- On completion of all CNVIS reports for the subjective classification of the noise impact is to be evaluated and documented as:
    - Low Impact
    - Moderate Impact
    - High Impact

The classifications are to be determined on a case-by-case basis with consideration of the following points:

- The location of the works in relation to NSRs with consideration of noise attenuation features such as noise barriers including topographical features (earth-mounds), buildings, dividing fences etc (distance of works from sensitive receiver(s)).
- The type and sensitivity of the NSRs:
  - Low Impact: e.g. Commercial buildings/ Scattered Residential (low density)
  - Moderate Impact: e.g. Standard residential (typical density)
  - High Impact: e.g. Residential home for the elderly/high density unit blocks/persistent complainers/residents deemed to have “construction noise fatigue”.
- The extent of noise exceedance above Noise Management Level.
- The likelihood for potential sleep disturbance RBL + 15 dB.
- The type of and intensity of noise emitted from works (i.e. tonal or impulsive):
  - Lower Impact: No high noise and/or vibration intensive activities
  - Moderate Impact: Short/intermittent high noise and/or vibration intensive activities
  - High Impact: Prolonged high noise and/or vibration intensive activities.
- The duration of any OOHW required.
- The time frames for any OOHW:
  - Lower Impact: 6.00 pm till 10.00 pm weekdays 1.00 pm till 10.00pm Saturdays 8.00 am till 6.00 pm Sundays or Public Holidays.
  - Moderate Impact: 10.00 pm to 7.00 am Weekday Nights 10.00 pm to 8.00 am Saturdays.
  - High Impact: 6.00 pm to 7.00 am Sundays and Public Holidays.
- As a result of noise classification and/or the noise level exceedances at sensitive receivers provided by the CNVIS reports, appropriate reasonable and feasible noise mitigation is to be adopted and implemented. For sites where works are predicted to significantly exceed noise goals and impact on receivers for a significant period of time, additional reasonable and feasible noise mitigation measures such as those outlined in Section 7 would be considered if practical to reduce the noise levels and impact on sensitive receivers.

3.3. Expected Construction Activities

Construction activities which are likely to be undertaken during the construction of all Sydney Metro projects is presented in **Table 8**, together with typical plant and equipment required to execute each activity.

Table 8: Construction Activities and Typical Plant and Equipment

Activity	Significant Noise and Vibration Generating Plant and Equipment
Demolition	Excavator Dump Trucks Rock breaker / pulveriser Jackhammer

Activity	Significant Noise and Vibration Generating Plant and Equipment
General Earthworks and site establishment	Excavator Dumps Trucks Delivery Trucks Piling rigs
Spoil Removal	Excavator Dump Trucks
Shaft Excavation	Rock breakers Penetrating Cone Fracture (PCF) Blasting Jackhammer
Station Cavern Excavation	Road headers Rock anchor drilling
Tunnelling	Tunnel Boring Machine (TBM) Road headers
Cross passages	Rock breakers Road headers
Building/Facility Construction	Standard Construction Techniques Including: - Cranes - Delivery Trucks - Hand Tools/Hand Held Power Tools

3.4. Noise and Vibration Sensitive Receivers

The sensitivity of occupants to noise and vibration varies according to the nature of the occupancy and the activities performed within the affected premises. For example, recording studios are more sensitive to vibration and ground borne noise than residential premises, which in turn are more sensitive than typical commercial premises.

Specific noise and vibration sensitive receivers (NSRs) relevant to individual construction sites would be identified and addressed in the Environmental Assessment of each Sydney Metro project. Each receiver would be identified as falling into one of the following categories:

- Commercial
- Educational
- Industrial
- Mixed residential/commercial
- Residential
- Residential occupied by shift workers
- Place of Worship
- Medical facilities
- Other sensitive receivers

3.5. Ground-Borne (Regenerated) Noise

Ground-borne noise as a result of construction activities is usually associated with tunnelling projects where equipment such as tunnel boring machines, road headers, rock hammers and drilling rigs are operated underground. It is therefore anticipated that ground-borne noise may be an issue during the construction of Sydney Metro projects.

If ground-borne noise is anticipated as a result of construction activities, a CNVIS report, specifically in relation to the assessment of ground-borne construction noise would be undertaken.

In undertaking a CNVIS report for ground-borne construction noise the following steps are to be taken:

- Determine the location of each plant and equipment item in relation to each receiver.
- On the basis of ground-borne noise versus distance prediction algorithms for each plant item, determine the level of ground-borne noise at each building location. For highly sensitive building occupancies, such as recording studios, the assessment may need to incorporate the acoustic properties of the building space and the structural response of the building. This is to be determined by a qualified acoustic consultant, should ground-borne noise be a potential issue.
- Include the effect of all relevant standard mitigation measures as part of the construction scenario.
- Calculate the $L_{Aeq(15minute)}$ noise levels from the proposed construction actives at each receiver and compare these to the ground-borne noise management levels.

3.6. Ground-Borne Vibration

Vibration as a result of construction activities is usually associated with tunnelling projects where equipment such as tunnel boring machines, road headers, rock hammers and drilling rigs are operated underground. It is therefore anticipated that ground-borne vibration may be an issue during the construction of Sydney Metro projects.

If vibration impacts are anticipated as a result of construction activities, a CNVIS report, specifically in relation to the assessment of construction vibration would be undertaken.

In undertaking a CNVIS report for ground-borne construction vibration the following steps are to be taken:

- Determine the location of each plant and equipment item in relation to each receiver.
- On the basis of ground-borne vibration versus distance prediction algorithms for each plant item, determine the level of ground-borne vibration at each building location. For highly sensitive building occupancies, such as recording studios, the assessment may need to incorporate the vibration properties of the building space and the structural response of the building. This is to be determined by a qualified acoustic consultant, should ground-borne vibration be a potential issue.
- Include the effect of all relevant standard mitigation measures as part of the construction scenario.

Calculate the vibration levels from the proposed construction actives at each receiver and compare these to the ground-borne vibration criteria.

3.7. Vibration and Overpressure from Blasting

Vibration and overpressure as a result of construction activities is usually associated with tunnelling projects where blasting is required. If this construction is implemented then vibration and overpressure may be an issue during the construction of Sydney Metro projects.

If vibration and overpressure impacts are anticipated as a result of construction blasting, a CNVIS report, specifically in relation to the assessment of construction blasting would be undertaken.

In undertaking a CNVIS report for blasting vibration and overpressure the following steps are to be taken:

- Determine the location of blast charge in relation to each receiver.
- On the basis of vibration / overpressure versus distance prediction algorithms for blasting determine the level of vibration / overpressure at each receiver (building) location.
- Include the effect of all relevant standard mitigation measures as part of the construction scenario.

Calculate the vibration and overpressure levels from the proposed blasting actives at each receiver and compare these to the blasting criteria.

4. STANDARD NOISE AND VIBRATION MITIGATION MEASURES

4.1. Minimum Requirements

This section sets out the standard construction noise and vibration mitigation measures to be implemented on all Sydney Metro projects and delivered via relevant procedures, systems, environmental assessment, construction environmental management and all relevant contract documentation.

For all Sydney Metro construction projects, the standard mitigation measures in **Table 9** shall be applied by default in order to minimise the potential noise and vibration impacts at the surrounding Noise Sensitive Receivers. The effect of applying standard mitigation measures may be considered in noise and vibration assessments to achieve NML's.

4.1.1. Management Strategies during Construction

- Construction hours would be in accordance with the ICNG, project approvals and the EPL if required, except where otherwise specified in an approved noise management plan.
- When working adjacent to schools, medical facilities and childcare centres, particularly noisy activities would be scheduled outside normal working hours, where feasible and reasonable.
- When working adjacent to churches and places of worship particularly noisy activities would be scheduled outside services, where feasible and reasonable.
- Avoiding the coincidence of noisy plant working simultaneously close together and adjacent to sensitive receivers will result in reduced noise emissions.
- Where feasible and reasonable, the offset distance between noisy plant items and nearby noise sensitive receivers would be as great as possible.
- Regular compliance checks on the noise emissions of all plant and machinery used for the project would indicate whether noise emissions from plant items were higher than predicted. This also identifies defective silencing equipment on the items of plant.
- Ongoing noise monitoring during construction at sensitive receivers during critical periods (i.e. times when noise emissions are expected to be at their highest - e.g. piling and hammering) to identify and assist in managing high risk noise events.
- Where feasible and reasonable heavy vehicle movements would be limited to daytime hours.
- The implementation of procedures to maximise the night-time onsite spoil storage capacity where spoil is produced between the hours of 10.00 pm and 7.00 am.

4.1.2. Site Induction for all Employees, Contractors and Subcontractors

The site induction would include the following as a minimum:

- All relevant project specific and standard noise and vibration mitigation measures
- Relevant licence and approval conditions
- Permissible hours of work
- Any limitations on high noise generating activities
- Location of nearest sensitive receivers
- Construction employee parking areas
- Designated loading/unloading areas and procedures
- Site opening/closing times (including deliveries)
- Environmental incident reporting and management procedures

4.1.3. Source Noise Control Strategies

- Engines and exhausts are typically the dominant noise sources on mobile plant such as cranes, graders, excavators, heavy vehicles, etc. In order to minimise noise emissions, residential grade mufflers would be fitted on all mobile plant utilised on Sydney Metro construction projects.
- The use of damped hammers is recommended such as the 'City' model Rammer hammers. These reduce the 'ringing' of the rock pick, cylinder and excavator arm that is commonly associated with rock breaking works. Approximately 10 dB attenuation can be achieved compared to undamped hammers of the same size.
- Regular maintenance of all plant and machinery used for the project will assist in minimising noise emissions, including the reporting of the results.
- Acoustic enclosure of plant items, if required, as identified during compliance monitoring.
- Air brake silencers would be correctly installed and fully operational for any heavy vehicle that approaches and uses any Sydney Metro construction site.
- Non-tonal reversing alarms would be used for all permanent mobile plant operating on Sydney Metro construction projects. Whilst the use of non-tonal reversing alarms is suggested to ensure noise impacts are minimised, it is noted that OH&S requirements must also be fully satisfied.

4.1.4. Noise Barrier Control Strategies

Temporary noise barriers are recommended between the noise sources and nearby potentially affected noise sensitive receivers, wherever feasible. Typically, 5 dB to 15 dB attenuation can be achieved with a well-constructed barrier.

4.1.5. Acoustic Enclosures

Where significant noise impacts are predicted and/or long periods of construction works are planned, acoustic enclosures can be used as an effective mitigation method. Acoustic enclosures act to contain the sources of noise, whilst also providing the benefit of screening the construction site from view. An enclosure with no openings would be expected to provide attenuation the order of 20 dB.

4.1.6. Vibration Control Strategies

Attended vibration measurements are required at the commencement of vibration generating activities to confirm that vibration levels satisfy the criteria for that vibration generating activity. Where there is potential for exceedances of the criteria further vibration site law investigations would be undertaken to determine the site-specific safe working distances for that vibration generating activity. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the calculated safe-working distances.

4.1.7. Community Consultation

Active community consultation and the maintenance of positive, cooperative relationships with schools, local residents and building owners and occupiers assists in managing impacts from noisier operations and in alleviating concerns and thereby minimising disturbance and complaint. This includes, for example:

- Periodic notification or work activities and progress (e.g. regular letterbox drops, e-consult)
- Specific notification (letter-box drop) prior to especially noisy activities
- Comprehensive website information
- Project information and construction response telephone line
- Email distribution list

4.2. Summary of the Standard Mitigation Measures

The actions set out in **Table 9** must be implemented on all Sydney Metro construction projects.

Table 9: Standard Mitigation Measures to Reduce Construction Noise and Vibration

Action required	Applies to	Details
Management Measures		
Implementation of any project specific mitigation measures required	Airborne noise Ground-borne noise and vibration	In addition to the measures set out in this table, any *project specific* mitigation measures identified in the environmental assessment documentation (e.g. EA, REF, submissions or representations report) or approval or licence conditions must be implemented.
Implement community consultation measures	Airborne noise Ground-borne noise and vibration	Periodic Notification (monthly letterbox drop)[1] Website Project information and construction response telephone line Email distribution list Place Managers

[1] Detailing all upcoming construction activities at least 14 days prior to commencement of relevant works

Action required	Applies to	Details
Register of Noise Sensitive Receivers	Airborne noise Ground-borne noise and vibration	A register of all noise and vibration sensitive receivers (NSRs) would be kept on site. The register would include the following details for each NSR: • Address of receiver • Category of receiver (e.g. Residential, Commercial etc.) • Contact name and phone number
Site inductions	Airborne noise Ground-borne noise and vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • All relevant project specific and standard noise and vibration mitigation measures • Relevant licence and approval conditions • Permissible hours of work • Any limitations on high noise generating activities • Location of nearest sensitive receivers • Construction employee parking areas • Designated loading/unloading areas and procedures • Site opening/closing times (including deliveries) • Environmental incident procedures
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios; on site. No dropping of materials from height; throwing of metal items; and slamming of doors. No excessive revving of plant and vehicle engines Controlled release of compressed air.
Monitoring	Airborne noise Ground-borne noise and vibration	A noise monitoring program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurements	Ground-borne vibration	Attended vibration measurements are required at the commencement of vibration generating activities to confirm that vibration levels satisfy the criteria for that vibration generating activity. Where there is potential for exceedances of the criteria further vibration site law investigations would be undertaken to determine the site-specific safe working distances for that vibration generating activity. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the applicable safe-working distances.
Source Controls		
Construction hours and scheduling	Airborne noise Ground-borne noise and vibration	Where feasible and reasonable, construction would be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels would be scheduled during less sensitive time periods.

Action required	Applies to	Details
Construction respite period	Ground-borne noise and vibration Airborne noise	High noise and vibration generating activities[2] may only be carried out in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block[3].
Equipment selection	Airborne noise Ground-borne noise and vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits.
Maximum noise levels	Airborne-noise	The noise levels of plant and equipment must have operating Sound Power Levels compliant with the criteria in **Table 11**.
Rental plant and equipment	Airborne-noise	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in **Table 11**.
Plan worksites and activities to minimise noise and vibration	Airborne noise Ground-borne vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Non-tonal reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Minimise disturbance arising from delivery of goods to construction sites	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from NSRs Select site access points and roads as far as possible away from NSRs Dedicated loading/unloading areas to be shielded if close to NSRs Delivery vehicles to be fitted with straps rather than chains for unloading, wherever feasible and reasonable
Path Controls		
Shield stationary noise sources such as pumps, compressors, fans etc	Airborne noise	Stationary noise sources would be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained. Appendix F of AS 2436: 1981 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities	Airborne noise	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

[2] Includes jack and rock hammering, sheet and pile driving, rock breaking and vibratory rolling.

[3] "Continuous" includes any period during which there is less than a 60 minutes respite between ceasing and recommencing any of the work.

Table 10: Minimum Requirements for Construction Methods

Method	Minimum Requirements
Excavator	Ensure that the Sound Power Levels given in **Table 11** have been met.
Truck	Ensure that the Sound Power Levels given in **Table 11** have been met.
Rock breakers and jackhammers	Ensure that the Sound Power Levels given in Error! Reference source not found. have been met. Noise and vibration monitoring would be conducted at the nearest identified NSR where exceedances of the criteria have been predicted.
PCF	Where it has been predicted that vibration / regenerated noise is likely to be in excess of the nominated goals, specific notification would be given to all NSRs a minimum of 2 weeks prior to a shot being fired. Vibration and overpressure monitoring would be conducted at the nearest identified NSR.
Blasting	Where it has been predicted that vibration / overpressure is likely to be in excess of the nominated goals, specific notification would be given to all NSRs a minimum of 2 weeks prior to a shot being fired. Vibration and overpressure monitoring would be conducted at the nearest identified NSR.
TBM	Noise and vibration monitoring would be conducted at the nearest identified NSR where levels are expected to exceed the relevant noise and vibration goals.
Road headers	Noise and vibration monitoring would be conducted at the nearest identified NSR where levels are expected to exceed the relevant noise and vibration goals.

4.3. Maximum Allowable Plant Sound Power Levels

Plant or equipment operating on Sydney Metro project construction sites shall have an operating sound power level (SWL) which is no higher than the corresponding SWL presented in **Table 11**. The SWLs presented in **Table 11** have been compiled from a selection of field measurements conducted between 2004 and 2008 of plant and equipment operating on large construction projects throughout NSW and are therefore considered to representative of plant and equipment SWLs which are readily achieved by current plant and equipment normally used in the construction industry.

Plant and equipment with SWLs higher than those presented in **Table 11** would be deemed to be emitting an excessive level of noise and would not be permitted to operate Sydney Metro project construction sites.

Table 11: Maximum Allowable Sound Power Levels for Construction Equipment

Equipment	Maximum Allowable Sound Power Level (dB) L_{Amax}	Maximum Allowable Sound Pressure Level (dB) L_{Amax} at 7 m
Excavator Hammer	118	93
Excavator (approx. 3 tonne)	90	65
Excavator (approx. 6 tonne)	95	70
Excavator (approx. 10 tonne)	100	75
Excavator (approx. 20 tonne)	105	80
Excavator (approx. 30 tonne)	110	85
Excavator (approx. 40 tonne)	115	90
Skidsteer Loaders (approx. 1/2 tonne)	107	82

Equipment	Maximum Allowable Sound Power Level (dB) LAmax	Maximum Allowable Sound Pressure Level (dB) LAmax at 7 m
Skidsteer Loaders (approx. 1 tonne)	110	85
Dozer (tracking) - equiv. CAT D8	118	93
Dozer (tracking) - equiv. CAT D9	120	95
Dozer (tracking) - equiv. CAT D10	121	96
Backhoe/FE Loader	111	86
Dump Truck (approx. 15 tonne)	108	83
Concrete Truck	112	87
Concrete Pump	109	84
Concrete Vibrator	105	80
Bored Piling Rig	110	85
Scraper	110	85
Grader	110	85
Vibratory Roller (approx. 10 tonne)	114	89
Vibratory Pile Driver	121	96
Impact Piling Rig	134	109
Compressor (approx. 600 CFM)	100	75
Compressor (approx. 1500 CFM)	105	80
Concrete Saw	118	93
Jackhammer	113	88
Generator	104	79
Lighting Tower	80	55
Flood Lights	90	65
Cherry Picker	102	77
Mobile Crane	110	85

Where an item of construction equipment is not listed in **Table 11**, generic sound power levels presented in **Table 12** may be adopted.

Table 12: Generic Equipment or System Sound Power Level Limit[1]

Equipment	Maximum Allowable Sound Power Level (dB) LAmax	Maximum Allowable Sound Pressure Level (dB) LAmax at 7 m
Motorised (<25kW)	90	65
Motorised (<50kW)	95	70
Motorised (<100kW)	100	75
Motorised (<200kW)	105	80
Motorised (>200kW)	110	85
All other Auxiliary Equipment or Systems	90	65

Note 1: Sound Power Levels in dBA relative to 10 pW.

4.4. Auditing and Monitoring

All items of plant would have noise audits conducted upon arrival at a Sydney Metro construction site and at 6 month intervals thereafter. The purpose of these audits is to validate that individual items of plant and equipment fall within the Sound Power Level ranges identified in **Table 11**.

Where it has been identified within this strategy that noise and/or vibration monitoring is required at the nearest sensitive receiver; however, the nearest sensitive receiver has refused monitoring at their property, monitoring would be undertaken at the near point to that receiver within the site boundary or at another suitable location determined by an acoustic consultant.

5. ADDITIONAL NOISE AND VIBRATION MITIGATION MEASURES

5.1. Works outside Standard Working Hours

The implementation of the standard management measures, compliance with maximum sound power levels for plant and equipment, construction hour management and standard community consultation measures in this Strategy should significantly reduce the noise and vibration impacts on nearby sensitive receivers.

Nevertheless, due to the highly variable nature of construction activities and the likelihood of work outside the standard construction hours on Sydney Metro projects, exceedances of the construction noise and vibration management levels are likely to occur.

Where there is a potential exceedance of the construction noise and vibration management levels a number of additional measures to mitigate such exceedances – primarily aimed at pro-active engagement with affected sensitive receivers – would be explored and have been included in this Strategy. The additional mitigation measures to be applied are outlined in **Table 13**.

Table 13: Additional Management Measures

Measure	Description	Abbreviation
Alternative accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts over an extended period of time. Alternative accommodation will be determined on a case-by-case basis.	AA
Monitoring	Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals, noise or vibration monitoring may be conducted at the affected receiver(s) or a nominated representative location (typically the nearest receiver where more than one receiver have been identified). Monitoring can be in the form of either unattended logging or operator attended surveys. The purpose of monitoring is to inform the relevant personnel when the noise or vibration goal has been exceeded so that additional management measures may be implemented.	M
Individual briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.	IB
Letter box drops	For each Sydney Metro project, a newsletter is produced and distributed to the local community via letterbox drop and the project mailing list. These newsletters provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage and inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on the community. Content and newsletter length is determined on a project-by-project basis. Most projects distribute notifications on a monthly basis. Each newsletter is graphically designed within a branded template.	LB
Project specific respite offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact.	RO
Phone calls and emails	Phone calls and/or emails detailing relevant information would be made to identified/affected stakeholders within 7 days of proposed work. Phone calls and/or emails provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.	PC
Specific notifications	Specific notifications would be letterbox dropped or hand distributed to identified stakeholders no later than 7 days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications, or to advertise unscheduled works.	SN

5.2. Applying Additional Mitigation Measures

In circumstances where - after application of the standard mitigation measures - the $L_{Aeq(15minute)}$ construction noise and vibration levels are still predicted to exceed the noise or vibration objectives, the relevant Additional Mitigation Measures Matrix (AMMM) (see **Table 14** to **Table 16**) is to be used to determine the additional measures to be implemented. This requirement is supplemental to the basic requirements in the ICNG.

Using the relevant AMMM, the following steps need to be carried out to determine the additional mitigation measures to be implemented:

- Determine the duration (time period) when the work is to be undertaken.
- Determine the level of exceedance.
- From the relevant AMMM table, identify the additional mitigation measures to be implemented (using the abbreviation codes - expanded in **Table 13**).

Table 14: Additional Mitigation Measures Matrix (AMMM) - Airborne Construction Noise

Time Period		Mitigation Measures – Predicted $L_{Aeq(15minute)}$ Noise Level Above Background (RBL)			
		0 to 10 dB	10 to 20 dB	20 to 30 dB	> 30 dB
Standard	Mon-Fri (7.00 am - 6.00 pm)	-	-	M, LB,	M, LB
	Sat (8.00 am - 1.00 pm)				
	Sun/Pub Hol (Nil)				
OOHW (Evening)	Mon-Fri (6.00 pm - 10.00 pm)	-	LB	M, LB	M, IB, LB, PC, RO,SN
	Sat (1.00 pm - 10.00 pm)				
	Sun/Pub Hol (8.00 am - 6.00 pm)				
OOHW (Night)	Mon-Fri (10.00 pm - 7.00 am)	-	M, LB,	M, IB, LB, PC, RO, SN	AA, M, IB, LB, PC, RO, SN
	Sat (10.00 pm - 8.00 am)				
	Sun/Pub Hol (6.00 pm - 7.00 am)				

Table 15: AMMM - Ground-borne Construction Noise

Time Period		Mitigation Measures		
		Predicted $L_{Aeq(15minute)}$ Noise Level Exceedance		
		0 to 10 dB	10 to 20 dB	> 20 dB
Standard	Mon-Fri (7.00 am - 6.00 pm)	LB	LB	M, LB, SN
	Sat (8.00 am - 1.00 pm)			
	Sun/Pub Hol (Nil)			
OOHW (Evening)	Mon-Fri (6.00 pm - 10.00 pm)	LB	M, LB, SN	M, IB, LB, PC, RO, SN
	Sat (1.00 pm - 10.00 pm)			
	Sun/Pub Hol (8.00 am - 6.00 pm)			
OOHW (Night)	Mon-Fri (10.00 pm - 7.00 am)	M, LB, SN	AA, M, IB, LB, PC, RO, SN	AA, M, IB, LB, PC, RO, SN
	Sat (10.00 pm - 8.00 am)			
	Sun/Pub Hol (6.00 pm - 7.00 am)			

Table 16: AMMM - Ground-borne Vibration

Time Period		Mitigation Measures
		Predicted Vibration Levels Exceed Maximum Levels
Standard	Mon-Fri (7.00 am - 6.00 pm)	M, LB, RP
	Sat (8.00 am - 1.00 pm)	
	Sun/Pub Hol (Nil)	
OOHW (Evening)	Mon-Fri (6.00 pm - 10.00 pm)	M, IB, LB, PC, RO, SN
	Sat (1.00 pm - 10.00 pm)	
	Sun/Pub Hol (8.00 am - 6.00 pm)	
OOHW (Night)	Mon-Fri (10.00 pm - 7.00 am)	AA, M, IB, LB, PC, RO, SN
	Sat (10.00 pm - 8.00 am)	
	Sun/Pub Hol (6.00 pm - 7.00 am)	

6. MONITORING, AUDITING AND REPORTING

6.1. Plant Noise Auditing, Compliance Evaluation and Reporting

In order to compare the noise levels of plant and equipment with the values in **Section 4.3**, the following guidelines are recommended:

- Measurements of Sound Pressure Level (SPL) at 7 m (with plant or equipment stationary) shall be undertaken using procedures that are consistent with the requirements of Australian Standard AS2012–1990 Acoustics – Measurement of Airborne Noise Emitted by Earthmoving Machinery and Agricultural Tractors – Stationary Test Condition Part 1: Determination of Compliance with Limits for Exterior Noise.
- Measurements of Sound Power Level (SWL) shall be determined using procedures that are consistent with the requirements of International Standard ISO 9614-2 1996 Acoustics – Determination of sound power levels of noise sources using sound intensity - Part 2: Measurement by scanning.
- If measuring the SPL at 7 m of moving plant, compliance measurements would be guided by the requirements of Australian Standard AS2012–1977 Method for Measurement of Airborne Noise From Agricultural Tractors and Earthmoving Machinery.

For all measurements, the plant or equipment under test would be measured while operating under typical operating conditions. If this is not practical, it may be appropriate to conduct a stationary test at high idle.

In the case of an exceedance in sound power levels the item of plant would either be replaced, or the advice of an acoustic consultant would be sought to provide suitable mitigation measures, which may include:

- ensuring all bolts are tightened and no parts are loose
- cleaning and/or lubricating moving parts
- replacing old or worn parts
- implementing additional or upgrading existing muffling devices
- building enclosures around items of stationary plant (e.g. pumps or generators).

A register of measured sound power levels for each item of plant would be kept for reference where future noise audits are conducted. The register would be reviewed annually in conjunction with this strategy and corresponding revisions made to the Sound Power Levels presented in **Section 4.3** to represent contemporary plant noise emission levels.

6.2. Noise Monitoring

Where a CNVIS report has been prepared for a Sydney Metro construction site and it has been predicted that noise levels may be in excess of the nominated construction noise goals at a noise sensitive receiver, noise monitoring would be conducted at:

- the affected receiver; or

- if more than one affected receiver has been identified, at the nearest affected receiver; or
- where the nearest affected receiver refuses noise monitoring on their property, at the near point to that receiver within the site boundary.
- If it can be demonstrated that direct measurement of noise from the construction site is impractical, alternative means of determining construction noise levels may be adopted in accordance with Chapter 11 of the NSW Industrial Noise Policy.

All noise monitoring results would be assessed against the nominated noise goals and compiled into a report to be forwarded to the construction contractor and project manager. Reporting would be submitted to the construction contractor and project manager within one week of being undertaken or at weekly intervals for continuous monitoring. All noise monitoring reports would also be made available to the public through a publicly accessible website.

6.3. Vibration Monitoring

Where it is anticipated that an item of plant will exceed the cosmetic damage criteria given in Section **2.3.3**, vibration monitoring would be required at the nearest affected receiver. Where it is anticipated that an item of plant will exceed the human response / ground borne noise criteria and concerns have been raised regarding vibration, vibration monitoring would also be required at the receiver(s) under question.

All vibration monitoring results would be assessed against the nominated vibration goals and compiled into a report to be forwarded to the construction contractor and project manager. Reporting would be submitted to the construction contractor and project manager within one week of being undertaken or at weekly intervals for continuous monitoring. All vibration monitoring reports would also be made available to the public through the publicly accessible website.

6.4. Blast Monitoring

As specified in the minimum requirements presented in **Section 3.7**, vibration and overpressure monitoring would be conducted for all PCF and blasting activities which take place on Sydney Metro construction sites.

Monitoring would be conducted as a minimum at the sensitive receiver(s) likely to receive the maximum vibration and/or overpressure emissions from the blast as identified by an acoustic consultant.

All blast monitoring results would be assessed against the nominated goals and compiled into a report to be forwarded to the construction contractor and project manager. All blast monitoring reports would also be made available to the public through the Sydney Metro website.

As the effect of vibration and overpressure from blasting have the potential to cause structural damage to buildings and services, accurate records of all blasts are required to be maintained. Such records would describe the location of the blast and all the blast holes, the design of the blast in terms of type of explosives, mass of explosives, initiating system used, ground vibration and overpressure measurement data.

Records of every blast would be kept for a minimum of seven years. A longer period of retention of the records may be warranted if a construction project is blasted over an extended or disrupted period.

For any section of tunnel construction where blasting is proposed, a series of initial trials at reduced scale shall be conducted prior to production blasting to determine site-specific blast response characteristics and to define allowable blast sizes to meet the airblast overpressure and ground vibration limits.

6.5. Dilapidation Surveys

If construction activities have the potential to cause damage through vibration to nearby public utilities, structures, buildings and their contents, an Existing Condition Inspection of these items is required to be undertaken in accordance with AS 4349.1 "*Inspection of Buildings*".

Prior to conducting the Existing Condition Inspections, the property owners will be advised of the inspection scope and methodology and the process for making a property damage claim. At the same time, maintain a register of all properties inspected and of any properties where owners refused the inspection offer.

The findings of all dilapidation surveys conducted for each Sydney Metro construction site would be complied into a report to be forwarded to the construction contractor and project manager. Follow-up Condition Inspections would be required at the completion of certain major works (e.g. completion of shaft bulk excavation works).

7. COMPLAINT HANDLING

All complaints handling would be in accordance with the Sydney Metro Construction Complaints Management System.

8. COMMUNITY CONSULTATION AND LIAISON

All community consultation would be in accordance with relevant project communications plans.

9. DOCUMENTATION REQUIREMENTS

Any acoustic assessment, CNVIS or CNVMP undertaken for the Sydney Metro project must document the following as a minimum (where applicable):

- Acoustic Terminology / Glossary
- Overview of the Project / Works
- Secretary's Environmental Assessment Requirements
- EPL conditions (if applicable)
- Site Plan and Sensitive Receivers
- Ambient Noise Monitoring: methodology, locations, analysis and results
- Construction Noise and Vibration Criteria
  - Construction Airborne Noise Criteria
  - Construction Tunnelling Ground-borne Noise Criteria (if applicable)
  - Construction Ground-borne Noise Criteria
  - Construction Vibration Criteria
- Construction Noise and Vibration Assessment
  - Construction Airborne Noise Methodology / Predictions
  - Construction Tunnelling Ground-borne Noise Methodology / Predictions (if applicable)
  - Construction Ground-borne Noise Methodology / Predictions
  - Construction Vibration Methodology / Predictions
- Summary of Noise and Vibration Impacts
- Summary of all Standard and Additional Mitigation Measures
- References

All noise and vibration predictions are to be presented (as a minimum) as facade noise maps for a distance of at least 300 m in all directions from each work site / project area under assessment.

10. REFERENCES

Related Documents and References
• ANZECC, 1990, Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration. Australian and New Zealand Environment Council.
• APTA, 1981, Guidelines for Design of Rapid Transit Systems. American Public Transit Association.
• AS 2107, 2000, Acoustics - Recommended design sound levels and reverberation times for building interiors. Standards Australia.
• AS 2012 Part 1, 1990, Acoustics - Measurement of airborne noise emitted by earth-moving machinery and agricultural tractors - Stationary test condition - Determination of compliance with limits for exterior noise. Standards Australia.
• AS 2187, Part 2, 2006, Explosives - Storage and Use - Part 2: Use of Explosives. Standards Australia.
• AS 2436, 1981, Guide to Noise Control on Construction, Maintenance and Demolition Sites. Standards Australia.
• AS 4349, 2007, Inspection of buildings - General requirements. Standards Australia.
• BS 6472, 2008, Evaluation of Human Exposure Vibration in Buildings. The British Standards Institution.
• BS 7385 Part 2, 1993, Evaluation and Measurement for Vibration in Buildings Part 2. The British Standards Institution.
• Colin G. Gordon, 1999, Generic Vibration Criteria for Vibration-Sensitive Equipment. International Society for Optical Engineering.
• The Association of Australian Acoustical Consultants (AAAC) Technical Guideline on Child Care Centre Noise Assessments
• DECC, 1999, Environmental Criteria for Road Traffic Noise. NSW Department of Environment and Climate Change.
• DECC, 2009, Interim Construction Noise Guideline. NSW Department of Environment and Climate Change NSW.
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• EPA, 2000, NSW industrial noise policy. NSW Environment Protection Authority.
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Appendix F

Sydney Metro Construction Traffic Management Framework

Construction Traffic Management Framework

Sydney Metro West and Greater West construction

April 2020| Version: 1

Contents

Author: Ken Hind – Traffic Advisor
Date: March 2020
Version: 1
Reference: Reference
Division: Operations, Customer and Place-making
Review date:

Definitions and terminology

All terminology in this CTMF Document is taken to mean the generally accepted or dictionary definition. Other terms and jargon specific to this CTMF Document are defined within SM QM-FT-435 Integrated Management System (IMS) Glossary. Terms and acronyms specific to this document are listed below.

Table 0-1: Definitions

Term	Definition
Approval	Any licence, permit, consent or approval required to be obtained from any authority to perform the construction activities or required in relation to the construction site by the contractor.
Authority/authorities	Any authority or person that has a right to impose requirements on any part of the contractor's activities or over the construction site.
Construction site	The land where the contractor undertakes the contractor's activities.
Transport Coordination	The office established to lead the proactive planning and coordination of the operations and management of the transport network for major infrastructure projects on behalf of Transport for NSW. Transport Coordination includes the Transport Management Centre.
Construction Traffic Management Plan (CTMP)	The Construction Traffic Management Plan required by the SSI Approval. The CTMP is a plan showing how traffic will be managed when construction works are being carried out. It describes the work activities being proposed, their impact on the roadway and on road users, and how these impacts are being addressed. A CTMP must incorporate Traffic Staging Plans, Traffic Control Plans and Vehicle Movement Plans. Pedestrian Movement Plans may also be required to be incorporated. Sydney Metro site-specific CTMPs will need to be prepared for each construction site. These plans will be developed in consultation with the TTLG and TCG meetings.
Contractor	The organisation engaged by the Principal for the delivery of the Project Works and the Temporary Works.
Contractor's Activities	All things and tasks that the contractor is required to do under the contract, whether or not such things and tasks are performed by subcontractors.
Disability Discrimination Act (DDA)	The Disability Discrimination Act 1992.
Emergency	An unforeseen event which requires urgent action to protect life or property, or an occasion when emergency services (Police, Fire and Rescue, Ambulance or State Emergency Services) take control of a portion of the road network.
Hold Point	A point beyond which a work process must not proceed without the authorisation or release of a designated authority.
Local Traffic Committee (LTC)	A technical committee chaired by the local council under delegated authority from TfNSW, which considers matters related to prescribed traffic control devices and traffic control facilities for which the council has delegated authority. It is made up of four formal, or voting, members: Council, NSW Police, TfNSW, and the local state Member of Parliament.

Term	Definition
Long-term works	Works that impact on the road network for more than one shift. Traffic management measures will be installed on one day/night and remain in place for weeks or months but are removed on completion of the project or that work; for example, concrete barriers and signage.
Pedestrian Movement Plan	A diagram showing the allocated travel paths for workers or pedestrians around or through a construction site. A PMP may be combined with or superimposed on a Traffic Control Plan.
Planning Approval	The approval being sought under the EP&A Act and relevant Commonwealth legislation (if required) by Sydney Metro and which is required to be complied with by the contractor, as directed in respective Project Deeds.
Preferred Infrastructure Report (PIR)	The report prepared to address issues raised in submissions on the Environmental Impact Statement and any proposed changes to the project to minimise its environmental impact.
Principal	Sydney Metro
Project Works	Any permanent works that the contractor is required to design, construct, complete and hand over.
Reference documents	The codes, standards, specification and guidelines specified in this document.
Revised Environmental Mitigation Measures (REMM)	Mitigation measures, additional to the project design, which are identified through the Environment Impact Assessment.
Road occupancy	An activity that is likely to impact on the traffic flow of the road network, and may involve the closure of traffic lane(s) or parking lane(s).
Road Occupancy Licence (ROL)	A licence for Road Occupancy issued by TMC that allows the holder to use or occupy a specified road space at approved times, providing that certain conditions are met.
Road Safety Audit (RSA)	An assessment and report of a road's safety performance and crash potential at various stages of a road/project's life cycle.
Road user	All users of roads and public spaces including, but not limited to, pedestrians, pedal cyclists, public transport passengers, public transport operators and motorists.
Short-term works	Works that are undertaken for one shift only. They may return the next day/night but it is set up and packed entirely in one shift; for example, cones and signs for a lane closure.
Subcontractor	A subcontractor of the contractor and includes a supplier of goods or services (including professional services and construction plant hire) or both.
Transport for NSW (TfNSW)	Relates to those sections of the former Roads and Maritime Services (RMS), with regard to operations and impacts on State Roads, traffic signals and other road responsibilities of that organisation. RMS has been integrated into Transport for NSW from 1 December 2019, as part of the Greater Sydney Division. Where existing documents or procedures were published by RMS this reference has been retained. All references to either TfNSW or RMS in this document should be taken to mean the same thing.
Temporary works	Any temporary works required to carry out the contractor's activities but which do not form part of the Project works.

Term	Definition
TBM	Tunnel boring machine.
Traffic Control Plan (TCP)	A diagram showing signs and devices arranged to warn traffic and to guide it around, past or if necessary through a work site or temporary hazard.
Traffic Control Group (TCG)	A group chaired by the Sydney Coordination Office and including the Principal, relevant contractor's traffic and transport representative and other stakeholders.
Traffic Management Plan (TMP)	The TMP is a plan showing how traffic will be managed when construction works which will impact on the surrounding road network are being carried out. It describes the work activities being proposed, their impact on the roadway and on road users, and how these impacts are being addressed. A TMP may incorporate Traffic Staging Plans, Traffic Control Plans and Vehicle Movement Plans. Pedestrian Movement Plans may also be required to be incorporated. These plans will be developed for activities such as OSOM routes to and from the construction sites and in consultation with the TTLG and TCG meetings.
Traffic Staging Plan	Road design drawings showing traffic lane configurations to be provided for traffic passing through the site during the various construction stages, including details of road alignment and geometry, intersection layouts, provision for buses and cyclists, work areas and pedestrian areas, drainage, signs and pavement markings, etc.
Traffic and Transport Liaison Group (TTLG)	The group formed by the Principal in accordance with the requirements in the Project Planning Approval. Meetings are chaired by the Sydney Coordination Office.
Traffic and transport representative	The person appointed to the position of traffic and transport representative by the contractor.
Vehicle Movement Plan (VMP)	A diagram showing the preferred travel paths for vehicles associated with a construction site entering, leaving or crossing the through traffic stream. A VMP may be combined with or superimposed on a Traffic Control Plan.
Verifier	A person appointed to the position of verifier by the contractor.
WAD	A Works Authorisation Deed, an agreement between TfNSW and the proponent authorising implementation of road works or other works for which TfNSW has a statutory interest and subject to identified requirements and conditions.
WHS	Workplace Health & Safety.

1 Introduction

1.1 Purpose

This Construction Traffic Management Framework (CTMF) sets out the approach to managing traffic impacts during the construction of the Sydney Metro projects (the Project). The CTMF also outlines contractor requirements, with reference to third party agreements.

1.2 Scope

The CTMF provides the overall strategy and approach for construction traffic management for the Project, and an outline of the traffic management requirements and processes that will be common to each of the proposed work sites. It establishes the traffic management processes and acceptable criteria to be considered and followed in managing roads and footpaths adjacent to Project construction sites.

A site specific Construction Traffic Management Plan (CTMP), along with Traffic Control Plans (TCPs) as required, will also be documented based on this framework. These documents will be prepared by the Principal contractors responsible for each works package for Sydney Metro construction works to align with the contents, principles and objectives of this CTMF, as well as contractual requirements, Revised Environmental Mitigation Measures (REMM) and all other obligations of the relevant planning approval.

Some of the construction sites associated with the Sydney Metro Projects will be located within high-activity, densely developed, and in some cases congested sections of the road network, and any traffic management measures will need to consider all the potential impacts that might occur because of the construction activities, and deliver safe environments for all road users.

1.3 Metro West & Greater West Project description

Sydney Metro is a key component of Future Transport 2056 (Transport for NSW, 2018), a plan to create and maintain a world class, safe, efficient and reliable transport system. The Sydney Metro network will consist of a number of metro lines.

- Sydney Metro Northwest is constructed and operational between Tallawong and Chatswood.
- Sydney Metro City and Southwest (Chatswood to Sydenham) is under construction between Chatswood and Sydenham Stations with operations planned to commence in 2024.
- Sydney Metro City and Southwest (Sydenham to Bankstown) is currently in initial stages of construction (early works) with operations planned to commence in 2024.
- Sydney Metro West (Westmead to Sydney CBD) is currently in planning with construction to commence in 2020.
- Sydney Metro Greater West (St Marys to Western Sydney Airport and Western Sydney Aerotropolis) is currently in the initial stages of planning with construction to commence in 2021.

Sydney Metro West will service the key precincts of Greater Parramatta, Sydney Olympic Park, The Bays Precinct and the Sydney CBD. Sydney Metro West includes:

- A new underground metro station at Westmead, to support the growing residential area as well as the health, research and education precinct
- A new metro station under an existing suburban station on the T1 Northern Line east of Sydney Olympic Park – allowing faster connections for customers from the Central Coast and Sydney's north to Parramatta and Sydney through a quick and easy interchange between suburban and metro services
- At least one Sydney Metro West station under the Sydney CBD, delivering an easy interchange between suburban rail, new light rail and the new metro stations currently under construction
- Further consultation is being undertaken on new intermediate metro stations between Parramatta and Sydney Olympic Park and between Olympic Park and the Sydney CBD.

Sydney Metro Greater West will service Greater Western Sydney and the new Western Sydney International (Nancy-Bird Walton) Airport. Sydney Metro Greater West will include:

- Stations at Western Sydney Airport and the Western Sydney Aerotropolis;
- A station at St Marys, interchanging with the existing station and connecting customers with the rest of Sydney's rail system.

The Projects will also include ancillary components, including stabling and maintenance facilities, new or upgraded overhead wiring, signalling, access tracks/paths, rail corridor fencing, noise walls, fresh air ventilation equipment, temporary and permanent alterations to the road network, facilities for pedestrians, and other construction related works.

1.4 Governance

The approved version of the CTMF will be available on the Sydney Metro website.

Sydney Metro will be the document owner of the approved CTMF. This CTMF will be part of the EIS for both Sydney Metro Greater West (SMGW) and Sydney Metro West (SMW) submitted for approval by the Secretary, Department of Planning, Industry and Environment.

2 Traffic management objectives

This section outlines the approach, strategy and hierarchy of access required when managing traffic for Sydney Metro projects.

The Projects will require demolition and construction work to be undertaken within various local government areas (councils) and other road authorities within the Greater Sydney Region. At all locations, it is important that adequate consideration and emphasis is given to the operation of public transport, private vehicles, service vehicles, and pedestrian and cyclist management measures, to minimise impacts. It is also important that access for residents and businesses is maintained, where possible.

The design and operation of any proposed temporary traffic management measures will require careful planning, coordination and implementation.

Pedestrians, cyclists and vehicle drivers expect a high level of safety and service in using the existing road and pedestrian network. This requires efficient, effective and reliable traffic management strategies to be in place that:

- Achieve uniform traffic throughput.
- Minimise changes to pedestrian and cycle routes and movement.
- Ensure reliable and consistent travel times.
- Provide clear information to allow drivers and other road users to make appropriate decisions in relation to their journey.
- Support operation and use of sustainable transport modes to reduce on-road single occupant motor vehicle demand
- Minimise potential road safety risk, especially for pedestrians and cyclists.

These traffic management goals will be achieved by:

- Understanding the impacts of the Projects and identifying appropriate methods to mitigate these impacts.
- Strategic advanced planning of the traffic management.
- Taking an approach to traffic management that minimises traffic disruption.
- Ongoing stakeholder engagement and communication.

2.1 General traffic management approach

Sydney Metro is committed to achieving desired performance goals in relation to the health and safety of workers employed to construct Sydney Metro Projects, and to minimising the impacts of the works on road users and the community. The construction objectives that relate to the CTMF are outlined in **Table 2-1**.

Table 2-1: CTMF related construction objectives

Key Result Area	Construction Objectives
Transport network	• Minimise disruption to pedestrians, cyclists and motorists. • Ensure Sydney Metro construction traffic accesses the arterial network as soon as practicable on route to, and immediately after leaving, the construction site. • Keep Sydney moving. • Minimise impacts on route bus operations, routes and stops, where possible. • Minimise changes to traffic operation and kerbside access. • Minimise construction traffic generation during network peak periods (maximum peak period construction vehicle volumes should not exceed those outlined in the EIS). • Maintain access to properties and businesses where possible, or arrange alternative. • Maintain a safe environment for pedestrians and cyclists.
Safety	• No worker injury accidents during construction. • No injury accidents to members of the public because of construction.
Cumulative impacts	• Work collaboratively with other stakeholders and other major projects to mitigate traffic and transport impacts.
Amenity	• Minimise noise and other environmental impacts on the residents and businesses in the vicinity of the construction sites, in line with the Construction Noise and Vibration Strategy (CNVS)

2.2 Traffic management strategy

There is the potential for activities associated with the construction of the Sydney Metro Projects to have an impact on the surrounding road network. Where possible, these impacts will be minimised through the provision of effective traffic management measures, in accordance with Sydney Metro's objectives and relevant guidelines and standards, to achieve the objectives of the Project. Development of the traffic management measures will be carried out in consultation with the Traffic Control Group (TCG), Traffic and Transport Liaison Group (TTLG), TfNSW, Transport Coordination and other relevant stakeholders.

Priority will be given to providing adequate guidance to pedestrians, cyclists, drivers and the community prior to the commencement of any works. Priority will also be given to responding appropriately to issues and events that may arise during the works. As part of this strategy, some key traffic management measures include:

- The provision of directional signage and line marking to safely direct and guide drivers, cyclists and pedestrians past work sites and to suitable alternative routes (if required) on the surrounding road network.
- Notification of proposed changes and duration using appropriate media e.g. newspapers (local or majors), radio, project website, social media and direct community engagement (as required).
- On-going or direct co-ordination with Transport Coordination, to mitigate congestion and provide rapid response should incidents or increased

congestion occur as a direct result of the works. Notification of incidents or congestion should also be relayed to Sydney Metro and relevant Transport Coordination representative immediately. The direct contact numbers of the contract-wide and site-specific lead contractors should be provided to Transport Coordination. The contract-wide lead contractor is responsible for ensuring the direct contact numbers are current during any stage of construction.

- Management and coordination of construction vehicle safe access to and from the work sites across pedestrian paths. The type of traffic management to be employed will be dependent on, and adjusted according to, the volume of pedestrians, passing traffic and the volume of construction vehicle activities for the site. The types of management could include manual supervision, physical barriers, temporary/portable traffic signals (where approved by TfNSW, council or other road authority) or modification to existing traffic signals (where approved by TfNSW).
- Ensuring that safe access to existing properties and businesses is maintained during the period of the works, or a suitable alternative is provided.
- Retain existing on-street parking and restrictions, as far as is practicable.

2.3 Hierarchy of access

In identifying the most appropriate form of traffic management for each site, consideration should be given to the priorities of the potential different users. The site specific CTMPs should be developed in line with the following hierarchy of access, listed from the highest to the lowest priority:

1. Incidents and emergency services access
2. Events (special and unplanned)
3. Pedestrians
4. Cyclists
5. Other public transport users – buses, coaches and light rail
6. Service vehicles
7. Coaches
8. Taxis
9. Kiss and ride and rideshare
10. Private cars

Roads are sometimes classified functionally as follows:

- Arterial/State road
- Sub-arterial or Regional road
- Collector road
- Local road

TfNSW publishes on its website a schedule of State and classified Regional roads with descriptions, which should be referred to in assessing the functional classification of any roads that may be potentially impacted by works. The document outlines the following:

"To manage the extensive network of roads for which councils are responsible for under the Roads Acts 1993, RMS in partnership with local government, established an administrative framework of State, Regional and Local Road categories. State Roads are managed and financed by RMS whilst Regional and Local Roads are managed and financed by councils.

Regional Roads perform an intermediate function between the main arterial network of State Roads and council controlled Local Roads. Due to their network significance, RMS provides financial assistance to councils for the management of their Regional Roads. The Regional Road category comprises two sub-categories: those Regional Roads that are classified pursuant to the Roads Act 1993, and those Regional Roads that are unclassified. For completeness, the Schedule includes unclassified Regional Roads.

Local Roads are unclassified roads and therefore are not included in the Schedule."[1]

[1] Schedule of Classified Roads and Unclassified Regional Roads - RMS, April 2017

3 Implementation framework

3.1 Construction Environmental Management Framework (CEMF)

The Construction Environmental Management Framework (CEMF) sets out the environmental, stakeholder and community management requirements for construction. It provides a linking document between the planning approval documentation and the construction environmental management documentation to be developed by the Principal Contractors relevant to their scope of works. The CEMF outlines construction traffic management requirements.

3.2 Construction traffic management task

The Projects require construction work to be undertaken for the tunnels, viaducts, stations, ancillary facilities and connections to the stations at locations within various council areas.

Managing the impacts of construction traffic on the road and pedestrian networks near the surface construction works is vital to the success of the Project.

3.3 Implementation process

The Construction Traffic Management Framework (CTMF) is one of several management plans required for the Projects, in accordance with the CEMF. The hierarchy of the traffic management plans for the Projects, their purpose, and the responsible entity for each are outlined in the table below.

Table 3-1: Traffic Management Plans hierarchy, purpose and responsible entity

Document	Purpose	Produced by
Construction Traffic Management Framework (CTMF) (this document)	Provides the approach within which subsequent site specific CTMPs will be prepared.	Sydney Metro
Site-specific Construction Traffic Management Plan (CTMP)	Site-specific CTMPs are to be prepared for each Sydney Metro construction site, for each contract.	Contractor
Traffic Control Plans (TCP)	Prepared as part of the site specific CTMP or as a standalone drawing for submission with Road Occupancy License applications and/or Council permits.	Contractor
Pedestrian Movement Plans (PMP) Vehicle Movements Plans (VMP)	Prepared, where required, as part of the site specific CTMP, combined with a TCP or as a standalone drawing for submission with Road Occupancy License applications and/or Council permits.	Contractor
Parking Management Plan (PkMP)	Prepared, where required, as part of the site specific CTMP or as a standalone document for submission with Road Occupancy License applications and/or Council permits.	Contractor

Document	Purpose	Produced by
Other plans	Refer to the Principal's General Specifications relating to Traffic and Transport Management	Sydney Metro

3.3.1 Construction Traffic Management Framework (this document)

This CTMF provides the framework within which subsequent site-specific CTMPs will be prepared. The CTMF describes the traffic management objectives, principles and strategies to be implemented during construction of Sydney Metro Projects.

This CTMF identifies and outlines areas that will be potentially impacted by the construction works and will require traffic, cycling and pedestrian management. The development of suitable traffic management plans to minimise, as much as possible, the potential impacts of the works is a key component to managing any disruptions to vehicle and people movement and the efficient construction of the Projects.

3.3.2 Construction traffic management plans

Construction Traffic Management Plans (CTMP) will be prepared by contractors, covering the full spatial extent of their works for sites.

The CTMP's will comply with the Traffic Control at Worksites Manual, relevant Australian Standards, relevant Austroads guides, TfNSW supplements to Australian Standards and Austroads, Principal's General Specifications – Traffic and Transport Management and the EIS.

In addition, site specific CTMPs will be prepared and implemented having regard to the relevant Project specific REMMs and Conditions of Approval.

3.3.3 Site specific CTMP

Contractors will prepare detailed site-specific Construction Traffic Management Plans (CTMPs). These will be developed by the contractor for each work site and identify proposed heavy vehicle routes, traffic and parking management measures. These plans will be developed in consultation with the TTLG and TCG meetings. Details of the consultation including presentation dates to TTLG and TCG and stakeholder consultation are to be included in the CTMP.

Details of station and construction work sites are to be provided in the each of the site-specific CTMPs.

Site specific CTMPs will detail construction work sites, access points, relevant signage, parking changes (if required), vehicle numbers (heavy and light vehicles) and frequency, maximum vehicle size, swept paths, expected dates and duration of works, work times. Other information to be included includes bus stop relocations (if required), proposed heavy vehicle routes, traffic and parking management measures, relevant correspondence with stakeholders (e.g. bus operators, Australia Post, business owners) and all traffic management and mitigation measures required to implement any proposed works.

It must also include Traffic Control Plans (TCP), Vehicle Movement Plans (VMP), Pedestrian Movement Plans (PMP), Parking Management Plans and Traffic Staging Plans for the specific works, unless otherwise agreed in writing with the Principal's Representative and relevant Authorities. The Parking Management Plan will also

provide details regarding on-site and off-site staff parking arrangements, including any proposed busing to and from construction sites. The TCP's should include the intended timing of the proposed traffic management measures e.g. nights, weekends, 24/7.

It is an important consideration in the development and approval of a CTMP that sufficient time is allowed for the review process and consideration by Transport Coordination, TfNSW, local Council, bus operators and other stakeholders as required. The identified Project Document Management System (e.g. Teambinder) should be used to distribute documents to stakeholders for review and comment, where available. If not available for the stakeholder being consulted, then the CTMP is to be forwarded by email or hard copy. The Principal's representative is to be copied in on any submitted documentation.

The approval process for CTMP's is outlined in **Section 6.3**.

Once all comments have been addressed, the final version of the CTMP is then formally submitted to TfNSW for final approval of the CTMP, following Transport Coordination endorsement. Ten business days should be allowed for the final approval.

3.3.4 Traffic control plans and other plans

The site-specific CTMPs provide the basis for preparation of the Traffic Control Plans (TCP) and Road Occupancy Licence (ROL) applications.

3.3.4.1 Traffic control plans

All Traffic Control Plans (TCPs) prepared for construction activities will be developed in accordance with Australian Standard AS1742.3 and the TfNSW Traffic Control at Worksites Technical Manual.

TCPs must be prepared by a person who has completed and passed the '*Prepare a Work Zone Traffic Management Plan*' training course and has current certification to the required level.

All work sites and related TCPs will be implemented in compliance with the ROL issued by Transport Coordination for the approved times and appropriate standards.

Documents to be referenced in the preparation of TCPs include:

- Australian Standard AS1742.3 – Manual of uniform traffic control devices, Part 3, traffic control devices for works on roads.
- Roads and Maritime Services NSW – Traffic Control at Worksites Technical Manual
- Principal's General Specifications – Traffic and Transport Management.
- Relevant Austroads Guides.
- TfNSW Supplements to Austroads and Australian Standards.
- Sydney Metro Principal Contractor Health and Safety Standard

Early consultation with TfNSW and Transport Coordination may highlight site-specific requirements associated with the forecast heavy vehicle and light vehicle movements at proposed work sites along the Project corridor. These will be addressed by contractors during construction planning and CTMP preparation for each of the sites. On local roads, Councils may also have operational requirements and these should be determined in consultation with the Councils.

3.3.4.2 Vehicle movement plans

The Traffic Control at Work Sites Technical manual outlines a vehicle movement plan as "*a diagram showing the preferred travel paths for vehicles associated with a worksite entering, leaving or crossing the through traffic stream.*" The requirements for the provision of a VMP are detailed in chapter 7 of the Traffic Control at Worksites Technical Manual.

Vehicle movement plans should be included in site-specific CTMPs prepared by a suitably qualified person for the contractor. The VMP should also include the proposed site access points and how these are to be managed.

3.3.4.3 Pedestrian movement plans

The Traffic Control at Worksites Manual outlines a Pedestrian Movement Plan (PMP) as "*a diagram showing the allocated travel paths for workers or pedestrians around or through a worksite*."

Wherever it is necessary to divert or warn pedestrians of works the PMP should be included in the CTMP prepared by the contractor. This may be a stand-alone document.

The needs of cyclists and other mobility devices (wheelchairs, mobility scooter) must also be considered and management measures documented in the pedestrian and cycle movement plan. This is particularly important where the work site is bounded by major roads such as State and Regional Roads.

PMPs are to be prepared for any work sites located where significant pedestrian activity occurs, e.g. shopping centres, commercial/office areas. Other construction sites may also require PMPs subject to site-specific assessments.

3.3.4.4 Parking management plans

Parking Management Plans identify parking requirements and also on-site and off-site parking arrangements and associated impacts; remote parking arrangements and associated access between sites and public transport nodes; alternate parking arrangements for displaced parking; and communication and parking management measures. For any proposed kerbside use impacts within a town centre or other activity centre, a proposal for relocation of impacted users may be required.

Changes to on-street parking restrictions will require the approval of the relevant road authority; either TfNSW or local council.

4 Consultation groups

The size of Sydney Metro projects requires effective and ongoing interaction between several different organisations, key stakeholders and the general public. This chapter outlines the consultation groups that will be convened to manage these interactions. Requirements for consultation with local businesses and the community are outlined in Chapter 5 Communication.

As the Project needs regular and ongoing discussions and distribution of information, the following groups will be convened to assist in traffic management planning, document review and stakeholder consultation:

a) Traffic and Transport Liaison Group(s) (TTLG).

b) Traffic Control Group(s) (TCG).

4.1 Traffic and Transport Liaison Group

A Traffic and Transport Liaison Group (TTLG) would operate, to ensure the stakeholders most affected are aware of the proposed construction activities, upcoming works and related traffic and transport implications. The participants in this group will reflect the location of the work site however, representation is anticipated to include, as relevant to the site:

- Sydney Metro
- Transport for NSW including:
    - Centre for Road and Maritime Safety
    - Sydney Light Rail
    - Parramatta Light Rail
    - Metro Bus and Ferry Planning and Development
    - Greater Sydney Planning and Programs
- Freight Strategy and Planning
- Transport Coordination
- Sydney Trains
- Port Authority of NSW
- Infrastructure NSW
- Department of Planning, Industry and Environment
- Western Sydney Airport
- Sydney Motorway Corporation (WestConnex)
- NSW Police
- NSW Fire and Rescue
- NSW Ambulance Service
- Local councils (depending on work site locations)
- Bus operators
- Sydney Metro contractors

The TTLG provides a forum for key stakeholders, contractors and Sydney Metro to discuss matters that could impact on the road network operations around the sites. The TTLG also provides a forum through which information on proposed traffic changes is made available to key stakeholders. It will allow key transport agencies, local councils and other authorities to inform the development of traffic management plans and construction staging by providing local and specialist knowledge and insights. The TTLG:

- Maintains good communication between Sydney Metro project team, contractors and other stakeholders.
- Discusses the construction traffic management arrangements for the Sydney Metro works and approvals.
- Assists in identification and refinement of potential measures to mitigate the impacts of the Sydney Metro works in an area.
- Assists coordination of works for Sydney Metro and other projects.
- Can request the provision of supplementary analysis and modelling for proposed traffic management measures to ensure any disruption to the traffic and pedestrian network is minimised
- Ensures that submitted plans are actioned and agreed in a timely manner in accordance with the overall Sydney Metro project program.
- Is consulted in the preparation of road safety audits before the completion and use of infrastructure.

4.1.1 Other organisations

Other organisations may be asked to attend the TTLG and/or receive relevant information depending on the matters under discussion or consideration. This may include:

- NSW Taxi Council
- NSW Taxi Drivers Association
- BusNSW
- Bicycle NSW
- Bicycle User Group(s)
- Pedestrian Council of Australia
- Sydney Buses
- Private bus operators (such as NightRide contractors)
- Property NSW
- Sydney Ferries, Harbour City Ferries and other relevant ferry operator(s)
- Disability Council of NSW
- Transurban
- NRMA
- NSW Trains
- NSW Health Infrastructure
- Managing Contractors of other adjacent major infrastructure projects

4.2 Traffic control group

For each (or multiple) Sydney Metro contract, a Traffic Control Group (TCG) will be convened to provide a technical forum for the discussion of proposed works that will impact on the surrounding road network and feedback on proposed TCPs prior to formal submission. This group would meet on regular occasions (weekly, fortnightly or as agreed by TCG members) to provide an assessment of the forthcoming traffic management measures and to ensure that any identified or potential issues are raised and addressed to ensure that works proceed in accordance with the agreed program. The participants in this group will vary depending on the contracts. Representation would be expected to include:

- Relevant Sydney Metro contractor's Traffic Manager and other construction staff as required.
- Sydney Metro
- Transport for NSW
- Transport Coordination
- Centre for Road and Maritime Safety
- Local councils
- Infrastructure NSW
- Port Authority of NSW (Bays West Precinct)

The TCG will provide a forum for discussion on proposed traffic management measures during the various stages of each of the contracts, discussion of potential impacts on the road network operations around the sites, and how to address or minimise those impacts.

4.3 Government stakeholders

Consultation with Transport Coordination, Port Authority and TfNSW in the preparation of this CTMF document has been carried out, the outcomes of which have been incorporated into this document.

A summary of the comments and responses from the consultations has been provided to the Department of Planning, Industry and Environment.

5 Communication

All external communication with the community, including businesses, must follow the guidelines set out in the Sydney Metro Community Communication Strategy.

The community must be notified of any current and upcoming works, temporary works or contractor activities that have the potential to impact on stakeholders and the community before they happen.

An overview of the approach to stakeholder and community involvement during construction of the Project is provided in the Construction Environmental Management Framework and Community Communication Strategy. A key element of this strategy will relate to notifications to stakeholders, local Councils and the community that may be affected by changes to transport, access and local traffic arrangements.

5.1 Existing businesses and residents

Owners and operators of potentially affected properties and businesses will be consulted throughout the delivery of the Project and notified in accordance with the Community Communications Strategy (CCS) in advance of any works that may potentially disrupt access to their property.

Every endeavour is to be made to maintain safe access at all times to properties for both pedestrians and vehicles. If works will temporarily affect access to a property, consideration should be given to the staging of the works, to maintain safe access and limit the disruption. Any access restrictions for residents, tenants or property owners and alternative arrangements are to be undertaken and agreed with the occupiers.

Residents, property owners and businesses in the surrounding area will also be notified prior to the start of works.

5.2 Notification of traffic changes or disruptive works

Activity specific communications strategies are required to be developed prior to any traffic event. These strategies should include details of the work, impacts and proposed mitigation measures. In addition to the strategy, activity-specific notifications will need to be developed and issued to directly impacted properties prior to works commencing. Notification of proposed changes should also be included on the Project website. Other communication methods that may be implemented could include, but are not limited to:

- Doorknocks
- Letterbox drops
- Advertising (newspapers)
- Social media updates
- Radio

5.3 Responsibilities

The contractor's Stakeholder and Community Manager will be responsible for ensuring a system is in place to advise the Sydney Metro Project Communications Team, the TTLG and other key stakeholders each time proposed changes are to be made to traffic arrangements. Advice will include information about the changes to the

traffic operation, anticipated delays to traffic, any changes to the times and duration of the work, and any other potential major disruptions. This advice should be provided at the earliest opportunity, in accordance with the CCS and provide sufficient time for key agencies to provide comments or information as necessary.

5.4 Roadside messaging

Appropriate signposting, whether static or Variable Message Signs (VMS), should be located and installed to provide for the easy and safe passage of vehicles, pedestrians and cyclists. This also includes public transport users accessing facilities such as bus stops. The installation of signs will be detailed within the relevant CTMP.

Any signposting should be placed in accordance with relevant guidelines and standards. Messages should be clear and easily interpreted by drivers, pedestrians and cyclists, and should not create a safety hazard. The proposed location of any VMS would require the approval of the road authority.

6 Approvals

6.1 Policy context and legislative backing

Notwithstanding the Project SSI Approval being secured under Division 5.2 of the EP&A Act or other approval obtained under relevant Commonwealth legislation (where relevant). Sydney Metro contractors will be required to secure all other required statutory approvals prior to the commencement of works.

Any changes to traffic control devices (e.g. traffic signals or traffic signs) and traffic control facilities will require the approval from the road authority and arrangements with the road authority for the changes to occur. Regulatory sign and line-marking changes on local or Regional roads will require approval from the local council through a submission to the local traffic committee. Sign and line marking changes on State roads will require the approval of TfNSW.

6.2 Stakeholders

The agencies that may have a potential interest in the traffic management measures proposed for each Project construction site are outlined below:

- Transport Coordination
- Local council
- Sydney Trains
- Transport for NSW
- Department of Planning, Industry and Environment (for Sydney Olympic Park)
- Port Authority of NSW

6.3 Construction traffic management plans approval process

Construction Traffic Management Plans will require approval and consideration by several key stakeholders. Contractors should assess the overall required approval times at the beginning of the Project to provide adequate scheduling of the preparation and submission of the CTMPs.

Construction Traffic Management Plans (CTMPs), consistent with this CTMF, must be prepared for each construction site in consultation with the TTLG(s), and submitted to TfNSW for approval following Transport Coordination endorsement before construction commences at the relevant construction site.

In addition, where construction results in conditions in excess of the forecast impacts or where traffic management measures cause excessive delays or impacts, the contractor must review the measures identified in the CTMPs in consultation with the TTLG(s), as relevant. Any changes to the CTMPs must be submitted to TfNSW for approval, following Transport Coordination endorsement, before implementing.

An overview of the approvals process for Sydney Metro is as follows:

- Site-specific CTMPs will be prepared consistent with this CTMF by the contractor for each site covered under the contract. These CTMPs must comprise other plans or drawings such as Traffic Staging Plans, Traffic Control Plans, Vehicle Movement Plans, Pedestrian Movement Plans, a Parking Management Plan, unless otherwise agreed with the Principal's representative and the relevant Authorities, and address any changes from the EIS indicative haulage routes.

- Prior to the submission of the CTMP, the planned works and traffic management measures are presented to TfNSW, Transport Coordination and relevant Council at a TCG meeting. This will enable initial comments from the stakeholders to be considered in the preparation of the CTMP. The presentation should be distributed via email or the identified Project Document Management System at least five business days prior to the TCG meeting to enable informed discussion on the proposed traffic management measures.
- Planned works and traffic management measures also presented to TTLG, to obtain feedback from other key stakeholders. Notwithstanding presentation at the TTLG, the CTMP should be distributed to emergency services and other key stakeholders for information.
- The CTMP is modified in accordance with TCG and TTLG feedback
- This would then provide the basis for submission of the CTMP to Transport Coordination, TfNSW and relevant road authority for formal comments. Up to twenty business days should be allowed for the review of the CTMP by stakeholders and return of comments on the plan.
- Once comments have been received and the CTMP discussed at the next available TCG, a revised CTMP is submitted (if required) for review to the stakeholders, allowing ten business days for formal response.
- After review and resolution of issues, submitted to TfNSW for approval following the SCO endorsement, before construction commences at the relevant site. Ten business days should be allowed for the final approval.
- Sent to DPIE for information only, if required
- Published on the contractor's website prior to works commencing at the relevant site, if required.

  The contractor will be responsible for documenting all stakeholder feedback and comments in a document specific issues register. These comments will be addressed and closed out by the contractor in consultation with the relevant stakeholders. Sydney Metro, TfNSW and Transport Coordination will not be responsible for processing or referring comments on behalf of the contractor
- Changes to traffic management requirements at a site which requires material changes to the existing CTMP will require re-submission of the revised CTMP (with tracked changes) to TfNSW, Transport Coordination and local road authority for approval as applicable

This CTMP approval process is outlined in the flow chart in Error! Reference source not found..

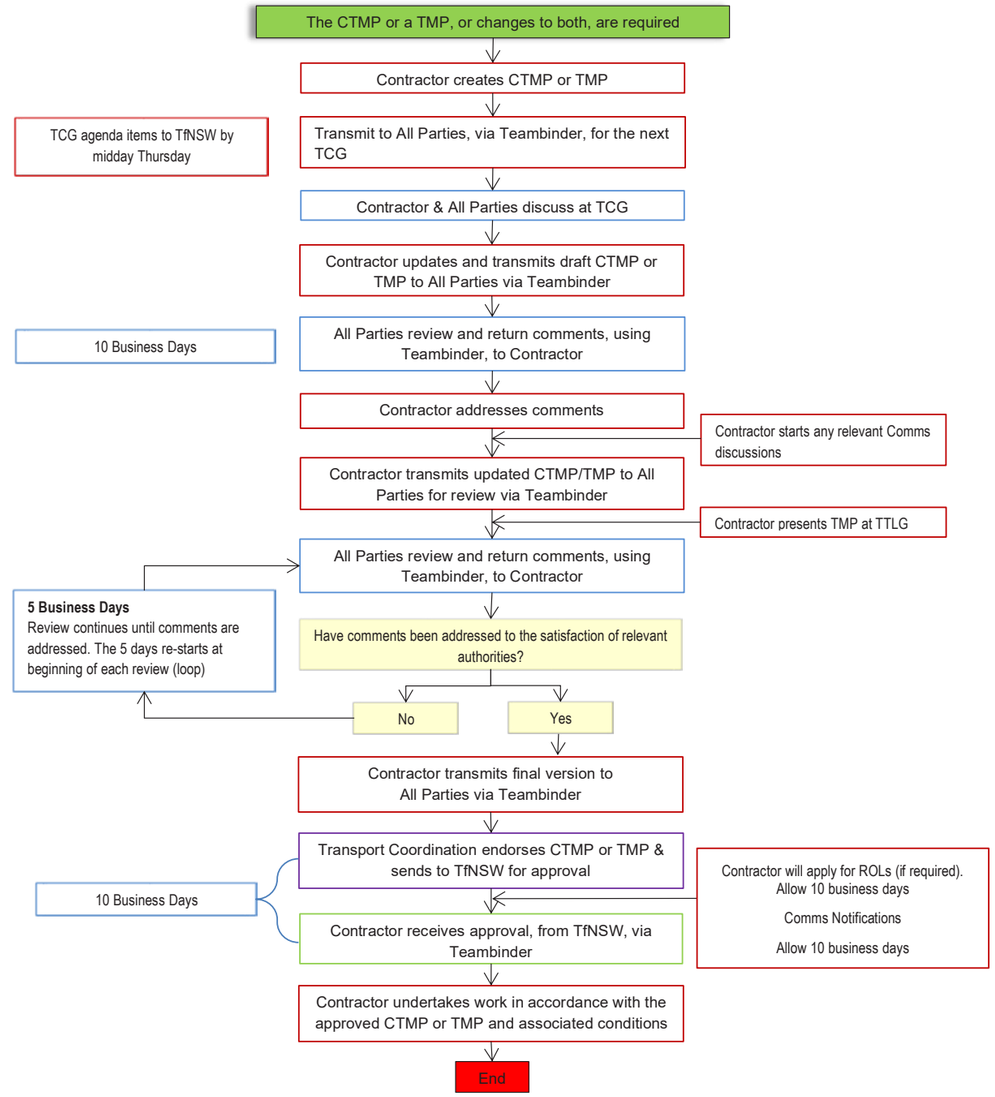

Figure 6-1: CTMP approval flowchart

6.4 Road Occupancy Licence process

Whenever it is proposed to occupy or close a lane or road during the construction program for each of the sites, the closure will require the contractor to apply for a Road Occupancy Licence (ROL) from Transport Coordination and/or the local council

or designated road authority. ROLs are issued by the Transport Coordination for approved times, following endorsement by the Transport Coordination, for TfNSW State roads or locations on Regional or local roads within 100 metres of traffic signals. It should be noted that due to the critical nature of the potential traffic impacts for local roads within the Sydney and Parramatta CBDs or other key centres that applications for ROLs on streets within these areas may be required to be submitted to Transport Coordination. The issuing of ROL's on local or Regional roads for lane or road closures in the CBD's above will also be subject to the approval of the local council.

The contractor will need to consult with stakeholders prior to submission of the ROL application and provide information as required.

For local roads, outside of the areas highlighted above, the approval of the local council or road authority will be required. This will require an application in the appropriate method to council or road authority.

The ROL requirements are outlined in the TfNSW Road Occupancy Manual (and in the Principal's General Specifications – Traffic and Transport Management).

The Contractor must allow a minimum of 10 business days for a response to an application from Transport Coordination. A minimum of 10 business days should also be assumed for responses to applications from other roads authorities.

ROLs will generally be issued for relatively short periods of time and Transport Coordination will require that an approved TCP or site CTMP for the work be in place.

Information on proposed and approved ROLs should also be provided to the Sydney Metro Project Communications Team for notification, prior to works commencement.

The general process for ROL's is outlined below:

- ROL and related applications are submitted by the contractor to Transport Coordination for occupation of roadway (other than approved work zones) on State and Regional roads and all works within 100m of traffic signals. These applications are approved by Transport Coordination for the times shown on the licence. A CTMP will be required to be approved prior to approval of the ROL.
- Application made to Transport Coordination for ROL.
- Transport Coordination assesses for potential conflicts, any identified conflicts to be resolved to satisfaction of Transport Coordination.
- Transport Coordination will review and assess prior to submission to TfNSW for approval
- Contractor may be requested by Transport Coordination to consult with other stakeholders including TfNSW (Infrastructure and Services)
- Contractors will require council or road authority approval of road occupancies/lane closures/permits to stand plant/road openings impacting Regional and local roads.

The contractor is to prepare and maintain a register of ROL applications and approvals providing stakeholders with status information throughout construction.

Upcoming ROL and related applications are to be discussed at TCG meetings for council and other stakeholder feedback prior to submission.

6.5 Speed zone authorisation

An application must be made to TfNSW for any proposed adjustment of the speed limit on the road network, whether they are proposed as temporary measures for work zones and road occupancies or for longer periods such as the duration of the construction works at a site. A Speed Zone Authorisation application usually accompanies a ROL application where a change in speed limit is proposed as part of the road occupancy.

The TfNSW speed zone change process involves the submission of the appropriate form, available online from the TfNSW website, which is to be submitted to Transport Coordination's Planned Incident Unit. Depending on the extent of the works and project familiarity the application will be supported by the site specific CTMP or a TCP. Short-term speed zone changes can be dealt with via the CTMP process. Longer term (over six months) or permanent changes are included in the site specific CTMP and are to be referred to TfNSW for assessment, consideration and approval. Permanent speed zone changes can only be approved by TfNSW.

6.6 Special event coordination

There are many special events that occur in and around the Sydney CBD, Parramatta CBD, Sydney Olympic Park and other locations around Sydney which may impact on the Projects. These special events have an impact through increased visitor numbers, road closures and diversion of bus services. The major events such as New Year's Eve, Australia Day, Vivid Festival, Royal Easter Show, major sporting events and ANZAC Day all have significant impacts with increased visitor numbers and the need to provide additional rail and bus services, and impacts on the road network. At some sites this may include pedestrian marshals if increased pedestrian activity is identified in the preparation of the CTMP.

Class 1 and 2 events, outlined below, are to be facilitated in the planning of work programs as works may not be permitted during these classes of events. For example, works are not permitted to happen between 3pm and midnight during the Vivid Festival in and around the Sydney CBD, Pyrmont and parts of Chatswood. Other areas and times may be incorporated in these restrictions in the future.

In addition, pedestrian activity in CBD and shopping centres increases significantly during December and early January, in the lead up to Christmas and the post-Christmas sales. The City of Sydney has a policy of not permitting works that will cause disruption to the retail core of the city during December. Other councils may have similar restrictions during key periods. Works that would have a significant impact on pedestrian paths and station access should be minimised during these periods and/or additional and increased interface supervision should be provided between the site and the adjoining pedestrian network.

The TfNSW special event management guidelines identify four classes of special events. These classes provide direction on the approvals required, timeframes and methods of advertising measures such as road closures and other aspects of the event. The classes of events can be summarised as follows:

- Class 1 – Events that impact major traffic and transport systems and result in significant disruption to the non-event community. For example, an event that affects a principal transport route in Sydney, or one that reduces the capacity of the main highway through a country town.
- Class 2 – Events that impact local traffic and transport systems and result in low-scale disruption to the non-event community. For example, an event that

blocks off the main street of a town or shopping centre but does not impact a principal transport route or highway.

- Class 3 – Events with minimal impact on local roads and negligible impact on the non-event community. For example, an on-street neighbourhood Christmas party.
- Class 4 – Events that are conducted entirely under Police control (but is not a protest or demonstration). For example, a small march conducted with a Police escort.

During the Project, special consideration and traffic planning will need to be undertaken for each of the sites to address the road user needs during programmed special events. It should also include the response to ad hoc events that may occur with minimal notice, including marches, protests and other public events.

The traffic management requirements of Special Events may require adjustments to times of operation and routes used for haulage or delivery operations as well as varying Road Occupancy Licence (ROL) conditions for Sydney Metro construction. The ROL approval and CTMP approvals will identify any time and day restrictions, taking in to account any known potential conflicts at the time of submission and approval. It should be noted that the contractor will be required to comply with any direction given by Transport Coordination regarding embargos that may be placed during Major / Special Events (all classes) and marches / special operations.

Sydney Metro contractors will be responsible for identifying special events that occur in the area of the work site, incorporating known special events into the construction program and detailing responses and contingencies in the CTMP for each site. This coordination will occur through Transport Coordination, approved event registers of councils, the TCG and the TTLG.

During development of the site specific CTMPs the proposed traffic management measures must take account of major and regular events, such as ANZAC Day or Royal Easter Show for example, to ensure that proposals do not impede or impact on these events.

6.7 Adjustments to traffic signals

Any temporary or permanent works that impact on the operation of, or require the reconstruction or adjustments to, traffic signals require close consultation with TfNSW and approval of the traffic signal design plans, prior to the commencement of any work.

The contractor will need to take account of potentially lengthy approval lead times in any works involving traffic signal construction or modifications. Additional time may also be required to facilitate the modification of the electronic hardware, in addition to undertaking any physical changes onsite. Approvals for modifications to existing traffic signals, or new traffic signals, can take up to six (6) months.

The contractor will be responsible for the preparation of any traffic signal designs and obtaining the necessary approvals, allowing sufficient time to maintain the works program. Designs will be required to be carried out by a TfNSW accredited signal designer and comply with the 'RMS Traffic Signal Design Manual' (RTA/Pub 08.092). Any works at a traffic signal site shall be carried out by a TfNSW accredited traffic signal contractor. A list of contractors for design and civil works can be found at http://www.rms.nsw.gov.au/business-industry/partners-suppliers/tenders-contracts/prequalified-contractors.html.

6.8 Over-size or Over-mass (OSOM) vehicle permits

Prior approval for the passage of any proposed over-size or over-mass vehicles is required from the National Heavy Vehicle Regulator, TfNSW for State roads, or councils for Regional or local roads, and an authorisation permit issued prior to the operation of the vehicle. A TMP is likely to be required that describes how an OSOM movement will be safely undertaken in NSW. Details can be found on the TfNSW website, which provides all requirements for applications.

6.9 Adjustments to bus routes and stops

Any proposed adjustments or relocation of bus routes and stops to facilitate construction works require the prior approval of TfNSW, Transport Coordination, the local council and affected bus operators.

Any proposed adjustments or relocation of bus shelters associated with bus stop changes or construction works require the approval of the local council and affected bus operators.

Customer information and wayfinding information for any relocated bus stops is to be provided before, and after, the relocation works have been carried out.

The following procedure for the relocation of bus stops and associated infrastructure is proposed:

1. Contractor consults with Transport Coordination, Transport Integration Section, on the proposal (which, in turn, consults with Infrastructure and Services Group of TfNSW and affected bus operators)
2. Contractor modifies proposal, as required
3. Contractor consults with Council(s)
4. Contractor documents bus stop change proposal in a CTMP
5. Contractor tables proposal at TCG and submits CTMP
6. Contractor to obtain approval through Local Traffic Committee (for local and Regional roads) or TfNSW (for State roads)

6.10 Adjustments to Australia Post mail boxes or other roadside furniture

Consultation regarding the relocation and/or adjustments to post boxes and the associated kerbside 'Mail Zone' will be required to be undertaken with Australia Post and the relevant road authority prior to any relocations occurring. In some instances, post boxes may be able to be relocated, however there will be instances where the post box, for heritage requirements, will not be able to be relocated. These post boxes will need to be protected to ensure that they are not damaged during construction works.

Adjustments or relocation of other roadside furniture or modifications to signposting such as advisory signs or regulatory signs will require consultation and approval of the owner. In most cases this will be the local council. Changes to regulatory signposting which defines the mail zone, and linemarking on local and Regional roads will require a submission to the Local Traffic Committee for agreement.

6.11 Local Traffic Committees (LTC)

Changes to regulatory signposting on local roads will require a submission to the Local Traffic Committee for council approval.

Each council is delegated authority by TfNSW on certain aspects for the control of traffic on Regional and local roads, including regulatory signposting. The delegation requires council to seek the advice of the NSW Police and TfNSW prior to exercising these delegated functions. This is usually done through the establishment and consultation with the Local Traffic Committee.

Councils can sub-delegate the approval of certain traffic control measures, such as Works Zones, to an appropriate staff member. These further delegations are determined by each individual council. Contractors will need to consult with council on the extent of the delegations.

Where possible, the contractor should endeavour to secure all necessary council approvals under delegation to avoid the need for approvals to be secured through the Local Traffic Committee and council meetings.

The Local Traffic Committee is a technical committee that considers matters related to prescribed traffic control devices and traffic control facilities for which the council has delegated authority. It is made up of four formal, or voting, members:

- One representative of council (may be a councillor or council officer)
- One representative of the NSW Police
- One representative of TfNSW
- The local state Member of Parliament or their nominee

Matters that may need to be considered by the Local Traffic Committee include:

- Establishment of a kerbside work zone on a local or Regional road
- CTMP's if regulatory signposting is proposed to be changed
- Changes to parking restrictions
- Road closures

It should be noted that a TMP will need to be provided separately to council for the above matters irrespective of any Transport Coordination/ TfNSW approval of a CTMP. Submission and approval of matters through the LTC can involve an extended timeframe. Matters will need to be submitted to council for inclusion on the LTC agenda approximately 2-8 weeks prior to the meeting. Different councils will have different requirements and these should be determined by the contractor to ensure sufficient time is allowed.

The LTC does not have delegation to approve matters on behalf of the council. The LTC provides recommendations to the Council. Only once the council has approved the LTC recommendation can work proceed. The timeframe between the LTC meeting and council meeting for approval can be 1-4 weeks.

Traffic management changes or proposed amendments to the public domain (e.g. footpaths or access across reserves) will require submission to the relevant Council, including possible referral to the Local Traffic Committee.

Road closures will require a TMP to be submitted to TfNSW (through Council) for approval prior to submission to LTC. Once approved by TfNSW it would then be listed for LTC meeting.

7 Management of construction traffic

7.1 Haulage routes

Designated access routes for heavy vehicle movements during demolition, construction and spoil removal will be along the arterial (state) road network as much as practically possible.

Where proposed haulage routes in the CTMP differ from the routes shown in the EIS/Submissions Report/PIR, the contractor will undertake a review and where necessary document these in the contract wide and site-specific CTMPs and provide a justification for these changes. Approved EIS heavy vehicle hourly volumes shall not be exceeded, unless otherwise agreed with relevant road authorities.

Details of any proposed routes for heavy vehicle access will be developed in consultation with the TCG, TTLG, relevant state or local government authority and detailed in the appropriate section of the site-specific CTMP. The CTMP would be approved by TfNSW following endorsement by Transport Coordination and the relevant roads authority.

In addition, measures should be in place to avoid heavy vehicles queuing on the road network near the worksite. In general, the sites for the project have a very constrained road network surrounding the site and the parking of vehicles on the surrounding road network will not be possible.

It will be necessary for the contractor to manage arrivals and departures for each site to ensure a consistent and timely arrival and departure of vehicles for the site, for example, the use of timetables. This should be communicated to all sub-contractors and operators prior to commencement of works.

Heavy vehicle movements through designated school zones should be minimised when these zones are in operation (8:00am to 9:30am, 2:30pm to 4:00pm, school days).

7.2 Management of heavy vehicle movements

Heavy vehicle movements must be managed in accordance with construction and traffic management principles of the CTMF and in accordance with the relevant standards. Each site-specific CTMP will need to demonstrate, where applicable, how marshalling facilities will be used to safely manage truck movements and reduce congestion. The arrival of trucks should be scheduled so that there is no queuing of trucks on adjacent streets. Trucks must not park on State, Regional or local roads for the sole purpose of waiting to enter the site.

Vehicle and pedestrian access to each work site, including the locations of entries, exits, turning restrictions, slip lanes, traffic signals, signage and other site management requirements will be established in line with the requirements of the Project approvals and in consultation with TfNSW, Transport Coordination and councils.

All vehicles are to enter and exit the construction sites in a forward direction. If this cannot be achieved then traffic control is to be provided. Refer to Section 7 of the 'Traffic Control at Worksites Technical Manual'.

7.3 Work zones and heavy vehicle marshalling

During some stages of the works at each of the sites there may be a requirement for using kerb space on adjacent streets for short-term parking or unloading for deliveries

to the site. Applications for a Works Zone will be undertaken by the contractor to the relevant authority (council for local and Regional roads and TfNSW for State roads). The use of a Works Zone should be minimised as much as practicable. Where approved, Works Zone locations are to be included in site specific CTMPs. In general, Works Zones will not be permitted within existing bus zones and their operating times, unless arrangements have been approved for the relocation of the bus zone.

7.4 Construction/demolition vehicle types

To minimise the number of heavy vehicle movements on the road network, the selection of vehicle size will consider the number of movements required, the impact of the quantity of vehicles on road and pedestrian movements, road geometry and safety. It is recognised that CBD sites will have constraints on access routes, safety considerations and specific site constraints.

The types of truck to be used for the transporting of materials will be assessed in consultation with the relevant authorities in the preparation of the contract wide and site specific CTMPs.

Heavy vehicles used on the project must comply with the relevant standards including the safety requirements outlined in the SM PS-ST-221 Sydney Metro Principal Contractor Health and Safety Standard.

Higher mass and longer heavy vehicles will be required to transport certain materials to and from the sites (some under permit) and these would be subject to separate approvals.

It is anticipated that contractors will need to make use of truck and dog heavy vehicle combinations for the removal of spoil from tunnel or station excavation. Details of proposed truck and dog use are to be provided in the CTMPs.

'Truck and dog' combinations of 19m or less in length and up to 4.3m in height are classified as General Access Vehicles (GAV) in that they comply with mass and dimension requirements prescribed by TfNSW and do not require a notice or permit to operate on the road network. These vehicles have general access to the road network unless the road is sign-posted otherwise.

7.4.1 Worker access and parking

The constrained nature of the sites means car parking for construction personnel will not be possible at most sites. At each of the sites there may be the opportunity to provide minimal light vehicle parking spaces for engineers and other site management staff use.

The contractor may also be required to identify remote parking areas for workers, to minimise any impacts of workers parking on-street.

The assumption for all site specific CTMPs is that there will be no provision, either on the road or within the work site, for worker parking. Workers should be encouraged to use public transport in travelling to and from the work sites.

7.4.2 Construction consolidation centre/depot

To mitigate the potential impact of construction traffic the provision of a centralised Project centre should be considered. This centre could receive deliveries and arrange for combining of loads and materials for distribution to the various construction sites. This would have the potential to reduce construction traffic movements to the sites, particularly for small loads. Contractors may make use of their existing depots.

7.4.3 Driver training

Heavy vehicle drivers should be made fully aware by the contractor of the construction site traffic management arrangements and site-access requirements, including approach and departure routes and any heavy vehicle noise management measures required. Driver training should consider current best practice and information, including cycle awareness training.

The contractor is to ensure that regular briefings are provided to drivers on routes, potential changes and impacts on the routes in the form of toolbox talks.

Contractors must ensure mandatory completion of the Sydney Metro project-specific heavy vehicle driver introduction training.

Contractors are required to have systems in place to monitor vehicle locations (e.g. telematics) at all times and report and address any identified non-conformances.

7.4.4 Chain of responsibility and Heavy Vehicle National Law

Contractors must have systems in place to ensure compliance with 'Chain of Responsibility' legislation, including the Heavy Vehicle National Law and regulations, at all times. All necessary heavy vehicle approvals and permits (for example, over-size, over-mass, etc.) must be obtained from the relevant road manager. Specific 'Chain of Responsibility' requirements are further outlined in Sydney Metro Principal Contractor Health and Safety Standard.

8 Construction site traffic management requirements

8.1 Traffic control at construction sites

The contractor must develop and implement Construction Traffic Management Plans (CTMPs) to minimise and mitigate traffic impacts, including road safety impacts, caused by the contractor's activities. In consultation with the TTLG, TfNSW, Transport Coordination and the relevant local council or road authority, the contractor must develop, formalise and implement traffic management, control and operational protocols, procedures, processes, systems and communication between the contractor and Transport Coordination. Works within the road reservation will be identified in the CTMP.

This consultation will be initiated through the TTLG and TCG.

8.1.1 Policy and responsibilities

Work zones provide for the safe operation of road workers and the safe passage of vehicular and pedestrian traffic. Traffic control devices are provided to warn, instruct and guide road users safely through, around or past construction sites on roads and footpaths.

An important aspect is for the planning and staging of the works to ensure that any workers required to work on or near the road are separated from traffic as much as possible. Traffic control at construction sites is to be provided in accordance with the latest edition of the *Traffic Control at Work Sites Technical Manual (TfNSW)* and *Sydney Metro Principal Contractor Health and Safety Standard*. Australian Standard *AS 1742.3 Manual of uniform traffic control devices – Traffic control for works on roads*, is also to be referenced when determining traffic controls and signposting.

It is the responsibility of all personnel engaged on the Project and at construction sites to ensure that any works carried out on the road are done so in a safe and efficient manner. The contractor will prepare specific Traffic Control Plans (TCP) for all work that will impact on the road and traffic.

TCPs are required to be prepared by a suitably qualified person who holds a current TfNSW certificate – *Prepare Work Zone Traffic Management Plan*.

When temporary speed limits are required, the contractor will be required to make the necessary application to TfNSW. These may also be required to be outlined in the site CTMP, detailing the anticipated impacts and mitigation strategies. This application will need to be submitted with sufficient time prior to the proposed implementation, to allow for processing and authorisation, via the Transport Coordination (TMC) OpLinc system.

8.1.2 Traffic control techniques

There are several traffic control methods that can be used at construction sites, which must be selected in accordance with the hierarchy of controls to ensure safety risks to workers (including traffic controllers) and the public are minimised 'so far as is reasonably practicable' (SFAIRP). These include:

(a) Temporary road deviations.

(b) Line-marking with raised pavement markers to delineate proposed diversion.

(c) The use of traffic cones, approved water filled barriers or other approved physical devices to delineate the required route.

(d) Directional and information signposting to direct or advise drivers. This can include Variable Message Signs (VMS), directional arrows or static signs.

(e) Portable traffic signals on local roads to control traffic flows if lane closures are required, subject to the relevant authority approval

(f) Other traffic control devices as provided in the TfNSW 'Traffic Control at Worksites Technical Manual'.

Refer also to Sydney Metro Principal Contractor Health and Safety Standard.

For longer-term works, where traffic management devices are in place for an extended length of time, regular inspections are to be carried out by the contractor's works supervisor. This is to ensure that the controls in place continue to provide safe traffic management. All controls are to comply with the current TfNSW guidelines.

8.1.3 Approved clothing for work personnel

Any worker working near traffic will be required to wear clothing in accordance with the requirements of Australian Standard AS1742.3 and *Sydney Metro Principal Contractor Health and Safety Standard*.

8.1.4 Plant and equipment

Any plant used and working near traffic or pedestrians is to be suitably highlighted with physical protection and appropriate warning signs provided to ensure public safety. Refer also to the 'Plant and Equipment' section of *Sydney Metro Principal Contractor Health and Safety Standard*.

8.2 Frequency of inspections

For long-term works, that is, longer than one shift, traffic management road inspections will be carried out regularly by the contractor's works supervisor to ensure the safe movement of traffic and the protection of persons and property through and/or around the construction site. The required inspections of all temporary traffic control devices are detailed in the following section.

Inspections will ensure that all signs and devices are properly located, oriented and maintained in an effective condition, and that the layout is satisfactory and not confusing to motorists or pedestrians. Records will be maintained by the contractor of all traffic guidance facilities and any adjustments or changes made to such facilities, together with dates and times the facilities were installed, varied and removed. Inspection reports recording dates and times of inspections of the traffic management facilities are to be recorded on a suitable pro-forma and made available for inspection.

Incidents are to be reported, investigated and actioned in accordance with the *Sydney Metro Principal Contractor Health and Safety Standard*.

8.2.1 Inspections of roadwork traffic management schemes

The requirement to undertake inspections of traffic control measures is outlined in Section 6.1 of the *Traffic Control at Worksites Technical Manual (TfNSW)* and Appendix A of Australian Standard *AS 1742.3 – Manual of uniform traffic control devices – Traffic control for works on roads*. There are three main types of inspections to be carried out:

(a) Pre-start and pre-close-down inspections of short-term traffic control.

(b) Weekly inspections of long-term traffic control.

(c) Night inspections of long-term traffic control.

Appendix E of the Traffic Control at Worksites Technical Manual provides inspection checklists and forms that can be used for all inspections, whether short term, long term or night. The responsibility and frequency of the inspections required is provided in Section 6.1 of the Traffic Control at Worksites Technical Manual.

8.3 Emergency incident planning

Incident management planning must be carried out in accordance with the *Sydney Metro Principal Contractor Health and Safety Standard*, and must include incidents that could occur on roads. An Incident Management Plan for on-road incidents, or incidents that impact on the public transport network should be submitted to Transport Coordination Emergency Transport Operation section for review and comment.

Examples of incidents could include the following:

- Traffic crashes
- Hazardous material spillage
- Power failure
- Terrorist attack
- Flooding
- Fire
- Structural damage to a rail line, building, road tunnel or bridge

The Incident Management Plan should include procedures such as:

- Duties of workers attending the site
- Procedures for contacting Police, emergency services, or back-up assistance from the relevant road authority
- Equipment that is to be ready always on potential call-out vehicles

All details of incidents that occur within the area of an approved ROL are to be recorded by the contractor, and reported and investigated in accordance with the requirements of the Sydney Metro Principal Contractor Health and Safety Standard.

8.3.1 Accidents/incidents and complaints

The contractor's ROL register will maintain records of traffic crashes and incidents reported at construction sites. Any complaints received regarding traffic delays at construction sites should be referred to the Principal. The contractor will be required to table the register, upon request, at TCG meetings.

The person in charge of the construction site will continue to be responsible for dealing with complaints regarding safety issues. Where action is considered necessary to address the matters of complaint, an appropriate recommendation will be forwarded to the Principal.

8.3.2 Chemical spills and leaks

Information on procedures to be followed and properties of hazardous chemicals are detailed in:

- NSW Environmental Protection Authority (http://www.epa.nsw.gov.au/licensing/Dutytonotify.htm)
- Safe Work NSW codes of practice
- TfNSW policy procedure – Procedure for Managing Hazardous Chemicals
- Contractors' Construction Environmental Management Plans.

NSW Fire and Rescue is primarily responsible for rendering safe, and cleaning up after, incidents involving flammable or hazardous substances, vapours, gases or liquid spillage, as well as an actual fire or explosion.

NSW Fire and Rescue holds detailed information on dangerous goods and hazardous chemicals. Sydney Metro staff and contractors are to be instructed not to approach such spills until NSW Fire and Rescue have declared the site safe. In such cases the contractor will close the roadway at a safe distance until NSW Fire and Rescue arrives and issues appropriate instructions.

8.4 Traffic controllers and temporary traffic signals

The use of traffic controllers and/or temporary traffic signals to control traffic at construction sites is to be in accordance with the Traffic Control at Work Sites Technical Manual (TfNSW) and Sydney Metro Principal Contractor Health and Safety Standard.

Variable Message Signs (VMS) will be used to inform drivers, where necessary, to avoid particular roads or areas where activities associated with Sydney Metro construction would cause disruption. Where these are used, it is to be in accordance with documented Austroads Guidelines, TfNSW supplements, procedures, guidance and approval of the road authority.

The placement of temporary VMS must consider pedestrian safety and disabled access needs when placed on footpaths. A ROL may be required when a portable VMS is proposed to be in a parking or loading bay. VMS placement should conform to Austroads Guidelines, TfNSW supplementary material and approval processes of the road authority.

9 Management of construction sites

9.1 Construction site boundaries

Details of the proposed erection and maintenance of hoardings, scaffolds and associated structures will be documented in the site-specific Construction Traffic Management Plans. Where reasonable and feasible, all construction site boundaries will be clearly defined with the use of hoardings or fencing. The CTMPs will identify the boundaries and detail accesses for the site, the footpath and road controls. Activities within the construction site are excluded from the CTMPs, except in relation to ensuring the movement of construction traffic in and out of the construction site is physically possible and can be done safely. Construction sites include any gantries (e.g. Type B hoardings) or other structures associated with the site layouts. The site specific CTMPs will consider these interactions and the impacts of gantries, etc., on the road and footpaths.

9.2 Hoardings

Hoardings will be required to be erected around the construction sites to protect the site and any passing pedestrians and vehicles. These may also need to provide site facilities for the workers on the site due to the constrained nature of the sites. The erection of hoardings around the sites will require the consideration and approval of the local council if located within the road reserve, and other local authorities where applicable. Applications for scaffolds and hoardings would be to the relevant council with concurrent notifications to Sydney Metro, TfNSW and Transport Coordination.

In providing any hoarding and gantry structures, consideration will be given to ensuring sight-lines for side roads, vehicle accesses, signposting, and traffic signals are maintained. Respective councils may have published policies on hoardings on their website. While the policy document provides guidelines for the presentation of the hoarding, the branding and visual aspects of the hoarding are to be in line with TfNSW/Sydney Metro requirements.

Each council or other authority may specify requirements for the type of hoarding proposed within the road reserve and may require the submission and approval of an application prior to the commencement of the site establishment works. Detailed information should be obtained from the respective council websites. In some locations there may also be a requirement for the hoarding to comply with design guidelines.

All hoardings around Sydney Metro construction sites should comply with the TfNSW/Sydney Metro branding requirements. If it has been determined that an application for a hoarding is required to be submitted to a local council for approval, information that would be required to be submitted with the application can include, but is not limited to, the following:

- Plans of the proposed hoarding drawn to scale, elevations of hoardings and identifying any council or other asset that may be impacted
- An engineer's statement on the proposed hoarding and any facilities to be provided
- Approval from NSW Police
- Approval from TfNSW (for sites located on a state road or on any road within 100 metres of traffic signals)
- Structural certificate (for Class B hoarding)

Hoarding application forms for specific councils can generally be found on the council website. In addition, councils or other road authorities may have specific requirements for the type of hoarding and operational requirements. The contractor must check with the relevant council and road authority over any specific requirements.

The application for permits to erect hoardings may differ between councils or road authority, and this will need to be considered for each construction site.

9.3 Site security, site access and signage

The issues to be considered in determining the location of site accesses are:

- Safety of travelling public
- Safety of construction workers and equipment
- Efficient and safe entry and exit to the site including turning paths, consistent with the requirements of the relevant Australian Standard, Austroads or TfNSW guidelines
- Impact on local communities in terms of safety, noise and road damage
- Ease of access for emergency vehicles
- Site security

The construction sites will have appropriate arrangements to discourage entry without approval and minimise vandalism. All access points to construction sites will have lockable gates.

Appropriate information signs will be provided at construction sites to identify the Project and contact persons.

Contractors will be required to develop and prepare Security Management Plans based on the site-specific security threats (hazards) identified. Requirements for Security Management Plans are outlined in Sydney Metro Principal Contractor Health and Safety Standard.

9.4 Pedestrian security/safety/lighting

The consideration of safety and security issues for pedestrians will be considered at all construction sites. For those footpath or specific cycle facility areas which will be impacted by construction works the contractor is to undertake a condition assessment to ensure that they remain suitable for use. This would include an assessment of the paving and lighting of the footpath/cycleway to maintain a safe and suitable passage.

Any hoardings or other structures on the site boundaries will have lighting in accordance with current standards, particularly where existing street lighting is removed or obscured because of the site works. In those locations where this occurs, supplementary lighting is to be provided to meet the current standards.

Discussions will be carried out with the relevant authority or operator of CCTV cameras if the coverage or operation of CCTV cameras is impacted by the works. The relevant authority may be TfNSW, council, other authority or building owner.

9.5 Management of risks to vulnerable road users

The contractor is to adopt applicable vulnerable road user safety measures, as per Sydney Metro Principal Contractor Health and Safety Standard, to minimise the road

safety risks to pedestrians, cyclists and motorcyclists on route to, and near, construction sites. Such measures include, but are not limited to:

(a) Assessing the suitability of construction haulage routes through sensitive land use areas with respect to road safety

(b) Deployment of speed awareness signs in conjunction with variable message signs near construction sites to provide alerts to drivers

(c) Providing community education and awareness about sharing the road safely with heavy vehicles

(d) Specific construction driver training to understand route constraints, safety and environmental considerations such as sharing the road safely with other road users and limiting the use of compression braking

(e) Requiring technology and equipment to eliminate heavy vehicle blind spots, monitor vehicle location and driver behaviour, and improve vehicle safety standards.

Where construction sites have an impact on footpaths, consideration must be given to the requirements of all pedestrians and especially where there is the potential for vulnerable road users, such as school children, elderly people and mobility impaired people. This is to include condition surveys of affected footpath areas to ensure that they are suitable and appropriate for use.

DDA requirements will be adopted with kerb ramps or other measures provided at road crossings. Footpath widths are required to provide for two-way pedestrian traffic allowing for prams or strollers and wheelchairs to pass each other without requiring temporary widening from their existing width prior to construction commencement. Narrowing of the footpath width, if required, is to be approved by the relevant authorities.

Where high numbers of vulnerable road users are using a footpath, special provision and design consideration may be required to mitigate any impacts.

10 Road safety audits

10.1 Purpose and benefits

A Road Safety Audit (RSA) “assesses a road’s safety performance and crash potential at various stages of a road/project’s life cycle” (Road Safety Audits Fact sheet – RTA 2010).

It is a formal procedure for checking the design, implementation and operation of road works and other traffic measures from a safety perspective. The establishment of quality systems provides the philosophy underpinning the RSA process. The overriding objective of the process is to ensure that all existing road schemes and future routes operate at an acceptable level of safety, with safety being an integral part of the road network development process.

The benefits of a RSA are that:

(a) The likelihood of crashes on the road and the adjacent network can be reduced.

(b) The severity of crashes can be reduced.

(c) Road safety is given prominence in the minds of road designers.

(d) The need for costly remedial work is reduced.

(e) The total cost of a project to the community, including crashes, disruption and trauma, is reduced.

Road Safety Audits will be undertaken by the contractor during the three stages outlined below.

- Detailed design stage

At this stage, the geometric design, traffic signage scheme, line-marking plans, lighting plans and landscaping plans are available and will be reviewed in in relation to the operation of the road.

- Pre-opening stage

Prior to the opening of a site, an inspection will be made for all relevant conditions during both the night and day for all likely road users, to ensure that the construction has addressed earlier audit concerns and to check for any hazardous conditions that were not apparent at the feasibility or design stages.

- Road safety audits of Construction Traffic Management Plans

Sydney Metro and/or its contractors will undertake Road Safety Audits for site-specific CTMPs, to be submitted with the CTMP to stakeholders. The contractor will be required to respond and address all RSA comments before the approval of the CTMP by Transport Coordination.

Regular safety audits of work zones are also to be undertaken to ensure all construction site safety arrangements are in place. These audits will be additional to the daily inspections by the site staff. Attention will be given to WHS guidelines, work areas adjacent to the road, movement of construction traffic, vehicle speeds and all warning devices or systems.

- Road safety audit procedure

All Road Safety Audits will be undertaken in accordance with the Guidelines for Road Safety Audit Practices (RMS, 2011), with reference to current practices outlined in

Guide to Road Safety Part 6, Road Safety Audit (Austroads, 2009) and Sydney Metro Principal Contractor Health and Safety Standard.

11 Related documents and references

Related documents and references
• SM PS-ST-221 Sydney Metro Principal Contractor Health and Safety Standard • Principal's General Specifications – Traffic and Transport Management • SM QM-FT-435 Integrated Management System (IMS) Glossary

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Appendix G

Cumulative impacts assessment methodology – Stage 1

Appendix G

Cumulative impacts assessment methodology – Stage 1

This appendix describes the methodology for the cumulative impacts assessment included in the Stage 1 impact assessment.

1.1 Overview

Cumulative impacts can occur when impacts from a project interact or overlap with impacts from other projects and can potentially result in a larger overall effect on the environment, businesses or local communities. Cumulative impacts may occur when projects are constructed concurrently or consecutively. Projects constructed consecutively (or sequentially) can have construction activities occurring over extended periods of time with little or no break in construction activities. This has the potential for increased impacts and construction fatigue for local communities. Construction fatigue can also potentially cause complaint fatigue, which is where impacted residents do not complain as they believe corrective action is unlikely to occur and hence there is no point in lodging a complaint.

1.2 Legislative and policy context

The Department of Planning, Industry and Environment is currently developing a guideline on cumulative impact assessment for State significant projects. The Secretary's Environmental Assessment Requirements refers to the need to undertake an assessment of the relevant cumulative impacts that take into account other State significant projects that have been approved but where construction has not commenced, projects that have commenced construction, and projects that have recently been completed and approved construction in the relevant precincts. The Secretary's Environmental Assessment Requirements also require that for each Stage 1 key issue, the impacts of concurrent activities and cumulative impacts (parallel and sequential) with other projects be assessed.

The cumulative impact assessment of Stage 1 has been prepared to address the Secretary's Environmental Assessment Requirements.

1.3 Assessment methodology

The assessment methodology for the cumulative impact assessment for Stage 1 involved:

- Development of screening criteria that would be used to determine whether a project should be assessed for cumulative impacts
- Identification of projects for each Stage 1 construction site, that could be considered for cumulative impacts
- Application of screening criteria to determine which projects should be taken forward to the cumulative impact assessment.

The assessment methodology is shown in Figure 1.

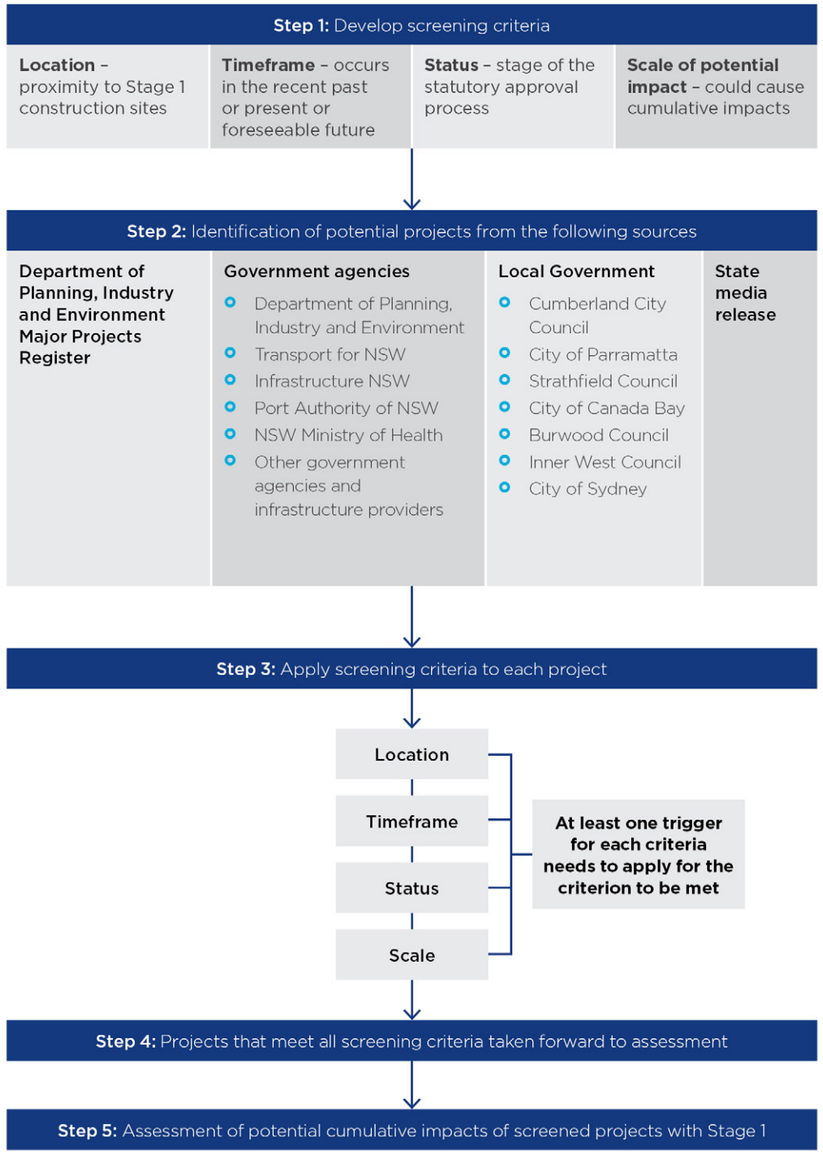

Figure 1: Overview of the cumulative impact assessment methodology

1.3.1 Screening criteria

Screening criteria were developed as shown in Table 1 to determine whether a project or local strategic plan should be included in the cumulative impact assessment.

The screening process includes four criteria to identify whether a project should be assessed for cumulative impacts with Stage 1:

- Location – proximity to Stage 1 construction sites
- Timeframe – occurs in the recent past or present or foreseeable future
- Status – considers the stage of the statutory assessment and approval process
- Scale – impacts of a scale that could cause cumulative impacts with Stage 1.

Several triggers were developed for each screening criteria to objectively determine whether a project could potentially cause a cumulative impact with Stage 1 and should be considered in the cumulative impact assessment.

Projects that satisfied at least one of the triggers in each criteria were included in the cumulative impact assessment and are described in Section 1.4.

Table 1: Screening criteria for cumulative impact assessment

Criteria	Description	Triggers
1. Location	A project was considered relevant for consideration where the project met at least one of the triggers	• Direct overlap: construction footprints intersect with Stage 1 • In the area: within one kilometre of Stage 1 construction footprint[1]
2. Timeframe	A project was considered relevant where the project met at least one of the triggers	• Concurrent construction programs • Consecutive construction programs (18 months or less between the Stage 1 and the projects construction programs) and can include projects that have recently completed construction Note: A conservative approach was adopted for approved projects with no published construction program. In these cases, the projects were considered in the cumulative impact assessment and assumed to have met either trigger 2a or 2b.
3. Status	A project was considered relevant where the project was at one of the following stages of the statutory assessment and approval process	• Approved projects (statutory approvals received), including approved projects that have not started construction, projects currently under construction, and recently completed projects • Proposed projects (currently under statutory environmental impact assessment which includes where an application has been lodged) • Local strategic plans (made public by a government agency)
4. Scale of potential impact	A project was considered relevant where the project involved substantial impacts to one or more of the following aspects	• Traffic and transport • Noise and vibration • Non-Aboriginal heritage • Aboriginal heritage • Property and land use • Landscape character and visual amenity • Business impacts • Social impacts • Groundwater and ground movement • Soils and surface water quality • Contamination • Hydrology and flooding • Biodiversity • Air quality • Waste management and resource use • Hazards • Sustainability

Note: Some exceptions have been identified where there is a potential impact to extend beyond this zone, such as noise from road haulage on roads that are further than one kilometre from the construction site.

1.3.2 Identification of projects

An initial list of major projects for potential inclusion in the cumulative impact assessment was identified from the sources outlined in Figure 1.

Projects on this initial list that satisfied at least one of the triggers for each screening criteria in Table 1 were included in the cumulative impact assessment.

The list of projects identified can be broadly categorised as:

- Major transport infrastructure projects, including public transport projects and road projects
- Large-scale urban development projects and other infrastructure projects.

Local strategic plans were also considered where they may result in future development with potential cumulative impacts with Stage 1.

The Stage 1 construction sites are relatively distant from each other geographically, so there are unlikely to be intra-project cumulative effects (where a Stage 1 construction site could cause a cumulative impact with another Stage 1 construction site). If intra-project cumulative effects are predicted, these have been discussed in the main body chapters of the Environmental Impact Statement.

1.3.3 Approach to potential cumulative impact assessment

Projects and plans that met the screening criteria and were identified for the cumulative impact assessment have been considered for the cumulative impact assessment.

Potential cumulative impacts may occur on the same receiving environment or community from:

- Stage 1 activities in an area recently affected by activities from previous projects
- Stage 1 activities combined with activities from other projects that could cause a cumulative impact on a single environmental or social value or asset
- Stage 1 activities combined with activities from other projects that could cause a cumulative impact on multiple environmental or social values or assets.

The potential cumulative impacts during construction of Stage 1 are described in Chapters 10 to 25 of this Environmental Impact Statement. In locations where cumulative impacts relating to a key issue has been assessed as negligible, the issue is not considered further.

1.4 Projects assessed

The projects that met the screening criteria for consideration in the cumulative impact assessment are included in Table 2.

Local strategic plans listed in Table 3 have been considered in the assessment where relevant, as they could influence future development that has the potential to result in cumulative impacts with Stage 1. However, the potential impacts from local strategic plans have not been considered in detail given the uncertainty of the status, timing, design and construction methods of associated projects.

Table 2: Projects assessed in the cumulative impact assessment

Project name, status, and expected construction period	Brief project description	Relevant locations where cumulative impacts may occur
24-26 Railway Parade Westmead ***Approved (with deferred commencement)*** ***No construction program***	The proposal involves the demolition of existing structures, tree removal, and the construction of a 16-storey mixed-use development. The development would comprise retail, indoor recreation (gymnasium), licensed bar/restaurant, medical centre, from basement to Level 2, then 5 storeys for hotel accommodation with 97 rooms, 6 storeys for 33 residential apartments, and 4 levels of basement car parking. The proposal also includes site preparation works, public domain works, an accessible through site link and public domain upgrades along railway Parade and Ashley Lane.	• Westmead metro station
Parramatta Light Rail – Stage 1 ***Approved*** ***Construction program 2018 – 2023***	Parramatta Light Rail Stage 1 comprises a light rail network from Westmead to Carlingford and Camellia. Key features of the project include: • 12 kilometres of light rail track, including seven kilometres within the existing road corridor separated from general traffic and five kilometres utilising the existing T6 Carlingford Line and former Sandown freight line • 16 light rail stops • Two light rail and pedestrian zones within the Parramatta CBD along Church Street (between Market Street and Macquarie Street) and Macquarie Street (between Horwood Place and Smith Street) • An integrated stabling and maintenance facility located in Camellia • Light rail vehicle driver amenities at light rail termini at Westmead and Carlingford and at the stabling and maintenance facility at Camellia • Ancillary infrastructure (substations, overhead lines and poles) • Alterations to the existing road and rail network to accommodate the project • Active transport corridors and additional urban design features along sections of the alignment and at stop locations.	• Westmead metro station • Parramatta metro station • Clyde stabling and maintenance facility
Parramatta Light Rail – Stage 2 ***Proposed*** ***No construction program***	Parramatta Light Rail Stage 2 would involve a new light rail network connecting Stage 1 and the Parramatta CBD to Ermington, Melrose Park, Wentworth Point and Sydney Olympic Park along a nine-kilometre route.	• Parramatta metro station • Clyde stabling and maintenance facility • Sydney Olympic Park metro station
Parramatta Leagues Club Hotel ***Proposed*** ***No construction program***	The proposal involves the demolition of existing buildings and the construction of a 17-storey hotel building (plus a single level basement for services). The building would include accommodation, a café, pool, fitness/recreational uses and a function room ancillary to the hotel. Access is proposed from O'Connell Street to the south of the building (via an access road to the adjoining Parramatta Stadium). The proposal includes public domain works and service upgrades surrounding the building to integrate the building with the surrounding area and infrastructure.	• Parramatta metro station
Quest Hotel (5 Victoria Road, Parramatta) ***Approved*** ***No construction program***	The project involves the demolition of existing structures and the construction of an eight-storey hotel and two levels of basement car parking.	• Parramatta metro station
New Powerhouse Museum, Parramatta ***Proposed*** ***Construction program 2019 – 2023***	The proposal involves the construction and operation of the New Powerhouse Museum at the intersection of Philip Street and Wilde Avenue in Parramatta. The proposal includes 18,000 square metres of exhibition space and is currently the subject of an international design competition.	• Parramatta metro station
Westfield Shopping Centre Parramatta Retail and Commercial development (Stage 1) ***Approved*** ***No construction program***	The project involves the staged extension of Westfield Shopping Centre Parramatta. The concept plan included in the proposal includes the following construction components: • An additional single level of retail uses over the existing shopping centre footprint • A 20-storey commercial tower above the retail podium • An additional 1,100 aboveground car spaces • Street activation and public domain works on the corner of Church and Argyle Streets. Stage 1 involves the construction of the additional retail uses and car spaces described above.	• Parramatta metro station
89 George Street Parramatta ***Approved*** ***No construction program***	The project involves the demolition of existing structures and the construction a 24-storey hotel building. The building would include accommodation, an ancillary restaurant/bar, outdoor terrace/pool, ballroom, and 69 above ground car parking spaces. The project includes landscaping works.	• Parramatta metro station
99 - 119 Macquarie Street, Parramatta ***Proposed*** ***No construction program***	The project involves a 14 storey mixed use (retail, office, student housing, group home and boarding house) building envelope at 99-113 Macquarie Street (Epworth House), 13 storey mixed use (church administration, community facility, student housing, group home and boarding house) building envelope at 119A Macquarie Street (Fellowship Centre), 2-6 storey basement envelope (retail, church administration and 142 parking spaces)	• Parramatta metro station
6-7 Parramatta Square, Parramatta ***Approved*** ***Construction program 2018 - 2022***	Construction of a 56 storey commercial tower, including plant and a function centre on level 55. The development includes works within Darcy Street comprising service infrastructure diversions, rebuilding of Darcy Street roadway, kerb and footpaths, associated landscaping and public domain works, and provision and augmentation of physical infrastructure. The determining authority for the application is the Sydney Central City Planning Panel.	• Parramatta metro station

Project name, status, and expected construction period	Brief project description	Relevant locations where cumulative impacts may occur
116 Macquarie Street and 7 Charles Street, Parramatta *Approved* *No construction program*	The proposal involves the demolition of existing structures and the construction of a 48-storey mixed-use tower. The building would include residential units, retail floor space, office floor space and basement levels for car parking, storage and services.	• Parramatta metro station
Macquarie Street residential development (142-154 Macquarie Street, Parramatta) *Approved* *Construction program 2017 - 2021*	The project involves the demolition of existing structures and the construction of three mixed-use towers. The towers will be 60, 35 and 25 storeys respective and include residential units, hotel accommodation, commercial and retail space and basements levels for car parking, storage and services.	• Parramatta metro station
Western Sydney University Innovation Hub (2B-6 Hassall Street, Parramatta) *Approved* *No construction program*	The proposal involves the development of a mixed-use facility comprising a tertiary institution, commercial office space and retail space. The proposal includes the following construction components: • Construction of a 19-storey building • Landscaping and public domain works including a ground-level pedestrian plaza • Extension and augmentation of services and infrastructure as required.	• Parramatta metro station
163-165 George Street Parramatta *Approved* *No construction program*	The proposal involves the construction of a place of worship building, comprising a Grand Cathedral, public forecourt space, multipurpose hall and associated basement parking.	• Parramatta metro station • Clyde stabling and maintenance facility
Clyde Terminal Conversion Project *Approved* *Construction program 2015 - 2025*	The project involves the removal of redundant crude oil refinery and import facilities at the Clyde Terminal and upgrade of existing facilities to allow for the receipt, storage and distribution of finished petroleum products. The project would result in a reduced operational footprint for the terminal. The project involves the following components: • Demolition of existing oil refinery processing units, surplus storage tanks and other redundant infrastructure • Upgrade of existing storage tanks and supporting infrastructure and utilities to be retained.	• Clyde stabling and maintenance facility • Silverwater services facility
Viva Energy Clyde Western Area Remediation Project *Proposed* *No construction program*	The proposal involves the remediation of contaminated soils associated with former oil refinery activities to facilitate future development of the land for other purposes permissible under the existing land use zoning.	• Clyde stabling and maintenance facility • Silverwater services facility
WestConnex M4 East *Approved* *Construction program 2016 – 2019, construction completed in July 2019*	The project involves the extension of the M4 Motorway in tunnels between Homebush and Haberfield via Concord. The project is about 6.5 kilometres long, with 5.5 kilometres of the motorway underground.	• Sydney Olympic Park metro station • North Strathfield metro station • Burwood North Station • Five Dock Station
WestConnex M4 Widening Modification – Westbound Off-ramp to Hill Road *Proposed* *No construction program*	The proposal involves the construction of a westbound off ramp from the M4 Motorway onto Hill Road, Lidcombe as part of the WestConnex network.	• Sydney Olympic Park metro station
Stadium Australia Redevelopment *Proposed* *No construction program*	The proposal involves the redevelopment of Stadium Australia, including alterations to the roof and upgrades to lower and middle seating rows, corporate and member facilities, ancillary food and beverage facilities and amenities.	• Sydney Olympic Park metro station
Site 8C Murray Rose Avenue, Sydney Olympic Park *Approved* *No construction program*	The project involves the construction of a commercial and retail development, including the following components: • Excavation of two basement parking levels • Construction of a six-storey building.	• Sydney Olympic Park metro station
4 Murray Rose Avenue, Sydney Olympic Park *Approved* *No construction program*	The project involves the demolition of existing structures and the construction of a six-storey commercial building, with three levels of basement car parking and associated landscaping.	• Sydney Olympic Park metro station
Residential development, 1 and 2 Murray Rose Avenue, Sydney Olympic Park *Approved* *No construction program*	The proposal involves the construction of two residential flat buildings, with a maximum height of 12 and 15 storeys respectively. The proposal also involves the construction of three levels of basement parking under both buildings and landscaping on both sites.	• Sydney Olympic Park metro station
2A and 2B Australia Avenue mixed-use towers, Sydney Olympic Park *Proposed* *No construction program*	The proposal involves the construction of two 30-storey mixed-use towers, with four levels of basement car parking. The Site 2A tower proposes a mix of hotel, child care facility, office and conference space. The Site 2B tower proposes a mix of retail, offices and apartments.	• Sydney Olympic Park metro station
Site 43/44, Sydney Olympic Park – Stage 1 and 2 (6 Australia Avenue and 2 Herb Elliot Avenue) *Approved* *No construction program*	The project involves the staged development of two mixed-use buildings for commercial and retail spaces, associated basement car parking, landscaping and driveway access.	• Sydney Olympic Park metro station
Site 67 Sydney Olympic Park (100 Bennelong Parkway) *Approved* *No construction program*	The project involves a multi-storey residential development comprising the following components: • Two buildings, with maximum heights of eight storeys and 10 storeys respectively and basement car parking • A childcare centre • Landscaping, access and public domain works.	• Sydney Olympic Park metro station

Project name, status, and expected construction period	Brief project description	Relevant locations where cumulative impacts may occur
Mixed-use development Site 68 Sydney Olympic Park (Corner of Bennelong Park and Australia Avenue) *Approved* *No construction program*	The project involves the staged development of a mixed-use development on the north-east corner of Bennelong Parkway and Australia Avenue comprising: • A 33-storey tower for residential, retail and commercial uses, with three levels of basement car parking • A child care centre building • A stormwater detention tank • Landscaping works.	• Sydney Olympic Park metro station
Site 53 Sydney Olympic Park (2 Figtree Drive) *Approved* *No construction program*	The project involves the construction of a mixed-use development comprising the following components: • Four residential buildings ranging in height between nine and 35 storeys with ground floor retail spaces and basement car parking • Landscaping, access and public domain works.	• Sydney Olympic Park metro station
Site 13 Commercial Building, Sydney Olympic Park (Corner of Sarah Durack Avenue and Olympic Boulevard) *Approved* *No construction program*	The project involves the construction of a five-storey commercial building, with ground-level retail spaces and basement car parking.	• Sydney Olympic Park metro station
Site 9 Sydney Olympic Park Mixed-Use Residential building (Corner of Sarah Durack Avenue and Olympic Boulevard) *Approved* *No construction program*	The project involves the construction of a 39-storey mixed-use development for residential, commercial and retail uses, including basement car parking and ground-level access, and public domain works.	• Sydney Olympic Park metro station
27-33 Everton Road Strathfield *Approved* *No construction program*	The project involves the alterations of an existing hotel including the following construction components: • Construction of two new commercial spaces • Construction of an eight-storey residential apartment building with basement car parking at the rear of the site above a ground-floor podium.	• Burwood North Station
MLC Senior School Centre – modification *Approved* *No construction program*	The project involves the redevelopment of the MLC Senior School Centre, including the following construction components: • Demolition of existing structures and vegetation • Construction of two new buildings • Alterations, additions and refurbishment of two existing buildings • Landscaping works.	• Burwood North Station
68-72 Railway Parade and 2-10 Oxford Street, Burwood *Approved* *No construction program*	The project involves the construction of an eight-storey building with basement car parking for mixed uses, including residential apartments and ground-floor retail space.	• Burwood North Station
17 Deane Street Burwood *Approved* *No construction program*	The project involves the construction of a 23-storey mixed-use building with basement car parking, including residential apartments, hotel accommodation and conference facilities, commercial and retail space, a child care centre, and a restaurant.	• Burwood North Station
Concord Oval redevelopment *Approved* *Construction program 2020 – 2021*	The project involves the redevelopment of Concord Oval including the following components: • Facilities for the West Tigers rugby club • Match-day facilities for local sporting clubs • Multi-use indoor and outdoor community and sport facilities • Covered seating for sports spectators • Informal outdoor sports areas • Shared use paths.	• Burwood North Station
Five Dock Streetscape Upgrade – Stage 2 *Approved* *Construction program 2019 – 2020*	The project involves streetscape upgrade works to Great North Road and local roads between Queens Road and Henry Street. The project involves the following components: • Installation of new pavements and street furnishings • Planting of street trees and shrubs • Drainage improvements.	• Five Dock Station
M4-M5 Link *Approved* *Construction program 2018 – 2023*	The M4-M5 Link component of WestConnex involves the construction and operation of twin tunnels between the New M4 at Haberfield and the New M5 at St Peters, with an interchange at Rozelle and tunnel connection to Victoria Road at Iron Cove. Components of the project relevant to this cumulative impact assessment include: • Wattle Street surface works • Rozelle surface works • Iron Cove Link surface works • Ventilation facilities at Rozelle and Iron Cove.	• Five Dock Station • The Bays Station
Sydney Metro City & Southwest (Chatswood to Sydenham) *Approved* *Construction program 2017 – 2024*	The Chatswood to Sydenham component of Sydney Metro City & Southwest Project involves the construction and operation of a 15.5 km metro line from Chatswood, under Sydney Harbour and through Sydney's CBD out to Sydenham. Components of the project relevant to this assessment include the White Bay truck marshalling yard.	• The Bays Station
Western Harbour Tunnel and Warringah Freeway Upgrade *Proposed* *Construction program 2023 – 2024*	The Western Harbour Tunnel and Warringah Freeway Upgrade project form part of the Western Harbour Tunnel and Beaches Link Program and comprise a new motorway tunnel connection across Sydney Harbour, and an upgrade of the Warringah Freeway to integrate the new motorway infrastructure with the existing road network, with a connection to the Beaches Link and Gore Hill Freeway Connection project. Components of the proposal relevant to this assessment include: • Construction activities at Rozelle Rail Yards • Construction activities at White Bay.	• The Bays Station
Glebe Island concrete batching plant and aggregate handling *Proposed* *No construction program*	This proposal is for the construction and operation of a new aggregate handling and concrete batching facility, with the capacity to produce up to one million cubic metres of concrete per annum.	• The Bays Station

Project name, status, and expected construction period	Brief project description	Relevant locations where cumulative impacts may occur
Glebe Island Multi-User Facility *Approved* *Construction program 2020 – 2021*	This proposal includes the construction and operation of a ship off-loading, storage and dispatch facility for bulk construction materials such as sand, aggregates and other dry bulk construction materials. The proposal site is located within land owned by the Port Authority on the eastern side of Glebe Island.	• The Bays Station
Extension to Longitude Office Building – 36 James Craig Road *Proposed* *No construction program*	This proposal involves alternations and extensions to an existing office building on James Craig Road, including: • 5-8 storey extension • Extension of existing floorplates • Internal alterations • Addition of green elements to facades and roof.	• The Bays Station

Table 3: Local strategic plans considered in the cumulative impact assessment

Local strategic plan	Brief description	Relevant locations where cumulative impacts might occur
Westmead Innovation District: Building Western Sydney's jobs engine Strategic Vision 2016-2036	The Westmead Strategic Vision 2016-2036 is a 20-year plan developed by the NSW Government and the Westmead Alliance to guide investment decisions that support the growth of Westmead as a world class medical, educational and research precinct. The Westmead metro station construction site is located within the area included in the Strategic Vision.	• Westmead metro station
Greater Parramatta Interim Land Use and Infrastructure Implementation Plan	The Greater Parramatta Interim Land Use and Infrastructure Implementation Plan outlines actions to support the delivery of new homes, jobs, services and infrastructure in the Greater Parramatta area. It includes a land use framework to guide future redevelopment of the priority growth area, identifies key actions for the short term and allows us and other government agencies to identify and plan for the infrastructure required. A number of construction footprints for Stage 1 are located in the suburbs included in the District Plan, including Westmead, Parramatta, Clyde, Silverwater, Sydney Olympic Park and North Strathfield.	• Westmead metro station • Parramatta metro station • Clyde stabling and maintenance facility • Silverwater services facility • Sydney Olympic Park metro station • North Strathfield metro station
Parramatta North Urban Renewal Area Plan	The Parramatta North Urban Renewal Area Plan is a rezoning plan for government-owned land in Parramatta North developed by the NSW Government and Infrastructure NSW. Key features of the plan include provisions for the adaptive reuse of heritage items, the development of a village centre and the construction of around 3,000 homes. The Stage 1 construction footprints for Westmead metro station and Parramatta metro station are near land included in the Parramatta North Urban Renewal Area Plan.	• Westmead metro station • Parramatta metro station
City of Parramatta Civic Link Framework Plan	The Civic Link Framework Plan provides a long-term aspiration, strategies, design ideas and recommendations for Parramatta's new public open space. The Civic Link extends about 500 metres long from Parramatta Square to River Square and the broader foreshore precinct. This new public open space runs along the existing Horwood Place alignment and will be made possible by the redevelopment of the above-ground Council-owned Horwood Place car park.	• Parramatta metro station
Draft Camellia Town Centre Master Plan	The Draft Camellia Town Centre Master Plan is a 20 to 30 year plan developed by the NSW Government to establish a new town centre in Camellia. The draft Plan focuses on the establishment of Camellia Town Centre to ensure the renewal occurs in tandem with access and transport improvements, such as a bridge across Parramatta River, road improvements, and the creation of walking and cycling paths. The Stage 1 construction footprint for Clyde stabling and maintenance facility is near land included in the Draft Camellia Town Centre Master Plan.	• Clyde stabling and maintenance facility • Silverwater services facility
Sydney Olympic Park Master Plan 2030	The Sydney Olympic Park Master Plan 2030 is a plan developed by the NSW Government to identify opportunities to transform the precinct into a thriving urban centre. The Master Plan includes the development of a new school, five additional or enhanced parks, employment opportunities, residential communities and retail developments. The Stage 1 construction footprint for Sydney Olympic Park metro station is located within the area included in the Master Plan. The Stage 1 construction footprints for Silverwater services facility and North Strathfield metro station are near land included in the Master Plan.	• Sydney Olympic Park metro station • Silverwater services facility • North Strathfield metro station
Burwood, Strathfield and Homebush Planned Precinct	The NSW Government is in the process of developing a precinct plan to guide land use controls and inform future development within the suburbs of Burwood, Strathfield and Homebush. It will build on the Parramatta Road Corridor Urban Transformation Strategy and will be developed in conjunction with the City of Canada Bay, Burwood and Strathfield Councils. The Stage 1 construction footprints for North Strathfield metro station and Burwood North metro station are likely to be located within land included in the future precinct plan. The Stage 1 construction footprint for Sydney Olympic Park metro station is likely to be near land included in the future plan.	• Sydney Olympic Park metro station • North Strathfield metro station • Burwood North Station
Parramatta Road Corridor Urban Transformation Strategy	The Parramatta Road Corridor Urban Transformation Strategy is a 30-year plan developed by the NSW Government and Landcom to drive and inform land use planning and development decisions as well as long-term infrastructure delivery programs in the Parramatta Road Corridor. The Stage 1 construction footprint for Burwood North metro station is located within land included in the Strategy.	• Burwood North Station
Five Dock Urban Design Study	The Five Dock Town Centre Urban Design Study was commissioned by the City of Canada Bay Council in 2013. The purpose of the Urban Design Study is to ensure that any potential changes to the existing planning controls were carefully considered, to identify improvements to the public domain, and consider opportunities for future redevelopment within the centre. The Stage 1 construction footprint for Five Dock Station is located within land included in the Urban Design Study.	• Five Dock Station
The Bays Precinct Urban Transformation Plan	This 20 to 30 year plan provides for a mix of cultural, maritime, recreational, retail and commercial uses around eight waterfront locations including White Bay Power Station, Glebe Island, White Bay, Blackwattle (including Sydney Fish Market), Wentworth Park, Rozelle Bay, and Rozelle rail yards. Infrastructure NSW is currently conducting studies to inform development of The Bays Markets District (Blackwattle Bay) and White Bay Power Station, which cover locations relevant to this assessment.	• The Bays Station

1.5 Location of projects assessed relative to Stage 1 construction sites

1.5.1 Westmead metro station construction site

Projects near Westmead metro station construction site considered in the cumulative impact assessment are shown in Figure 2.

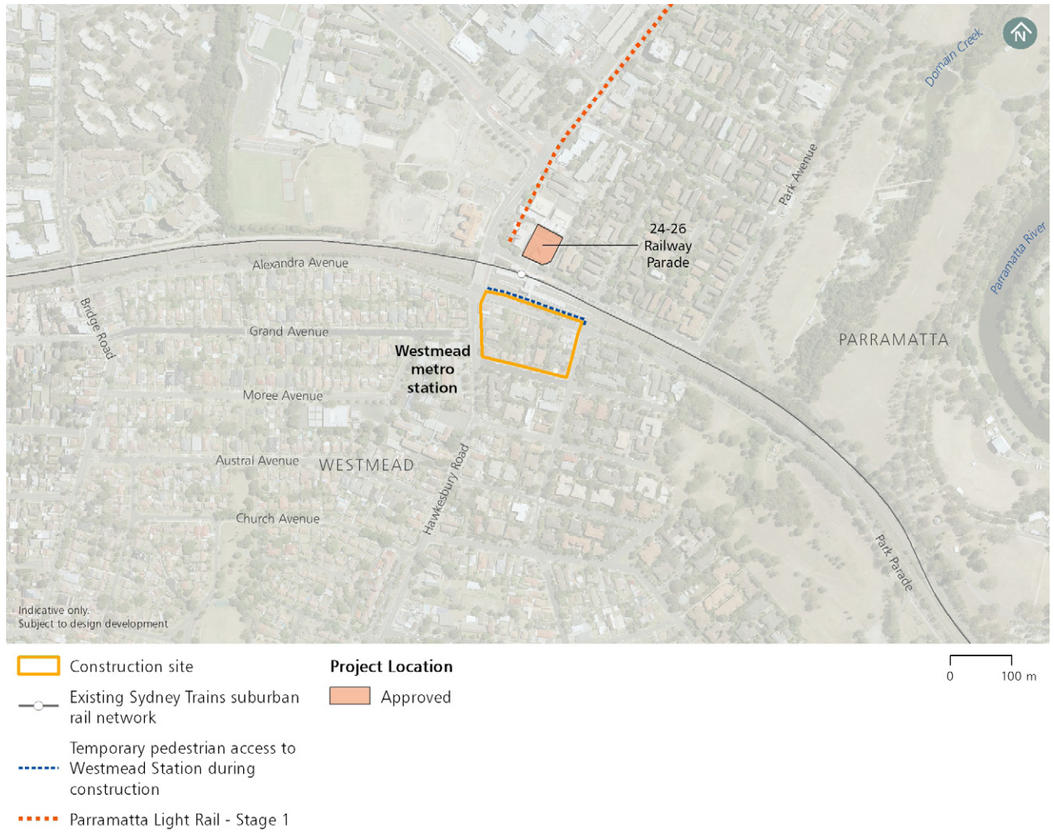

Figure 2: Projects near Westmead metro station construction site considered in cumulative impact assessment

1.5.2 Parramatta metro station construction site

Projects near Parramatta metro station construction site considered in the cumulative impact assessment are shown in Figure 3.

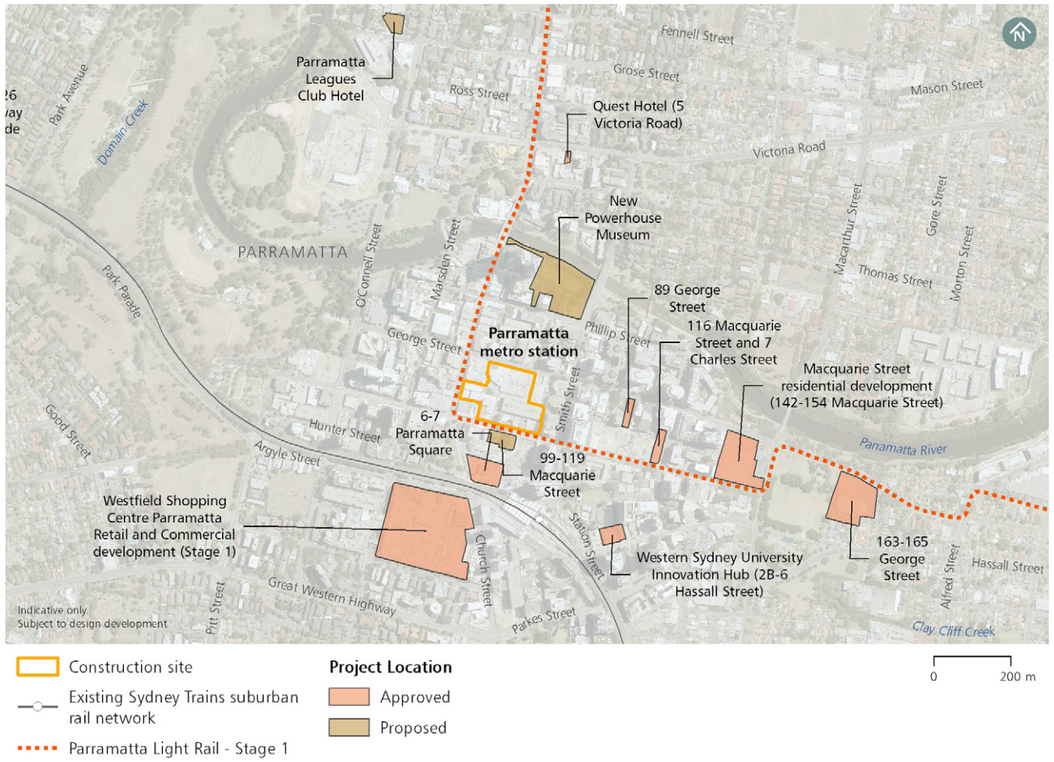

Figure 3: Projects near Parramatta metro station construction site considered in cumulative impact assessment

1.5.3 Clyde stabling and maintenance facility

Projects near Clyde stabling and maintenance facility construction site considered in the cumulative impact assessment are shown in Figure 4.

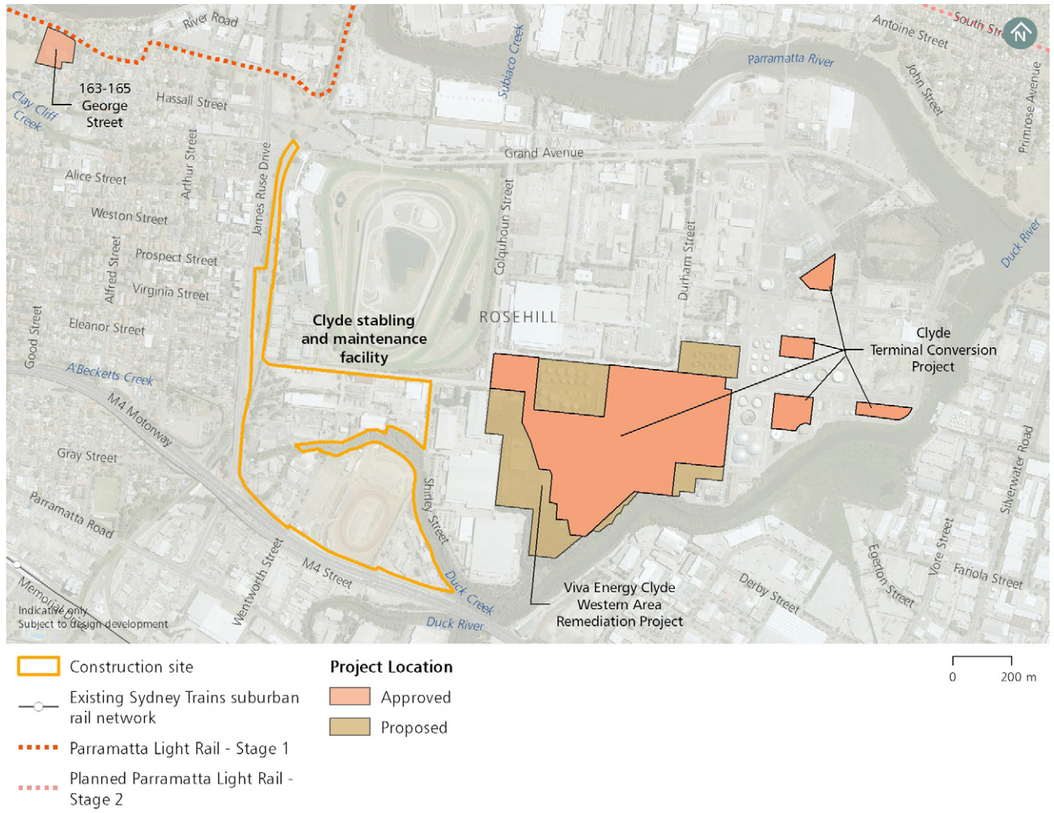

Figure 4: Projects near Clyde stabling and maintenance facility construction site considered in cumulative impact assessment

1.5.4 Silverwater services facility construction site

Projects near Silverwater services facility construction site considered in the cumulative impact assessment are shown in Figure 5.

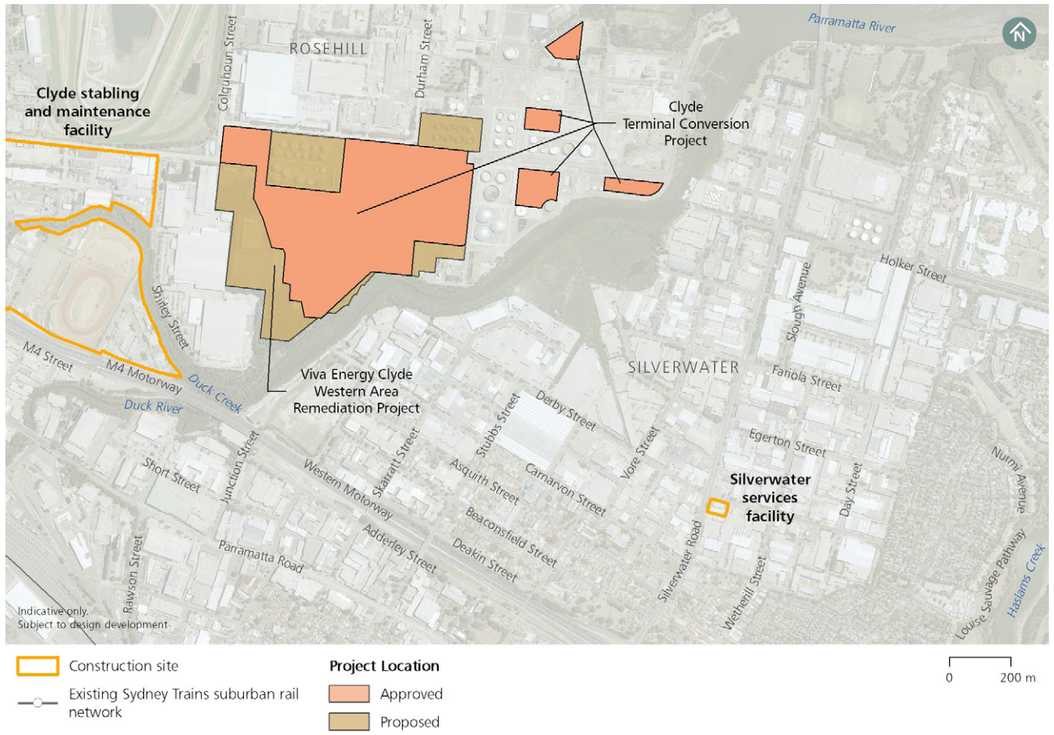

Figure 5: Projects near Silverwater services facility construction site considered in cumulative impact assessment

1.5.5 Sydney Olympic Park metro station construction site

Projects near Sydney Olympic Park metro station construction site considered in the cumulative impact assessment are shown in Figure 6.

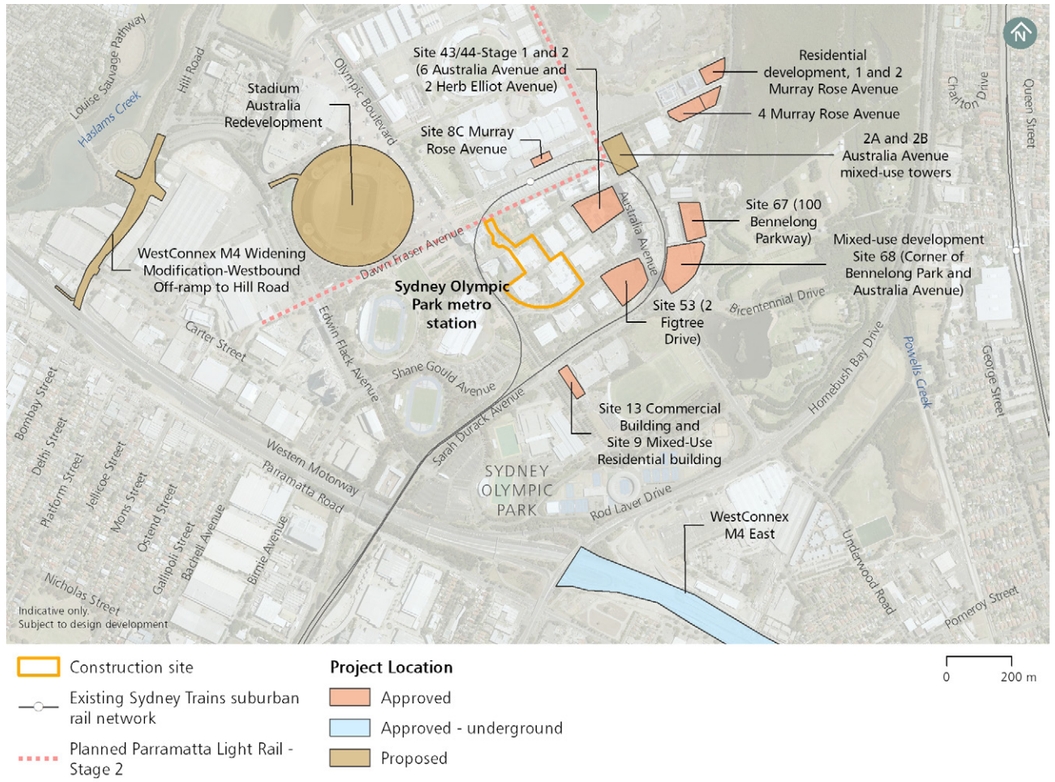

Figure 6: Projects near Sydney Olympic Park metro station construction site considered in cumulative impact assessment

1.5.6 North Strathfield metro station construction site

Projects near North Strathfield metro station construction site considered in the cumulative impact assessment are shown in Figure 7.

Figure 7: Projects near North Strathfield metro station construction site considered in cumulative impact assessment

1.5.7 Burwood North Station construction site

Projects near Burwood North Station construction site considered in the cumulative impact assessment are shown in Figure 8.

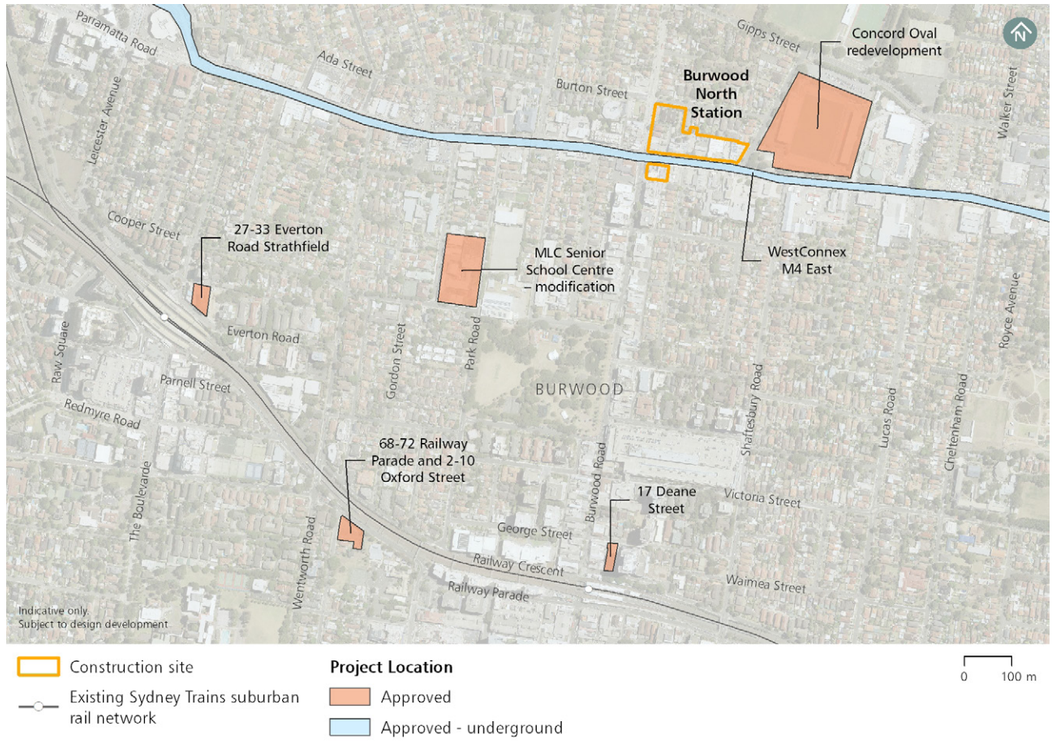

Figure 8: Projects near Burwood North Station construction site considered in cumulative impact assessment

1.5.8 Five Dock Station construction site

Projects near Five Dock Station construction site considered in the cumulative impact assessment are shown in Figure 9.

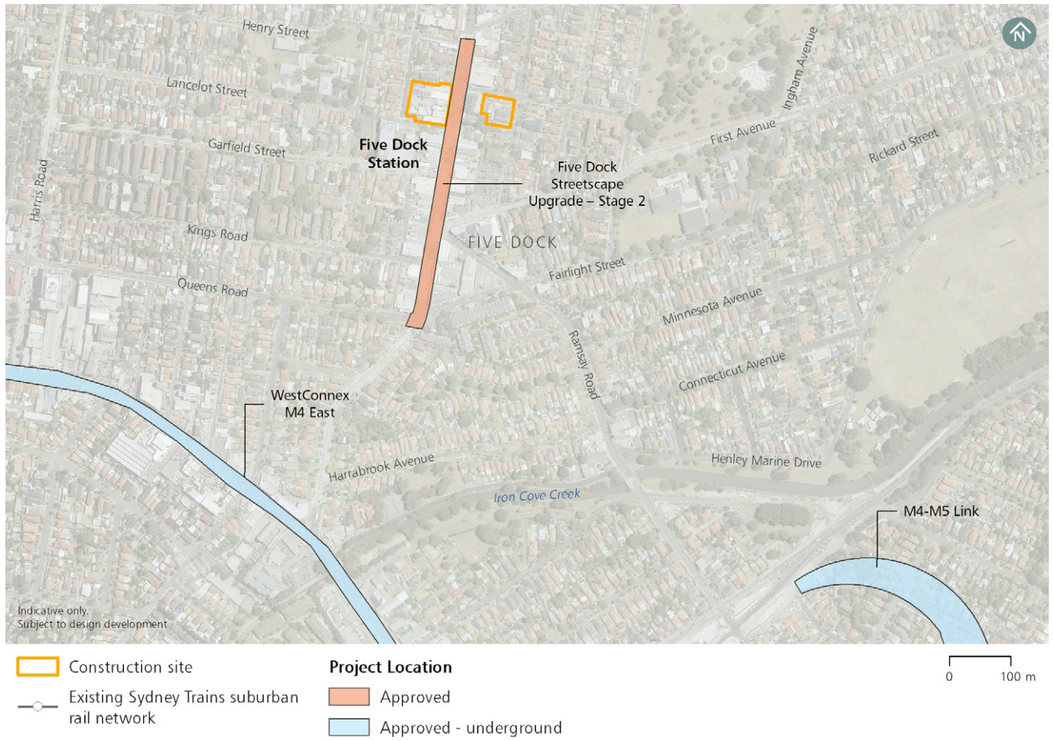

Figure 9: Projects near Five Dock Station construction site considered in cumulative impact assessment

1.5.9 The Bays Station construction site

Projects near The Bays Station construction site considered in the cumulative impact assessment are shown in Figure 10.

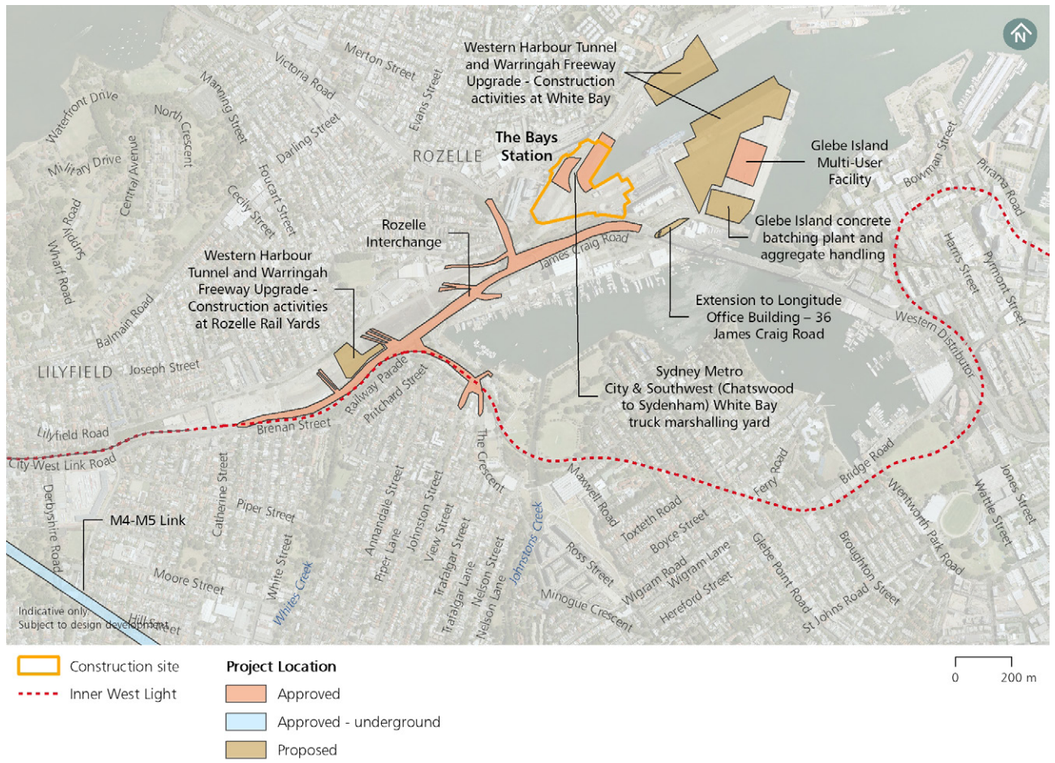

Figure 10: Projects near The Bays Station construction site considered in cumulative impact assessment

1.6 Mitigation measures

Where the cumulative impact assessment in Chapters 10 to 25 predicts impacts that would require the implementation of mitigation measures to address cumulative impacts, these measures are included in each respective chapter where the cumulative impact has been assessed.

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Appendix H

Services facility between Five Dock and The Bays

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Services facility between Five Dock and The Bays

Existing case studies

Services facilities similar to the one proposed between Five Dock Station and The Bays Station have been previously constructed at Epping and Cheltenham for the Metro North West Line. The Epping and Cheltenham services facilities provide tunnel ventilation and emergency access and egress to the metro rail tunnels. Construction works for these services facilities associated with shaft excavation and tunnelling at the construction sites included:

- Construction of temporary acoustic sheds (maximum height of 15 metres)
- Excavation of shafts
- Removal of spoil
- Support for roadheader tunnel excavation works
- Construction support facilities (such as workshops, equipment laydown, spoil handling and storage facilities, site offices, car parking, water treatment plant)
- Provision of temporary power supply routes (4.3 Mega Volt Ampere at each site)
- Tunnel boring machine retrieval (Epping construction site only).

While the construction works were similar at both Epping and Cheltenham construction sites, the size and locational context of the sites were substantially different. The characteristics of both construction sites are outlined in the following sections.

Epping services facility

The Epping services facility construction site had a construction footprint of about 3,400 metres with a construction duration (associated with shaft excavation) of about 24 months. The below ground shaft structure was constructed to depths of about 20 metres with a surface footprint of about 15 metres by 20 metres.

The construction site was located on land zoned for local business under the Hornsby Local Environmental Plan 2011 on the western side of Beecroft Road within the established town centre of Epping. Establishment of the construction site involved the demolition of a commercial building, and the car park access for three additional commercial buildings. The Epping commercial area is centred on the existing Sydney Trains railway station and provides a mix of smaller scale retail, cafes, restaurants, heath services, community facilities and medium to high density residential development, with surrounding lower density residential dwellings.

The closest sensitive receivers to the construction site were residential dwellings about 20 metres from the construction site boundary.

Cheltenham services facility

The Cheltenham services facility construction site had a construction footprint of about 12,000 square metres with a construction duration (associated with shaft excavation) of about 20 months. The below ground shaft structure was constructed to depths of about 35 metres with a surface footprint of about 20 metres by 20 metres.

The construction site was located in an area of open space zoned for public recreation under the Hornsby LEP 2011, incorporating the netball courts at Cheltenham Oval and some vegetation associated with Beecroft Reserve. The locality is characterised by low density residential dwellings surrounded by areas of established vegetation, open space and recreational areas, with no designated employment uses within the immediate area.

A number of aged care facilities were located in the vicinity of the construction site, including Beecroft Nursing Home and Chesalon Care Beecroft. The closest sensitive receivers to the construction site were residential dwellings about 30 metres away from the construction site boundary.

Types of construction impacts

The types of construction impacts predicted (as part of the North West Rail Link – Major Civil Construction Works Environmental Impact Statement) at the Epping and Cheltenham construction sites are outlined in the following sections. This information has been supplemented by community feedback provided during construction at these sites and by the results of monitoring during construction where data is available.

Construction traffic

The potential construction traffic impacts from both construction sites were predicted to arise primarily from the addition of heavy vehicles and light vehicles (cars and utes) onto surrounding roads. Eighty heavy vehicle movements and 34 light vehicle movements per day were predicted for the Epping construction sites, with 68 heavy vehicle movements and 34 light vehicle movements predicted for the Cheltenham construction sites. These vehicle movements were assessed as having:

- Minimal impacts on traffic congestion and on local intersection performance
- Minimal impacts on bus services, pedestrians and cyclists.

Existing on and off street car parking was also identified as being potentially affected from construction works and/or construction worker vehicle parking.

Community feedback provided during construction works on construction traffic at the Cheltenham construction site was limited to temporary changes to traffic access and construction traffic behaviour on local roads. There was no community feedback provided during construction works on construction traffic at the Epping construction site.

Construction noise and vibration

Construction noise at the Epping construction site was expected to be largely compliant with noise management levels set in the Environmental Impact Statement. Low, moderate and high exceedances for the closest residential receivers (about 20 metres away) were anticipated during some daytime works and limited evening works, with low to moderate exceedances expected for the closest commercial and educational receivers (about five metres and 135 metres away respectively) during limited daytime works.

Construction noise at the Cheltenham construction site was also expected to be largely compliant with noise management levels. Moderate to high exceedances were anticipated for the closest residential receivers (about 30 metres away) during some daytime works, with low exceedances for the closest recreational receivers (about 15 metres away).

Both construction sites were predicted to have a low risk of sleep disturbance and ground-borne noise impacts for surrounding receivers, with the potential for perceptible ground-borne vibration due to the proximity of the closest receivers (commercial receivers at the Epping construction site and residential receivers at the Cheltenham construction site).

During works, construction noise was monitored at various locations within and around both construction sites during construction works in response to community feedback. Noise levels were found to be compliant with the noise management levels during all monitoring.

Non-Aboriginal and Aboriginal heritage

Impacts to Non-Aboriginal heritage were predicted to involve limited impacts to a small number of local heritage items near the Epping and Cheltenham construction sites. The area around the Epping construction site was characterised by late nineteenth and early twentieth century residential development, and the Cheltenham construction site was located within the Beecroft/Cheltenham Heritage Conservation Area as identified in the Hornsby Local Environmental Plan 2011.

No impacts to Aboriginal heritage were predicted as a result of the Epping construction site, with limited potential for impacts at the Cheltenham construction site. Impacts to both Non-Aboriginal and Aboriginal heritage were expected to be successfully managed through the mitigation measures provided in the Environmental Impact Statement. No community feedback was provided on Non-Aboriginal or Aboriginal heritage matters during construction at the Epping and Cheltenham construction sites.

Property and land use

The Epping construction site resulted in a change in land use from a commercial area to a construction site for the duration of construction. It required the demolition of one commercial building, with the potential construction impacts to an additional four commercial buildings in the vicinity of the construction site. The construction site was located within the area covered by the Epping Town Centre Study and required modifications to the future town planning included in this study.

The Cheltenham construction site resulted in a change in land use from an open recreational space to a construction site for the duration of construction. It required the temporary removal of Cheltenham Netball Courts and associated facilities and the removal of vegetation within Beecroft Reserve. No residential or commercial properties were acquired at this location.

No community feedback was provided on property and land use matters during construction at the Epping and Cheltenham construction sites.

Landscape character and visual amenity

Landscape character and visual amenity impacts at the Epping and Cheltenham construction sites were expected to be limited to negligible to minor temporary impacts as a result of the visibility of structures, equipment and construction works at the sites. Vegetation removal adjacent to the construction sites and construction traffic on local roads was also expected to have landscape and visual impacts at both locations. The Cheltenham construction site had the potential for moderate impacts on recreational receivers at Cheltenham Oval and Beecroft Reserve due to the proximity of these facilities to the construction site.

Community feedback during construction regarding landscape character and visual amenity matters was limited to night-time visual impacts associated with lighting at the Epping construction site.

Social impacts

Social impacts at the Epping construction site were expected to be limited to reduced amenity at nearby community facilities including places of worship, educational establishments and a scout hall. Social impacts at the Cheltenham construction site were expected to include the loss of active recreation facilities, including Cheltenham Netball Courts, cricket nets and a playground. Reduced amenity was expected at the nearby Cheltenham Oval and on walking trails and bike tracks within Beecroft Reserve.

No community feedback was provided on social impact matters during construction at the Epping and Cheltenham construction sites.

Business impacts

Business impacts at the Epping construction site were expected to include benefits to local retail, accommodation, cafes, restaurants and the health and community services sector as a result of increased expenditure and patronage from construction workers. Construction noise and air quality impacts were predicted to result in a temporary reduction in amenity for nearby outdoor cafes, food outlets and eateries, with potential reduced accessibility to businesses caused by heavy vehicle movements on local roads.

There were no business impacts expected at the Cheltenham construction site, as it was located in a predominantly residential area with no businesses nearby.

No community feedback was provided on business impact matters during construction at the Epping and Cheltenham construction sites.

Groundwater and ground movement

No groundwater drawdown impacts were expected as a result of the Epping and Cheltenham construction sites, with limited potential for ground movement and groundwater seepage impacts identified.

No community feedback was provided on groundwater or ground movement matters during construction at the Epping and Cheltenham construction sites.

Soils and surface water quality

Both Epping and Cheltenham construction sites were located in the Devlins Creek catchment. Soils and surface water quality impacts at both construction sites were predicted to include potential erosion caused by excavation activities and sediment transport into stormwater and nearby waterbodies within the catchment. These potential impacts were expected to be successfully managed through the standard soils and water quality mitigation measures provided in the Environmental Impact Statement.

No community feedback was received during construction at the Cheltenham or Epping sites regarding soils and surface water quality impacts.

Contamination

The Environmental Impact Statement predicted a low likelihood of encountering contamination at both the Epping and Cheltenham construction sites, with any potential impacts to be managed through the mitigation measures provided in the Environmental Impact Statement.

No community feedback was provided on contamination matters during construction at the Epping and Cheltenham construction sites.

Hydrology and flooding

The Epping and Cheltenham construction sites were predicted to alter the extent of impervious surfaces in the local area, with potential impacts for catchment response times during flooding events. These potential impacts were expected to be successfully managed by the mitigation measures provided in the Environmental Impact Statement, including the design of construction sites to account for potential flooding risks and the implementation of stormwater discharge controls.

No community feedback was provided on hydrology and flooding matters during construction at the Epping and Cheltenham construction sites.

Biodiversity

Limited temporary impacts to street trees were expected at the Epping construction site due to its location within the Epping town centre. Biodiversity impacts at the Cheltenham construction site were expected to include a temporary reduction in public open bushland space and potential temporary habitat disturbance. These potential impacts at both construction sites were expected to be successfully managed by the mitigation measures provided in the Environmental Impact Statement, including the use of offsets and replanting of vegetation following construction.

Community feedback was received during construction at both the Epping and Cheltenham construction sites regarding the removal of trees during construction.

Air quality

Air quality impacts at both construction sites were predicted to include dust generation and emissions from construction plant and vehicles that may affect surrounding residential, community and recreational receivers. These potential impacts were expected to be successfully managed through the standard air quality mitigation measures provided in the Environmental Impact Statement.

Community feedback was received during construction at both the Epping and Cheltenham construction sites regarding visible dust generation during construction. Inspections were carried out at a number of properties in the vicinity of the Epping construction site in response to community feedback, at which time construction dust was not visible.

Spoil and waste management

The Epping construction site was expected to produce about 5,600 cubic metres of spoil, and the Cheltenham construction site was expected to produce about 12,000 cubic metres of spoil. Spoil and waste generated at the construction sites was expected to be successfully managed through the standard spoil and waste mitigation measures provided in the Environmental Impact Statement.

No community feedback was provided on spoil and waste management matters during construction at the Epping and Cheltenham construction sites.

Services facility between Five Dock and The Bays

The case studies provided by the Epping and Cheltenham services facilities and the qualitative assessment of a services facility between Five Dock and The Bays (in Table 1) indicate that construction of this type of facility is able to be carried out with limited environmental impacts and can be managed using common construction mitigation measures. The site would also be managed in accordance with the Sydney Metro suite of environmental management documents including the Construction Environmental Management Framework, the Construction Traffic Management Framework and the Construction Noise and Vibration Strategy, as well as the relevant mitigation measures and performance outcomes identified in this Environmental Impact Statement.

These case studies and the assessment undertaken in this Environmental Impact Statement for the construction of similar facilities at Silverwater and Rosehill for Sydney Metro West have been applied to the proposed construction of a services facility between Five Dock and The Bays. The types of potential impacts for this construction site are outlined in Table 1. It is unlikely that all the potential types of impacts identified would be realised. The actual impacts during Stage 1 construction works would depend on the preferred location of the facility. For example, potential impacts such as the relocation of bus stops would only occur if the preferred facility was located directly adjacent to an existing bus stop.

Table 1: Types of potential impacts associated with Stage 1 construction works for a services facility between Five Dock and The Bays

Aspect	Type of potential impact
Construction traffic	Construction traffic volumes are likely to be relatively minor and would be managed in accordance with the Construction Traffic Management Framework. Potential impacts would be reduced through measures such as reducing construction vehicles in network peak periods and minimising the interface with high volume pedestrian areas. Potential impacts would include: • Temporary road network impacts due to heavy and light vehicle movements • Potential temporary loss of on-street parking in the immediate vicinity of the construction site • Potential temporary reduced and/or altered pedestrian and cycle access • Potential temporary relocation of bus stops, taxi ranks and/or kiss and ride areas, including route diversions • Potential temporary alternative access requirements for private properties and businesses in the immediate vicinity of the construction site.
Construction noise and vibration	Construction works for the services facility would typically be undertaken during standard daytime construction hours. The Epping and Cheltenham case studies identified that some construction works could comply with the relevant noise management levels with some works resulting in moderate to high exceedances. Potential construction noise and vibration impacts would be managed in accordance with the Construction Noise and Vibration Strategy. Potential impacts would include: • Temporary airborne noise impacts, particularly associated with noisy works such as rock breaking and piling • Limited temporary ground-borne noise and vibration impacts on sensitive receivers.
Non-Aboriginal and Aboriginal heritage	Based on the locational and design criteria in Chapter 9 (Stage 1 description) of this Environment Impact Statement, the facility would avoid direct impacts to item listed in the State heritage register and would not directly impact on significant elements of the local listed item. Potential impacts would include: • Potential direct impacts to local listed Non-Aboriginal and Aboriginal heritage items during construction • Potential indirect visual impacts where heritage items may be located adjacent to the construction site.
Property and land use	Based on the locational and design criteria in Chapter 9 (Stage 1 description) of this Environment Impact Statement, the facility would not be located on existing residential land. The amount of land required for construction would be minimised as far as possible and would be co-located with the permanent infrastructure footprint. Potential impacts would include: • Property acquisition for the construction site. Property acquisitions would be managed in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and the land acquisition reforms implemented by the NSW Government. Sydney Metro would offer assistance and support throughout the acquisition process to those directly impacted. • Land use change from the current land use (such as commercial, industrial or open space) to a construction site. Due to the size of the facility, this land use change would be relatively minor.
Landscape character and visual amenity	Potential landscape and visual impacts would be minimised as far as possible. For example, the removal of vegetation and street trees would be minimised and the construction site would be planned to minimise visible elements. Potential impacts would include: • Potential impacts associated with removal of vegetation and introduction of a temporary construction site to existing residential, commercial or recreation areas which may contrast in scale and character • Temporary alteration to footpaths, street and precinct arrangements with potential temporary impacts to local wayfinding, accessibility or legibility.
Social impacts	The construction site would be planned to avoid or minimise impacts to community facilities where possible. Potential social impacts would be minimised through the implementation of standard mitigation measures for amenity related impacts. Potential impacts would include: Potential temporary disruption to pedestrian and vehicle movements, changes to road and public transport routes and access patterns, changed wayfinding and pedestrian accessibility, resulting in potential temporary disruption to daily routines Potential temporary perceived safety impacts associated with changed sightlines, changes to wayfinding, the reduced (or increased) activation of construction precincts at night, and the influx of unfamiliar construction workers to neighbourhoods, particularly if the construction site is located close to sensitive receivers (e.g. schools, childcare centres, nursing homes) • Potential temporary reduced car parking, resulting in increased inconvenience and disruption • Potential temporary changes to access to local retail, community facilities and recreation facilities • Potential temporary perceived changes to sense of community associated with property acquisition and introduction of the construction site.
Business impacts	Where possible, direct impacts to businesses would be avoided. Potential indirect local business impacts would be minimised through the implementation of standard mitigation measures for amenity related impacts. Potential impacts would include: • Potential temporary amenity impacts to businesses in the immediate vicinity of the construction site. Businesses that are located on busier roads may be less susceptible to amenity impacts due to the existing lower amenity from high traffic volumes compared to quieter local roads • Potential temporary access impacts to local businesses due to potential parking losses or potential traffic congestion during heavy vehicle movements.
Groundwater and ground movement	Due to the small scale of the shaft required for the future services facility, the potential for impacts associated with ground movement and groundwater drawdown is low.
Soils and surface water quality	Due to the small scale of the construction site and excavation works, potential impacts associated with soils and water quality would be minor and manageable through the implementation of standard mitigation measures identified in Chapter 19 (Soils and surface water quality – Stage 1) of this Environmental Impact Statement. Potential impacts would include: • Potential soil erosion from the temporary exposure of soil to water runoff and wind through the removal of vegetation, overlying structures (such as buildings and footpaths) and excavation works • Potential disturbance of saline or acid sulfate soils • Potential mobilisation of soils and/or contaminants into stormwater runoff and nearby watercourses.

Aspect	Type of potential impact
Contamination	There is potential for contamination to be present on the site due to former or current land uses. Any potential contamination would be manageable through standard management and mitigation measures identified in Chapter 20 (Contamination – Stage 1) of this Environmental Impact Statement. Potential impacts would include: • Potential introduction of minor volumes of contaminants during construction associated with leaks and spills from construction plant and equipment • Potential disturbance of contaminants during construction works associated with former and current land uses.
Hydrology and flooding	Due to the small scale of the construction site, potential hydrology and flooding impacts would be minor and manageable through standard measures. Potential impacts would include: • Potential temporary minor impacts to existing flooding behaviour through the disruption of existing drainage conditions, floodplain storage and/or overland flow paths by temporary construction site infrastructure • Potential temporary minor increase in runoff volumes following rainfall events due to an increase in impervious surfaces at the construction site.
Biodiversity	The location between Five Dock Station and The Bays Station is generally an urban environment and has been subject to previous development. As a result, biodiversity impacts are unlikely to occur or would be minor. In addition, based on the locational and design criteria in Chapter 9 (Stage 1 description) of this Environment Impact Statement, the facility would not impact vegetation that constitutes a locally occurring Plant Community Type. If vegetation clearing is required for the site potential impacts would include potential disturbance of native vegetation, habitat, species and ecosystems. These impacts are likely to be confined to a small isolated area and the biodiversity would be negligible.
Air quality	Due to the small scale of the construction site and excavation works, potential air quality impacts would be minor and manageable through the implementation of standard mitigation measures identified in Chapter 23 (Air quality – Stage 1) of this Environmental Impact Statement. Potential impacts would include potential temporary nuisance and human health impacts of construction dust and exhaust emissions generated during construction works, which would be managed appropriately through mitigation strategies.
Spoil and waste management	Construction and excavation works would generate relatively minor volumes of spoil and general construction waste. The spoil volume would likely be less than 40,000 cubic metres. This would be managed in accordance with standard mitigation measures identified in Chapter 24 (Spoil, waste management and resource use – Stage 1) of this Environmental Impact Statement.

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